9. Infections and sports

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Summary

In general, physical activity in association with infections is accompanied by certain medical risks, in part for the infected individual, in part for other athletic practitioners who can be infected. The latter is primarily relevant to team sports, but also other sports where the athletes have close physical contact, before, during or after training and competition. Both of these aspects are discussed in this chapter. Furthermore, suggestions on guidelines are provided, which primarily pertain to adult individuals, to counselling for healthcare personnel as well as others in the management and counselling of athletes affected by acute infections. Lastly, concrete retraining programmes are proposed after mononucleosis, which can also be used after pneumonia and other powerful infections.

Definitions, occurrence and causes

The infections that are in question in sports medicine in the Nordic region are caused by viruses or bacteria. Infections are very common, especially upper respiratory infections. Among these, the common cold is dominant. They are caused by viruses and are largely complication-free and self-healing, but sometimes bacteria can "take over" and give rise to complications such as sinus infections, ear infections and, in worst case, pneumonia. Sore throats (tonsillopharyngitis) are also most often caused by different viruses, but sometimes it is a matter of an infection by beta-streptococci, which requires antibiotic treatment. Mononucleosis is a special form of sore throat. It is viral, often has an extended course of disease and requires extra attention with careful follow-up and special advice to athletes. Infections of the heart muscle (myocarditis) can be caused by multiple viruses and bacteria, and like mononucleosis, constitute a special problem area in sports medicine,

requiring specialist treatment. Mononucleosis and myocarditis are therefore discussed in separate sections. Acute diarrhoea diseases (gastroenteritis) always give rise to fluid loss, which more or less affects performance capacity.

Infections of the skin and soft tissue requiring treatment are more common among athletes than the average population, although it is most often a matter of skin damage, such as scrapes, that seldom obstruct training and competition. Epidermophytosis (athlete's foot) is also common. The herpes virus causes small blisters on the skin, most often around the mouth, but also in other places. Herpes is not more common among athletes than others, but in contact sports can spread to other athletes. Infection to opponents and teammates occurs through small cracks in the skin. Herpes gladiatorum is classic, where blisters develop at several different places where the skin has been damaged.

A borrelia infection in the skin (erythema migrans) is seen among athletes exposed to tick bites. Borrelia can sometimes spread to the inner organs. Ticks can also transmit viral encephalitis (tick-borne encephalitis, TBE) within certain geographical areas. Borrelia can be cured with antibiotics and an effective vaccine exists to prevent TBE.

Symptoms, diagnostics, treatment and complications

The symptoms of infection are primarily due to the immune system's reaction to viruses and bacteria, and are signs that the body reacts normally. The symptoms of the common cold are known to all. Irritation of the nasal mucous membrane with a running nose and nasal congestion with or without a sore throat are most common as well as bronchitis with coughing and hoarseness in worse colds. Body temperature is normal or only slightly raised. In these cases, antibiotic treatment should be avoided.

Viruses that accumulate in the surface of the mucous membrane (epithel layer) damage it. Bacteria can then more easily gain a foothold and cause complications to the cold such as an **ear infection** (otitis media) and a **sinus infection** (sinusitis). A feeling of having an ear blockage, reduced hearing and pain in the ear and, respectively, thick green-yellow mucous and pressure at the base of the nose and cheeks with or without a fever are then common symptoms. With these conditions, anti-inflammatory preparations for the mucous membranes and, as a rule, antibiotic treatment are administered.

Bacterial tonsillitis (tonsillopharyngitis caused by beta-streptococci) usually starts abruptly with a fever, often up to 39 degrees, and painful swallowing in contrast to viral throat infections. There is no cough or rhinitis. The tonsils are swollen and red, often with yellow pus clots. As a rule, the soft palate and palatal arches are intensively red, usually with elements of skin bleeding (petechiae). There are often distinctly tender lymph nodes in the mandibular angles. Bacteria can be directly indicated with the help of a rapid test or culture from the throat. A more or less pronounced polymorphonuclear leukocytosis develops in the blood and the C-reactive protein (CRP) increases (an increase is a sign of inflammation or infection). Treatment is given with penicillin V (Kåvepenin®) for 10 days. With a shorter period of treatment, the risk of relapse is greater. For those allergic to penicillin, clindamycin (Dalacin®) is suggested instead.

With **viral tonsillopharyngitis,** onset is less sudden and the throat symptoms not quite as marked as a rule. Rhinitis/nasal congestion and/or a cough are also often present. Fever may or may not be present. The reddening of the mucous membrane is paler than with streptococcal tonsillitis. Grey-white clots occur in the tonsils. Several respiratory viruses can be the cause, such as an adenovirus. Tests to establish this, as well as some other respiratory viruses that can have similar symptoms, exist but are not used, since treatment against these viruses does not exist and the infection is self-healing. In tonsillopharyngitis among athletes, particularly when there is no simultaneous rhinitis, hoarseness or cough, it is wise to test for beta-streptococci, since the clinical presentation is not always typical and a streptococcus infection needs to be treated with antibiotics.

