Return to Play After Infectious Disease

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56.1 Introduction

Acute illness, specifically infective illness, is a significant health concern for recreational and elite athletes. An acute illness may prevent participation in training sessions or important competitions. Also in the football player, the pathophysiological consequences of an acute infective illness not only reduce exercise performance but also increase the risk of serious medical complications, including sudden death [1–5]. Some recommendations have been produced that can aid the sports medicine physician in return to play (RTP) decisions after illness but also to prepare the athlete to act in a more preventive manner.

V. Musahl et al. (eds.), *Return to Play in Football*, https://doi.org/10.1007/978-3-662-55713-6_56

56.2 Scope of the Problem: Epidemiology

Adults suffer on average from one to six episodes of an acute infection per year. The epidemiology of acute illness in elite level athletes has been studied in a variety of settings, mainly during major tournaments and in different sports including swimming, rugby and football [6]. Six to seventeen percent of registered athletes participating in major international games and tournaments of shorter duration (<4 weeks) are likely to suffer an acute illness episode. There are some data indicating that higher-risk subgroups are (1) female athletes, (2) athletes participating in winter sports (e.g. Olympic and Paralympic Games), (3) athletes with disability [7–9] and (4) athletes participating in more prolonged tournaments or competition [10]. Data from these studies consistently show that the most common system affected by acute illness is the respiratory tract, followed by the gastrointestinal system and the dermatological system [11, 12]. Scarce data exists on the incidence and aetiology of acute illness of athletes outside the major tournaments and competitions, i.e. in their home setting. Studies exclusively in football players show that the respiratory and gastrointestinal tracts are the most common systems affected by illness, during the studied tournaments. During the 2009 Confederations Cup, the incidence of illness was 16.9 per 1000 player days, with the respiratory tract (RT) accounting for over 50% of all illness (the ear, nose and throat = 37%; other respiratory tract = 20%) [12]. Similarly, during the 2010 FIFA World Cup, respiratory illness was the most common medical condition affecting football players (40% of all illness) [11].

56.3 Risk Factors Associated with Acute Illness in Athletes

There are many intrinsic and extrinsic risk factors that are being linked to acute illness in athletes, with varying degree of scientific support. Risk factors for acute illness can differ between different organ systems.

56.3.1 General Intrinsic Risk Factors Associated with Acute Illness in Athletes

56.3.1.1 Immune System Changes

An extensive body of literature describes the relationship between exercise and the immune system. The main theory is that a transient or more prolonged immune depression postexercise may contribute to the pathophysiology and risk of acute illness [13–18]. Indeed, changes in a variety of immune system components following a single intensive exercise session have been observed. Postexercise immune changes may be most pronounced when the exercise session is >90-min long and the intensity is 55–75% of maximum oxygen uptake (VO_2Max) [13], while other data indicate that a session longer than 60 min at an intensity >80% of maximum ability causes a depression in the immune system [19]. Observed changes include an increase in circulating neutrophils [3, 15, 20], a decrease in the lymphocytes [3, 15], a decrease in neutrophil function (oxidative activity and phagocytic capacity) for 1–3 days after the exercise session [3, 15, 17], a reduction in natural killer (NK) cell numbers and cytotoxic activity [3, 13] as well as a decrease in the salivary IgA concentrations [3, 17, 21]. Furthermore, there is an increase in the neutrophil/lymphocyte ratio (used as a predictor of stress to the immune system) for most of the following days after a heavy exercise session [22]. A 20% reduction in plasma glutamine concentration may occur, while there is conflicting evidence regarding T-cell function [3, 23]. The existing studies are typically in endurance type of sports, while strength sports have been less studied, in this regard.

A single bout of exercise thus results in changes in various immune parameters, typically lasting for 3–72 h. This period is known as the "open window" and has been widely proposed to reflect a time of "dysfunction" of the immune system, during which the athlete may be predisposed to viral and bacterial infections [1, 3, 21, 23]. However, the clinical relevance of the observed changes is still debated. Despite evidence that certain immunologic parameters change after strenuous exercise sessions, there is a lack of evidence of a direct link between the altered immune parameters and an increased incidence for URT illness, postexercise [3, 13, 24, 25]. The reason for this lack of evidence may be that some of the observed changes are physiological, as part of the acute-phase (inflammatory) response to training [26]. In addition, it has also been shown that overtraining leads to immune suppression, which may render the athlete susceptible to an acute URT illness [19, 27]. Clinically, reports of elite athletes experiencing repeated colds could also be due to the fact that an elite athlete will be relatively more affected by an ordinary cold than the average person who has less demand on maximal performance in everyday life.

56.3.1.2 A History of a Recent Acute Illness

In one prospective cohort study conducted during the Stockholm Marathon, 33% of athletes who experienced an URT illness in the 3-week period prior to the race developed an URT illness in the 3-week period after the race [28]. This was significantly greater than the 16% of athletes who did not have an acute illness prior to the marathon race. These data suggest that strenuous exercise too soon after an acute illness may be a risk factor to develop a subsequent illness. Alternatively, it may reflect that the athlete may have had a subclinical disease during the race, being aggravated by exercise.

56.3.1.3 Female Gender

Some evidence suggests that female athletes are at higher risk of an acute illness. In one prospective cohort study, 210 endurance athletes (63 females and 147 males) completed a self-reported health questionnaire on a daily basis for 16 weeks [29]. The proportion of participants who experienced one or more periods of URT illness symptoms was 40% in males and 52% in females, with the mean duration of URT illness symptoms being longer in female athletes (15.5 days vs. 11.6 days, $p = 0.024$).

Similarly, in the 2012 Winter Youth Olympic Games ($N = 1021$), the incidence of acute illness was 84.2 per 1000 athletes [30], with 6% of male athletes and 11% of female athletes suffering from an illness ($p = 0.003$). During the 2012 Summer Olympic Games, similar figures were found [8], with an overall illness incidence of 71.7 per 1000 athletes, with females again having a higher incidence (8.6% vs. 5.3%).

56.3.1.4 Body Mass Index

There are limited data to suggest that an increased body mass index (BMI) raises an athlete's risk to develop an acute illness. In one prospective cohort study, illness patterns were studied in 530 runners who completed a monthly log for 12 months. The results of this study showed that a higher BMI was associated with an increased risk to develop an URT illness [31].

56.3.2 General Extrinsic Risk Factors for Acute Illness in Athletes

56.3.2.1 Training Load

Individuals that engage in regular moderate exercise (50–70% of maximum ability, 30–60 min per session, 3–5 sessions per week) have a lower incidence of symptoms of URT illness compared with sedentary individuals [3]. On the other hand, regular, intense and prolonged exercise bouts may result in a chronic depression of the immune system, possibly increasing the risk of illness.

Historically, the relationship between the training load ("dose") of exercise and the risk of acute illness was reported as a "J-shaped" curve [2, 32–35]. However, more recently it has been suggested that the J-shaped relationship between absolute training load and illness is not necessarily applicable to elite athletes [36], as data from a number of recent studies show that high absolute training loads in international-level [37–39] and medal-winning athletes [40] are associated with a lower risk of illness compared with sub-elite or national-level athletes [6].

In 2016, the relationship between illness risk and training and competition load was reviewed [6]. The main findings were that changes in both external (increased volume and intensity of training) and internal training load are associated with an increased risk of illness. However, it is not yet possible to quantify which amount of training load increase is related to increased risk of a specific illness or in a specific sport.

56.3.2.2 Nutritional Factors

In general, immune cells require an adequate amount of glucose, protein, water and electrolytes to maintain normal function. Therefore, a well-balanced diet seems to be important for immune function. In a review of 66 placebo-controlled and/or crossover trials, it was concluded that a poor nutritional status affects almost all aspects of the immune system [15]. More specifically, an unbalanced diet, training in a dehydrated state and excessive use of nutritional supplements may negatively affect immune function.

In addition, glucose is considered to be an important fuel substrate for various immune cells, including macrophages, lymphocytes and neutrophils. There is some evidence that frequent ingestion of a ≥6% carbohydrate solution (1 l/h) during prolonged or high-intensity exercise maintains blood glucose levels, which lead to an attenuated postexercise cortisol level, resulting in a less suppressed immune function [15]. The ingestion of the carbohydrate may also attenuate exercise-induced increases in the total leucocyte count and/or monocytes and neutrophils and cytokine changes, which are associated with a decreased immune function. It has also been documented that the immune function is suppressed during periods of low calorie intake and weight loss [32].