Acute diarrhoea (gastroenteritis) can be caused by a virus, bacteria or parasites and is associated with more or less fluid loss. The ensuing dehydration, which can give rise to reduced plasma volume, as well as the general impact of the infection reduces performance capacity. Additional fluid loss through sweating in connection with physical exertion can lead to a collapse. Undiagnosed heart disease can also manifest itself. Myocarditis can occasionally occur as a complication of infectious gastroenteritis.

Herpes blisters (herpes simplex-virus) are the most common form of "mouth ulcers", but also occur at other places on the skin. They are self-healing, but have a tendency to return often among certain people. Early, local treatment with virus-inhibiting cream/ointment can be tried. Specific antiviral substances in tablet form or as an injection exist against herpes simplex, but are only used in special cases, for example, for persons with sharply reduced infection defence or in serious herpes illness such as encephalitis. In sports, special measures are required in outbreaks of herpes blisters in the skin among practitioners of contact sports.

Borrelia of the skin (skin borreliosis, erythema migrans) presents itself as a growing redness at the site of a tick bite. Redness caused by borrelia will, as a rule, present 4–5 days after the bite at the earliest, but sometimes first becomes visible after up to four weeks afterwards. It then grows in a ring shape for a few weeks and at the same time fades in the centre. On the arms and legs, it often appears more as red garlands than as a ring. Early redness within a few days at a tick bite is, however, a general bite reaction, which does not need to be treated unless it continues to grow in extent.

Most people who have skin borreliosis do not know that they have been bitten by a tick. A person that has a slowly growing redness somewhere on the body can have borreliosis, but it can also be due to many other conditions such as a fungal infection, eczema or other special skin diseases. Serologic tests are unreliable for skin borreliosis, which is therefore a clinical diagnosis. Skin borreliosis is indeed generally self-healing, but should still be treated with regular penicillin, because otherwise there is a risk that the bacteria spread to other organs, such as the central nervous system (neuroborreliosis), joints or the heart muscle. In neuroborreliosis, peripheral facial paralysis, in other words a paralysis of the muscles of one side of the face (Bell's palsy), is a common manifestation. In other cases,

meningoencephalitis develops with fever, neck pain and sometimes radiating pain (radiculitis pains). Then, the spinal fluid (liquor) shows an increase in the number of leukocytes (pleocytosis) with a preponderance of monocytes, that is to say a clinical presentation similar to that of viral meningitis. The diagnosis of neuroborreliosis is established with an antibody test in blood and liquor. Neuroborreliosis is now treated with high doses of doxycyclin in tablet form as a rule. There is not yet a vaccine against borreliosis. Ticks should be removed with tweezers or special tick removers: pull straight out without rotating! Any remaining jaw sections eventually loosen without any special action.

Tick-borne encephalitis (TBE) is a virus infection that spreads through tick bites. It often has a two-phase course that begins with a few days' of fever and general malaise, after which a powerful headache arises and the fever rises again. In the spinal fluid, both pleocytosis with an excess of monocytes and an increase in albumin (barrier damage) are seen as signs of encephalitis. Palsies, often in an extremity (monoplegia), and cramps are not uncommon. There is often a long convalescence and residual symptoms such as concentration difficulties and focal muscle weakness are more common than previously believed. The virus diagnosis is made with the help of an antibody test (specific TBE-IgM antibody test in blood serum is positive five days after the first symptom and is always positive if encephalitis has had time to develop). No special treatment is available, but there is an effective vaccine and persons who are at risk of tick bites in the geographic areas in question should be vaccinated.

Mononucleosis (EBV infection)

Mononucleosis is a prolonged virus infection that gives rise to a sore throat, but also causes symptoms from several other organs. The cause is the Epstein-Barr virus (EBV), which has the throat as an entry point and comes from infected saliva from other persons. The majority are already infected as small children without developing the typical clinical presentation. However, this presentation arises if the infection first occurs in the teenage years or later ("kissing disease"). In mononucleosis, onset occurs more slowly than with streptococcal tonsillopharyngitis. Typical symptoms include swallowing pain that increases over several days, increasingly swollen lymph glands in the neck, as well as in the armpits, and a fever that reaches 39 degrees. Headache, muddled speech and acetone-smelling breath is common.

The virus spreads through the blood vessels to the entire reticulo-endothelial system (RES), where mainly the T-lymphocytes proliferate. The spleen swells to varying degrees, but is soft and therefore sensitive and fragile. In rare cases, the spleen can rupture spontaneously, for example, due to the increase in pressure that occurs in the abdomen in heavy lifts, which can result in life-threatening bleeding. The risk of the spleen rupturing increases if it is subjected to blows or pressure, common in contact sports for example. A ruptured spleen requires an immediate operation with the removal of the spleen to prevent the person from bleeding to death. Also refer to the section "Suggestions for guidelines for management and counselling" (1).

The course of the disease in mononucleosis often takes several weeks and blood tests provide good guidance for diagnosis. Accordingly, the total number of leukocytes in the blood increases at the same time that the white blood count is shifted in the first week of illness towards a dominance of mononuclear cells. Some of these have leaking cytoplasm, so-called atypical lymphocytes (McKinley-cells). Liver function tests in serum (for example ALAT) are slightly to moderately increased as a rule. Among older children, adolescents and adults, mononucleosis can in most cases be diagnosed with rapid testing with blood tests that indicate heterophilic antibodies. It is positive within 5–7 days after the onset of symptoms. In the cases where the rapid test has a negative outcome, samples can be sent for conventional analysis of specific IgM and IgG antibodies against EBV, which confirms or rules out the diagnosis. There is no specific treatment.

Myocarditis

Through the years, myocarditis has probably been the infection complication discussed most in connection with sports and training. This is because myocarditis can in exceptional cases have a serious development at the same time that the symptoms are often diffuse. In the majority of cases, myocarditis heals without residual symptoms and sports and training can be resumed. Sudden death or heart failure is rare (2, 3).

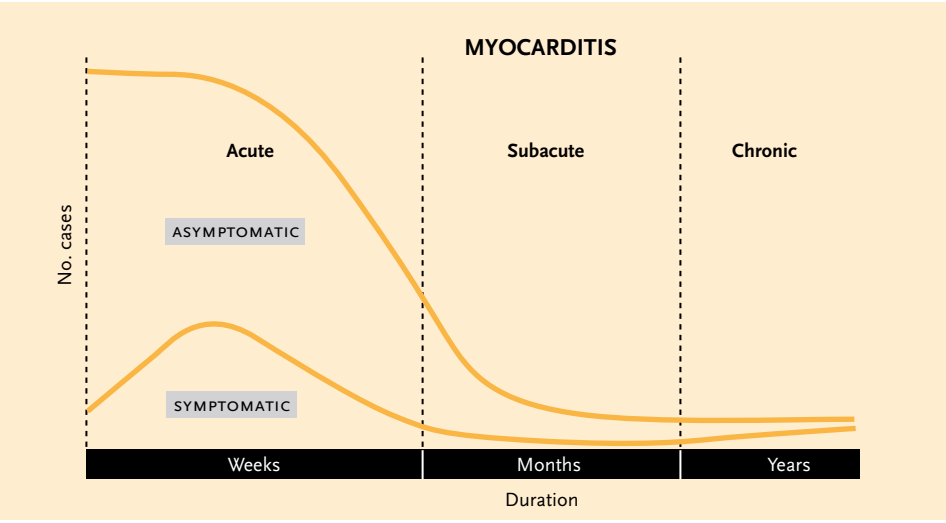

Figure 1. The main characteristics of the epidemiology of myocarditis. The knowledge of the large proportion of symptom-free (sub-clinical) cases is based on findings among persons that have died from other causes. From the original diagram by L Wesslén, 1997 (4).

The accumulation of sudden deaths among young Swedish elite orienteers during the 1980s and beginning of the 1990s was caused by an uncommon variant of bacterial myocarditis with no or very few symptoms until serious, acute dysrhythmias occurred. In these cases, the myocarditis had been prolonged (subacute). Despite the lack of symptoms in the majority of cases, similar advanced changes were seen in all of the hearts after death. Only one such death is known to have occurred among young orienteers (under the age of 35) at the elite level after 1992, when a six-month suspension of competition was introduced and antibiotic treatments were given to the Swedish elite ranked athletes.

Because of the special disease mechanisms, myocarditis is a condition of central interest in sports medicine. This is related to the infection being located in an organ that is activated and strained considerably in sports, particularly in oxygen-intensive (aerobic) endurance work. The metabolism of the heart muscle is then significantly increased. In increased activity and metabolism, the heart muscle is more receptive to infection than at rest. Among other things, this is due to an increased number of protein receptors that capture microorganisms then being exposed on the surface of the heart muscle cells. Microorganisms often come out in the blood during an early phase of a viral infection and can then more easily than at rest "attach" to and penetrate the heart muscle cells. Many different viruses and bacteria can infect the heart and give rise to myocarditis. Some microorganisms have a relatively large tendency to attack the heart, while others very seldom do so. Among the former are enteroviruses (primarily Coxsackie viruses) as well as many others, such as the Epstein-Barr virus (EBV, mononucleosis) and adenoviruses. Among the latter are the common cold viruses (rhinovirus and coronavirus). It is also well-established in experimental studies that increasing the work load of an individual with ongoing myocarditis results in an increase of the amount of microorganisms and the tissue damage in the heart muscle.