56.3.2.3 Other Extrinsic Risk Factors

If too few resting periods are applied between strenuous exercise sessions, the athlete is at an increased risk to develop an URT illness, as the immune function has insufficient time to recover from the perturbations caused by the strenuous exercise session [2, 3, 41]. Increased risk of illness has also been related to fatigue [20] and overtraining [2, 3, 5]. There is also evidence that other extrinsic factors such as alterations in normal sleep patterns and psychological stress can increase the risk of acute illness [22].

Nowadays the elite football player frequently travels to different locations throughout the world to participate in events lasting from a few days to weeks. These events are characterized by regular strenuous games with training sessions in-between. Matches are also scheduled at night causing sleep disturbances. Data from two studies show that during periods of travelling, players may be exposed to higher risk of acute illness [40, 42]. Different environmental conditions such as extremes of temperature, humidity, adverse atmospheric pollution, aeroallergen exposure and dietary changes may play a role. Travelling between the northern and southern hemispheres, athletes are exposed to different pathogenic organisms including seasonal viral influenza strains, which may increase the risk of developing an illness [42]. In addition, sports physicians travelling with teams to foreign destinations should be aware of general and location-specific vaccination requirements.

Fact Box 1 Risk factors for developing acute illness in athletes

Intrinsic factors	Variable
Immune system	Depression of immune system components
Medical history	History of recent acute illness
Gender	Female
BMI	BMI > 75th percentile
Extrinsic factors	
Training load	High training volume High training intensity
Nutrition	Inadequate carbohydrate intake Inadequate calorie intake Exercise in dehydrated state Exercise without food intake
Other extrinsic factors	International travel Inadequate recovery time between exercise bouts Altered sleeping patterns Psychological stress Overtraining

56.4 Possible Sequelae to Infections

56.4.1 Fever

Fever is the symptom best known to any athlete or team physician, to make them aware of a possible ongoing infection. An infection will result in different degrees of response from the immune system. The hypothalamic thermoregulatory centre integrates afferent information from the periphery to regulate body temperature [43]. The core body temperature is normally kept within a range of 1–36.5–37.5 °C. Clinically, it is important to note that rectal temperatures are slightly higher than oral temperatures, with the difference being about 0.5°C. Women may have cyclic variations in their body temperature, in association with the menstrual phases. Fever is defined as a temperature that exceeds the normal and is accompanied by a shift in the thermoregulatory control. Exogenous pyrogens, such as microbial toxins or viruses, bind to macrophages and trigger the release of endogenous pyrogens (pyrogenic cytokines such as interleukins, TNF, IFN-α) [44]. Both types of pyrogens increase the synthesis of prostaglandin E2 (PGE2), which acts on the hypothalamus, via cyclic AMP, to adjust the thermoregulation upwards. Although fever is a physiologic response to an infection, it could also be the result of other immune stimuli, such as inflammation, malignancy or haemorrhagic stroke.

The potential complications during exercise due to fever are multiple. For several reasons, it may also be beneficial to treat the fever itself and not only the underlying cause. Especially, when the temperature is extremely high, approaching hyperpyrexia (>41.5°C), it is necessary to decrease the temperature by antipyretics, as the risk of complications is increased

56.4.2 Heat Stroke

Fever due to an infectious disease needs to be differentiated from hyperthermia (heat stroke) [45]. Heat stroke is defined as an increased body temperature, not caused by exogenous or endogenous pyrogens. The mechanism is an uncontrolled increase in body temperature due to excessive heat production (i.e. playing in a hot environment, without proper cooling). In this case, heat production may be faster than the combined peripheral loss of heat by sweating and respiration. This condition may be fatal, in extreme cases (>41–43°C) causing multi-organ dysfunction, including rapid liver and kidney failure (due to muscle necrosis) [46, 47], and is therefore important to distinguish from fever/hyperpyrexia. Heat stroke is the most extreme form of heat-related illnesses, which also include heat exhaustion and muscle cramps. Importantly, antipyretics may be ineffective in reducing the temperature in hyperthermia.