The majority of myocarditis patients have or have recently had a respiratory infection when the myocarditis becomes symptomatic. However, myocarditis can sometimes appear without the patient feeling any prior symptoms. Unfortunately, there are currently no rapid tests for all of the different viruses and bacteria that are of interest in the context of myocarditis (with the exception of beta-streptococci, EBV and a few more viruses). In addition, in respiratory infections, it is often difficult or impossible based on the symptoms and signs of the patient to determine which virus or bacteria is the cause and consequently, whether there is a risk of myocarditis. Consequently, the general recommendation is to avoid heavy physical loads and strain with acute symptoms of infection.

The symptoms of acute myocarditis most often have a rapid onset, ranging from diffuse sensations in the chest to sharp, often breathing-correlated pain in the area of the heart. As a rule, pain presupposes that the pericardium is inflamed, since the actual heart muscle (myocardium) does not clearly signal pain upon inflammation except in severe oxygen deficiency such as in a heart attack. With viral myocarditis, the pain-sensitive pericardium is generally more or less involved in the infection, but this is often not the case with bacterial myocarditis. Rapidly occurring dizziness, unexplained shortness of breath and fatigue are other common symptoms in acute myocarditis. Irregular heart activity, a racing heart, dizziness or fainting during ongoing exertion are always serious signs. All of the symptoms

mentioned here and the signs shall always lead to an emergency physician consultation. Occasional extra heartbeats at rest directly after completed exertion are, however, common in the healthy heart, but if there are several extra beats in an uninterrupted sequence, a doctor should be consulted. Under a microscope (histopathologically), randomly spread inflammatory sites (accumulations of leukocytes) are as a rule seen in the heart with myocarditis in the occasional cases that lead to death and are autopsied. If such an inflammatory site strikes the heart's impulse relay system, sudden death can occur even without prior symptoms due to electric instability that leads to serious cardiac arrhythmias.

The prognosis in acute myocarditis, with or without pericarditis, is good in the majority of cases, in other words the myocarditis heals without residual symptoms and sports can gradually be resumed. The follow-up should be individualised. In recent years, the diagnosis of myocarditis has been expanded with the concept of inflammatory cardiomyopathy, which means both that the common signs of heart muscle inflammation have been observed and that a functional disruption of the heart has also been established. In these cases, as a physician, one should be very careful with the investigation and follow-up to ensure a desirable healing process. In the uncomplicated cases, it most often suffices with an exertion ECG being done prior to giving a clean bill of health together with a doctor's visit. A large Finnish study of myocarditis among military conscripts indicated that the majority of the recruits with myocarditis could return to military duty within 2–3 months of the onset of the disease (2); in a minority of cases, longer convalescence was required.

There are still no vaccines for the majority of the viruses and bacteria that can give rise to myocarditis. Therefore, general precautions must instead be taken to avoid infection to the furthest extent possible.

How is physical capacity affected by infections?

Infections with fever (with or without myocarditis) are accompanied by a change in metabolism with the aim of mobilising the infection defences (3, 4). The healing of an infectious disease does not occur automatically, but instead requires that the body succeeds in defending against the microorganisms (viruses and bacteria), sometimes with the help of antibiotics. This effort affects various organs and tissues. Amino acids are expended for the increased synthesis of immunoglobulins, immune cells, etc. and as a source of energy. Fever further increases the energy needs since the metabolic processes then go faster. In addition, a loss of appetite (anorexia) is common in fever, and the body is largely relegated to using its own deposits for the energy supply. The fat deposits cannot be effectively utilised in fever and amino acids are instead collected from the striated muscles. A negative nitrogen balance is therefore quickly established. A study of a cross section of young men indicated that muscle strength had fallen by 15 per cent upon *recovery* after a week-long infection with fever. The individual variations were somewhat large, however. The relative inactivity or confinement to bed that can be seen as a part of the treatment of febrile infections contributed insignificantly to the drop in muscle strength. This was instead primarily due to the infection-caused adjustment of the metabolism when muscle

is decomposed to become energy for the immune system (muscle catabolism). The aerobic (oxygen-dependent) capacity had, however, fallen by 25 per cent and inactivity/being bedridden significantly contributed to this. Besides "muscle condition", aerobic capacity is also determined by the blood volume and blood circulation's autonomic controls (the sympathetic and parasympathetic nervous system), which were both disadvantaged by both the infection and being bedridden. During an *ongoing* infection and fever, aerobic capacity, muscle strength and muscle stamina are reduced as is the coordination of muscle activities. An athlete that has to perform in connection with an infection can therefore expect reduced muscle strength, reduced aerobic and muscular endurance and degraded coordination ability, which has an impact in elite contexts where competition is tough.

Physical activity both stimulates and inhibits the immune system

In general, physical exertion stimulates the immune system and consequently the defence against infection. An untrained individual that begins to exercise regularly gradually strengthens his or her immune function and thereby decreases his or her receptiveness to infections. Intensive aerobic endurance work (such as middle and long distance running, skiing, cycling, rowing, orienteering) of a duration of at least one hour initially gives a strong stimulation of the immune system, which afterwards turns to the opposite; a period of temporary weakening of the immune function occurs after the exercise session/competition. In other words, the immune system "recovers" after the strong stimulation that the exercise/competition incited, and then the susceptibility to infections is temporarily greater (figure 2).

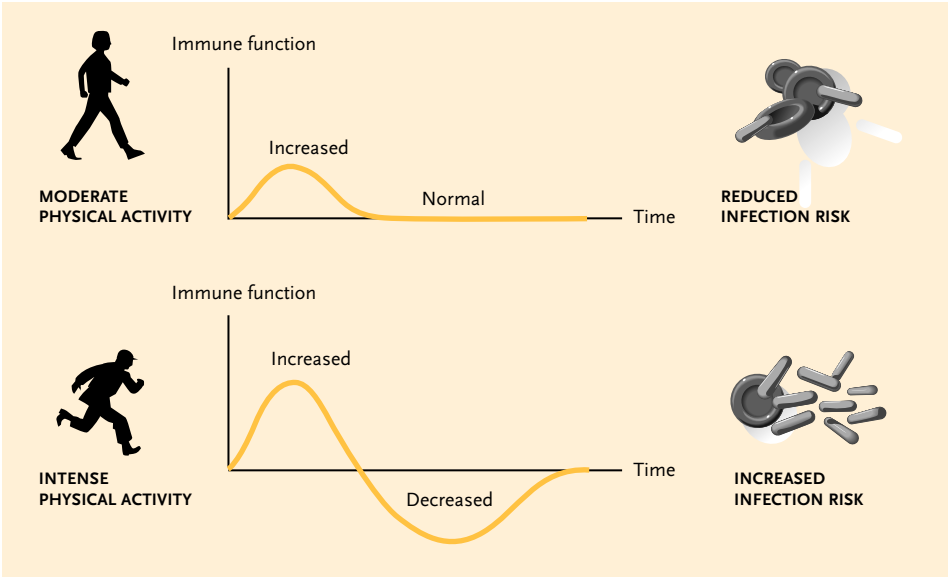

Figure 2. During moderate to intense physical exertion, the immune function is stimulated through the mobilisation of lymphocytes to the blood, among other effects. Intense exertion is followed by a period of degraded immune function with reduced NK cell activity, subdued lymphocyte proliferation and reduced levels of IgA antibodies in the saliva. Susceptibility to infection is then increased (5).

This effect is seen in both untrained and very well-trained individuals. The duration of this drop in immune function partially depends on the exertion's intensity and duration and is partially individual. One usually expects the drop to be able to last from a few hours up to a day (even longer after a marathon, for example). This type of repeated exertion sessions done with too little time in between is at risk of leading to a prolonged increase in susceptibility to infection and greater risk of complications if one comes down with an infection (figure 3). The planning of the frequency of training and competition as well as resting periods is therefore important.

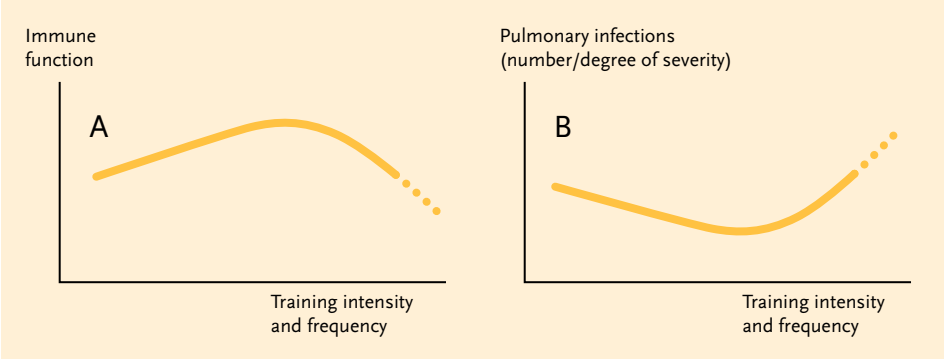

Figure 3. A. The immune function in relation to physical activity and exercise. B. Susceptibility to respiratory infections in relation to physical activity and exercise (6).

Infections and physical activity – medical risks

One perception that is often met with is that one can "run the rubbish out of the body", in other words, get rid of an infection that has begun to show symptoms through an intense exercise session. However, there is no scientific support for this working. On the contrary, it can be risky. The infection can take a more serious turn and complications can occur. In other words, if an infection has already been established, the immune stimulation of such an exercise session provides no benefit. On the contrary, it can worsen the infection. For example, an upper respiratory infection can spread to the bronchi and lungs and, if one is unfortunate, myocarditis can occur. This is also true even if the individual has no fever.