Fact Box 2 Complications of fever during exercise

- Fever is associated with systemic symptoms such as headache, myalgia and arthralgia
- The body will be dehydrated – due to sweating and decreased ADH production [17]
- Protein catabolism (amino acids for immune system components), decreased glucose availability and increased peripheral vascular resistance lead to nutritional deficiency and decreased muscle strength. Acute infectious disease may result in 5–15% decrease in isometric muscle strength, compared to bed rest [48]
- Fever reduces stroke volume and cardiac output to an extent depending on the severity of the fever [5]. It also increases oxygen consumption and heart rate: for every 1°C body temperature rise above 37°C, there is a 13% increase in oxygen consumption, and for every 1.5°C increase in body temperature, the heart rate may increase by 2.44 beats per minute [5]. A febrile illness may also decrease the blood volume and total haemoglobin. Together, these changes can lead to as much as a 25% reduction in endurance capacity. Maximal aerobic performance and endurance capacity decreased by 13–18% as a result of illness [49]

56.4.3 Reasons for Not Exercising During Infections

One of the most common clinical situations, in association with infection, is the question of the athlete's availability for training and/or competition. Later we will discuss some specific infections, but there are some general considerations, which may be used in the discussion with the athlete and the coach regarding the reasons for not exercising during infections:

- The infection may be prolonged and/or get worse, as has been shown in animal studies [43]. In humans, there is conflicting clinical evidence. It has been documented that exercising in the presence of an URT illness (with or without the presence of a fever) may aggravate the infection by causing more pronounced symptoms and/or prolonging the length of the illness [1, 2].
- The infection may be transmitted to teammates and colleagues. Depending on the type of infection and the causative agent, different precautions have to be undertaken [43]. See below, for diarrheal disease and dermatological infections.
- Neurologically, the coordination has been shown to decrease during infection/fever. In 1 study, 14 participants with influenza or echovirus infection, all suffering from myalgia, and 9 participants with mumps, in whom this symptom was lacking, were investigated with single-fibre electromyography (EMG) in the acute phase and during convalescence. A possible disturbance in neuromuscular transmission was revealed [1]. Decreased coordination and balance may be associated with an increased injury risk.
- Muscle strength will be negatively affected during an ongoing infection. There is evidence that infection leads to a decrease in muscle protein content (which correlates to a decline in muscle strength and endurance), a reduction in muscle enzyme activity and mitochondrial abnormalities. It might take up to 2 weeks for the muscle protein to be replenished. This is in addition to fever, which in itself may also cause a decrease in muscle strength (see above). The infection will contribute to the decrease in exercise performance experienced by athletes after an URT infection [50]. This is a reason in itself to refrain from training/playing. Furthermore, the decrease in exercise performance after full clinical recovery from an URT illness can last for 2–4 days [3] and in more severe infections (influenza) may be present for several weeks after the infection has subsided, even after the athlete has returned to sport.

Fact Box 3 Influence of acute illness on body systems, which leads to decreased exercise performance

System	Influence
Musculoskeletal	Muscle wasting (decrease in protein content) Decrease in muscle strength (isometric and isotonic) Decrease in muscle endurance Mitochondrial abnormalities
Cardiovascular	Decrease in stroke volume with a reduced cardiac output
Neurological	Impaired motor coordination Decreased neuromuscular transmission
Metabolism	Inability to maintain euglycemia Dehydration

- The risks of severe complications include cardiac complications, such as peri- and myocarditis. Different viruses and bacteria are more or less prone to affect the heart (being more cardiotoxic), with coxsackie B, influenza and parvoviruses being more and the common rhinovirus, less likely to cause myocarditis. Myocarditis is typically associated with general symptoms such as malaise and tiredness. Dyspnoea, palpitations, chest pain or even sudden cardiac arrest, due to malignant arrhythmia, may also be present [51]. Pericarditis is a similarly acquired infection of the pericardium and is also a possible complication to exercise during an ongoing infection [52].

- Rhabdomyolysis is the breakdown of skeletal muscle leading to compromised integrity of the muscle membrane, with subsequent leaking of the contents of the muscle cell into the plasma [4]. The myoglobin released from the muscle cells is filtered through the kidneys and excreted into the urine and can be directly toxic to the renal tubule and can lead to acute renal failure. It has been documented that the risk to develop rhabdomyolysis is increased when exercising during or after a viral illness [4].
- Other potential complications are listed in Fact Box 4.