It is at the very first symptoms of an infection such as a general feeling of malaise, an irritation in the throat, etc., with or without a fever, that it is very difficult to judge whether the symptoms constitute the start of a serious condition or not. Besides the risk of myocarditis, this is an important reason to apply the general recommendation to refrain from intense physical exertion while awaiting the continued development (3).

The risks of physical activity to those who are infected vary strongly depending on the location of the infection, its degree and microbial cause, as well as the intensity and type of physical activity. Intense/prolonged physical exertion, and even mental stress, can reduce the defence against infection and worsen the infection, as mentioned above. Furthermore, a subclinical (without symptoms) infection complication, such as myocarditis, is made worse by heavy exercise.

The risk level is generally higher for a trained and competing athlete, particularly at the elite level, than for the regular exerciser. A physician's advice to individual patients must therefore be individualised.

Muscular and cardiopulmonary performance capacity is reduced by the majority of infections, especially if the infection is associated with fever. This temporarily reduced performance capacity cannot generally be prevented by continuing to exercise during the infection. On the contrary, exercise during an infection can lead to additional reductions in performance capacity, infection complications and other injuries. This is particularly true with mononucleosis, which has a special immunological situation (1).

The nervous system is generally affected in infection and fever so that coordination capacity ("motor precision") is degraded. This condition can affect performance capacity, especially in sports that require a high degree of precision. At the same time, the risk of injuries in joints, ligaments and tendons increases (3).

Physical exertion with a fever entails an increased hemodynamic load on the heart compared with exertion in a healthy individual. This can lead to the manifestation of another, perhaps as yet undiagnosed, heart disease such as coronary sclerosis (obstructed coronary arteries), hypertrophic cardiomyopathy (pathological thickening of parts of the heart muscle) or myocarditis, sometimes in the form of a fatal arrhythmia.

In general, the physician should therefore always assume a cautious attitude to physical activity in his or her advice to infected individuals. This is particularly important when it concerns trained and competing athletes, who have greater "pressure" of their own and from their surroundings to perform than regular exercisers. Extra attention must be devoted to elite athletes, where the requirements and expectations of participation and success are extra large. Mental stress can always weaken the immune system. In some sports, the reduction of performance capacity associated with infection can be compensated by the athlete's routine and skill, which can incite greater risk-taking. The elite athlete must sometimes take certain risks to win, but they should not be unreasonably high and active individuals must be aware of them. Here, the physician has a duty of contributing to a reasonable risk assessment of the individual case.

The following proposal of concrete guidelines for management and counselling in cases of infection in elite athletes, primarily intended for general practitioner physicians, was published in connection with the 2000 Sydney Olympics (3).

Suggestion for guidelines for management and counselling

Risks to the individual

In people with fever (38 degrees Celsius or more), rest should always be recommended.

People who know their normal temperature and pulse curves should rest, if their resting temperature has increased by 0.5–1 degree or more and at the same time their resting heart rate has risen by 10 beats/minute or more, in combination with general symptoms (malaise, muscle pains, muscle tenderness, diffuse joint pains, headache).

In general malaise, alone or in combination with one or more of the symptoms muscle pains, muscle tenderness, diffuse joint pains and headache, should give reason to recommend rest, until these symptoms have disappeared.

In all infections, caution should be observed during the first 1–3 days of an infection, even with a normal body temperature, until the body's defence against infection has had time to become mobilized and until the further development of the infection becomes clear. Serious infections often have prodromal symptoms and in such cases it often takes 1–3 days before the serious nature of the infection becomes evident.

In people with nasal catarrh without a sore throat, cough or general symptoms, caution is recommended during the first 1–3 days, after which training can gradually be resumed if the symptoms do not become worse. (Note! Differential diagnosis: allergy.)

If additional manifestations exist at the same time as nasal catarrh (such as sore throat, hoarseness or cough), one should be more restrictive, depending on the degree and development of the symptoms.

In people with a sore throat without any other manifestations, caution is advised until the symptoms have begun to improve. In cases of beta-streptococcal tonsillopharyngitis,

which should be treated with penicillin for 10 days, rest is recommended until the symptoms have disappeared and caution is recommended during the first week of treatment even in the absence of symptoms, due to the risk of residual bacterial toxins that can affect the heart. (The objective of the last three days of antibiotic treatment is to reduce the risk of relapse.)

In mononucleosis, the situation is special. See "Advice regarding the start of training and training progression in athletes after mononucleosis" below (1).

Here, it shall only be mentioned that persons who pursue contact sports such as football, wrestling, weightlifting, etc., should wait 4–6 weeks after the onset of symptoms before resuming these sports, because it often takes such a long time before the spleen has regained its normal size and consistency. An enlarged spleen in mononucleosis is fragile and can rupture if it is subjected to a blow or increased pressure, and weightlifting can cause a spontaneous rupture.

In cystitis, a urinary tract infection without fever which mainly affects women, strenuous physical exertion should be avoided until the symptoms have subsided.

In gastroenteritis, heavy physical exercise should be avoided.

In skin infections, the recommendations need to be based on an individual assessment. All athletes should observe caution in episodes of herpes accompanied by regional lymphadenitis or general symptoms. Minor, surface skin infections seldom constitute contraindications to training and competing. An exception is a dermal herpes infection among wrestlers and other practitioners of contact sports. They should refrain from practicing the sport even with minor herpes lesions until the vesicles have dried. Erythema migrans should be treated with penicillin for 10 days and rest is recommended during the first week.

People with ongoing genital infections should avoid strenuous physical exertion. In asymptomatic genital chlamydial infection, it seems reasonable to restrict the physical activity during the period of antibiotic therapy, after which the infection can be considered to have healed.

Asymptomatic HIV infection constitutes no hindrance to exercise and sports. There are no indications that physical activity and sports have an unbeneficial effect on the health of HIV infected individuals. However, it has been documented that exercise and competition have an important promotional effect on the quality of life of many HIV patients.

Risks to the heart

In most cases of febrile infectious diseases, training can be resumed as soon as the fever has abated (3). This should be done gradually and it is important to pay attention to the "body's signals" at the same time. If unexpected symptoms suspected of coming from the heart should appear, for example dizziness/fainting under exertion (exertional syncope), pain, a sense of pressure or discomfort in the chest, irregular heart beats, abnormal breathlessness or fatigue, the training should be discontinued and a physician consulted, because myocarditis can occur in connection with a number of different infections. Fainting under exertion is a serious symptom that should always lead to an emergency physician's examination of the heart. It is important to point out that myocarditis can develop even without prior symptoms of infection. In middle aged people, the possibility of acute coronary disease (obstructed

coronary arteries), in other words acute myocardial infarction or angina pectoris, should also be considered with symptoms of this type. This is particularly true of chest pain brought on by exertion. Those intending to resume training after an acute myocarditis should seek individual consultation by a physician. A European expert group suggest competitive sports may be resumed within six months of the acute disease, provided that the individual has no symptoms, normal left ventricular function and no arrhythmias (10).

In general, it may be said that in infections, as in other situations, it is important to "listen to the body's signals".

Antibiotic treatment constitutes no inherent obstacle to physical activity and sports. It is the infection that "decides".

Risks to the environment – epidemiological aspects

Plantar warts are readily spread via shower floors and changing rooms. These warts should therefore be treated quickly in athletes.

Wrestling is probably the sport where the athletes have the closest physical contact. Besides air and droplet borne infections from the air passages, there is a significant risk of transmitting disease through contact. "Mat herpes" (herpes gladiatorum) is a classic example of this, where the herpes virus from one individual is inoculated through visible or invisible skin lesions to the other. This often occurs through small surface burns that arise from the friction when the wrestler lands on the mat. Epidemics of herpes gladiatorum among wrestlers have been described many times.

Respiratory tract infections can readily be transmitted both by droplet infection and by contact (direct or indirect contact via objects) among sportspeople who are in close proximity before, during or after a training or competitive event. Examples of this are countless. In addition, the fact that strenuous or prolonged physical exertion can reduce the defence against infection increases the susceptibility to respiratory tract infection.

Because prevention of exposure is the only prophylactic measure available, the risks of infection and the mechanisms of infection should be known by the individual athlete, as well as by trainers and sports leaders, before an infected individual allows himself or is allowed to meet his fellow participants prior to important training and competitive events. Annual immunization against influenza should be recommended for elite athletes. Vaccination against tick-borne encephalitis (TBE) is important for those spending time in the forest or land in areas of exposure (see above under "Symptoms, diagnostics, treatment and complications").

Athletes with HIV infection should be allowed to participate in sports just like any others. Physicians of HIV patients who are engaged in sports associated with a risk of exposure of blood, such as wrestling, boxing, football and so on, should inform the patients concerned of the theoretical risk that the infection can be transmitted further. In the U.S., doctors are additionally recommended to strongly advise against their HIV patients' continued participation in sports of this kind. It is important to consider the anonymity aspects and to make sure that the infection status of the person concerned does not come to the knowledge of the leaders or teammates unless the individual has given his or her consent.

Advice regarding the start of training and training progression

– after mononucleosis and other infectious diseases with significant reduction of the physical functional capacity

In mononucleosis, the immune system is the site of the infection, in other words the virus is located in the immune cells. Consequently, a particularly strong immunological activation occurs in mononucleosis. Because physical exercise is inherently immune stimulating, disease symptoms can therefore readily return when exercise is resumed (1). There is no simple test that indicates the activity level of the immune system to use as a guide. It is therefore important that elite athletes affected by mononucleosis consult with a physician who has experience of infection and sports medicine when the symptoms are on the way to subsiding and training begins to come into question again. The patient should have been symptom-free and managed the daily activities, in other words have had a clean bill of health, for at least one week before the physician makes his or her clinical assessment and potentially approves the resumption of training. Sometimes, fatigue after mononucleosis can last for many weeks or even months and consequently, the appropriate time to resume training must be assessed individually. The following factors can serve as guides (1):

1. The patient's general state of health, freedom from symptoms such as fever, fatigue, muscle pain, muscle tenderness, etc.
2. Normalisation/reduction of increased counts of leukocytes, lymphocytosis and liver enzymes.
3. Normalisation of any spleen enlargement, especially important among those active in contact sports such as wrestling, football, hockey, etc., as well as weightlifting (since Valsalva's manoeuvre can cause a ruptured spleen).

The physician must make a comprehensive assessment since no singe test predicts the suitable point in time for the start of training. It often takes 4–6 weeks from the onset of symptoms for an enlarged spleen to regain its normal size and consistency and thereby its protected place under the fifth rib (1, 7–9). An ultrasound examination can be recommended for contact sports practitioners who are free from symptoms and ready to resume training before then.

How much training is appropriate at the beginning and how quickly can one return to normal training after mononucleosis?

For ethical reasons, there are no controlled, scientific studies that can provide a conclusive answer to this question, since it would require at least one test group with training at a potentially harmful level of exertion. There are not even good studies with moderate exertion regarding the "return-to-play" problems. Consequently, the advice given is based on the individual physician's collective experience.

As a general recommendation, the following advice can be given to apply to the first month (1):

1. Train so cautiously and lightly that the pulse does not exceed approximately 120 beats per minute and you do not become especially out of breath.
2. Begin with 20–30 minute long training sessions, preferably alternating light strength and endurance training, and increase the training time by 5 minutes every training session.
3. Include one day of recovery and rest between every day of training, in other words train every other day the first week.
4. Carefully note how you tolerate the training and ensure that you recover during the day of rest before you train again the next day.
5. Take a break of 2–3 days, and possibly consult with your doctor, if you should feel that the disease symptoms return or other problems occur.
6. As long as the first 3–4 training sessions (6–8 days) could be completed without problem, you can continue with a cautious increase in the intensity of the training by increasing the number and length of the training sessions per week.
7. Use at least as much time to train up to your normal training amount and intensity (condition level) as the time the infection symptoms lasted when you were ill. Listen to your body's signals – consult with your physician when necessary – more time may be needed to come back!

References

1. Rønsen O. Prevention and management of respiratory tract infections in athletes. New Studies in Athletes 2005;20:49-56.
2. Karjalainen J, Heikkilä J. Incidence of three presentations of acute myocarditis in young men in military service. Eur Heart J 1999;20:1120-5.
3. Friman G, Wesslén L. Special feature. Infections and exercise in high-performance athletes. Immunology and Cell Biology 2000;78:510-22.
4. Friman G, Ilbäck NG. Acute infection. Metabolic responses, effects on performance, interaction with exercise, and myocarditis. Int J Sports Med 1998;19(suppl. 3):pp.172-82.
5. Klarlund-Pedersen B, Friman G, Wesslén L. Exercise and infectious diseases. In: Kjaer M, Krogsgaard M, Magnusson P, Engebretsen L, Roos H, Takala T, et al. Textbook of sports medicine. London. Blackwell Science Ltd; 2003, pp. 410-21.
6. Friman G, Wesslén L, Karjalainen J, Rolf C. Infectious and lymphocytic myocarditis epidemiology and factors relevant to sports medicine. Scand J Med Sci Sports 1995;5: 269-78.
7. Eichner ER. Sports medicine pearls and pitfalls. Defending the spleen. Return to play after infectious mononucleosis. Curr Sports Med Rep 2007;6:68-9.
8. Waninger KN, Harcke HT. Determination of safe return to play for athletes recovering from infectious mononucleosis. A review of the literature. Clin J Sport Med 2005;15: 410-6.
9. Auwaerter PG. Infectious mononucleosis. Return to play. Clin Sports Med 2004;23:485-97.
10. Corrado D, Pelliccia A, Bjørnstad HH, Vanhees L, Biffi A, Borjesson M, Panhuyzen-Goedkoop N, Deligiannis A, Solberg E, Dugmore D, Mellwig KP, Assanelli D, Delise P, van-Buuren F, Anastasakis A, Heidbuchel H, Hoffmann E, Fagard R, Priori SG, Basso C, Arbustini E, Blomstrom-Lundqvist C, McKenna WJ, Thiene G; Study Group of Myocardial and Pericardial Diseases of the European Society of Cardiology. Cardiovascular pre-participation screening of young competitive athletes for prevention of sudden death: proposal for a common European protocol. Consensus Statement of the Study Group of Sport Cardiology of the Working Group of Cardiac Rehabilitation and Exercise Physiology and the Working Group of Myocardial and Pericardial Diseases of the European Society of Cardiology. Eur Heart J. 2005;26(5):516-24.