Fact Box 4 Medical complications and risks associated with exercise training in athletes with an acute URT illness

System	Complication
Cardiovascular	Viral myocarditis Myopericarditis Dysrhythmias Sudden death
Musculoskeletal	Rhabdomyolysis Joint, ligament and tendon injuries due to impaired motor coordination
Respiratory system	Bronchial hyperreactivity
Others	Post-viral fatigue syndrome Increased duration and severity of symptoms of illness Heatstroke

56.5 Return to Play (RTP) After Infection

56.5.1 General Recommendations

Assuming that the athlete follows the recommendations of refraining from intense exercise during the duration of the infection, the key question will arise: When can he/she return to play? Although the specific recommendations vary for various infections, some general recommendations could be made:

- Firstly, and most importantly, return to play should occur only after the infection has cleared. This means that the athlete should have no remaining muscle pain, general malaise, fever or specific symptoms of the disease (diarrhoea, etc.).
- Secondly, RTP is a gradual process. The athlete should be closely monitored and only be allowed to increase training load if he/she is symptom-free. The length of this adjustment period is dependent on the duration and severity of the infection.
- Importantly, the athlete should not be advised to exercise in an alternative fashion, i.e. strength training instead of endurance training, which has sometimes been considered to be a less demanding activity. He or she should abstain from all training during the infection, to give the body a chance to recover fully.

56.5.2 Specific Conditions

56.5.2.1 Upper Respiratory Tract (URT) Infection

The most frequent upper respiratory infection (URI) is the common cold. It usually has a short duration of 2–4 days, typically being caused by rhinovirus, although many more viruses could be involved (Fact Box 5). URT is very common and is the reason for a large part of training interruption for an athlete, possibly several times/year [53]. An increase in the frequency of infections is usually seen in athletes during the years they have small children but also during heavy training periods. The clinically common worry of many athletes with frequent URI that they may have some underlying immune deficiency is typically unfounded. However, as the immune function may be decreased secondary to intense, prolonged and/or increased activity, athletes have to be gradually accustomed to the higher intensity of play/training. This is specifically applicable to new players coming from junior and/or lower football leagues. Repeated infections should therefore be taken as a possible warning sign of overloading (see below).

The return to play after a common cold follows the general recommendations as outlined above, that the athlete should return only after full recovery and gradually resume training. If the URI is caused by bacteria (differential diagnosis), this could both be a primary infection and secondary to a viral infection. Most commonly these infections are caused by the beta-streptococci, causing tonsillitis, impetigo, medial otitis and/or acute bronchitis. Oral antibiotic treatment should be started, and the athlete may return to sport when the infection has subsided and after finishing the antibiotic treatment.

In one prospective study performed on elite athletes, it was shown that pathogens were identified in less than 30% of athletes who reported symptoms of an URT illness [54], reflecting that non-infectious conditions must also be considered.

Fact Box 5 Most common viral causes for upper respiratory tract infection and related infections

Common cold	Rhinovirus Coronavirus Echovirus Coxsackie B
Influenza	Influenza A, B and C
Upper respiratory tract infection	Adenovirus Parainfluenza Coxsackie A Respiratory syncytial virus
Lower respiratory tract infection	Adenovirus Respiratory syncytial virus
Infectious mononucleosis	Epstein-Barr virus

The Clinical Neck Check

As different infections have different propensity for cardiac and other complications, because they are caused by different microbes, the differential diagnosis is important. Simple tests (such as for beta-streptococci in the throat) may be used to differentiate between a viral and bacterial infection. However, other tests, such as C-reactive protein (CRP), leucocyte count and liver enzymes, may also be used to establish the degree of severity of any given infection. Indeed, the most common clinical decision regarding URI is if the infection is viral or bacterial and thus treatable by antibiotics. A sign often used in clinical practice, with little scientific evidence, to determine the athletes' availability for training/playing, is the "neck check". The underlying theory is that infections causing symptoms below the neck contradict exercise, i.e. joint pain, widespread muscle pain, gastrointestinal symptoms and productive cough, while infections causing only symptoms above the neck, such as runny nose in an otherwise unaffected athlete, may be more compatible with exercise (slight cold or allergies). The grey zone will be the athlete presenting solely with a "sore throat". In our clinical experience, such an athlete should be advised to refrain from training/playing during the day in question. On the following day, the infection has become evident or the athlete will possibly have recovered fully to resume training.

Current recommendations for contraindications to exercise participation in athletes with an acute URT illness include [3]:

- Presence of fever
- Presence of myalgia (muscle pain)
- Presence of chest pain
- Resting tachycardia
- Excessive shortness of breath
- Excessive fatigue
- Swollen painful lymphadenopathy

More specifically, it has been suggested that rest should be advised to an athlete with an infection when fever is present (>38 °C) or when the individual's resting temperature has increased by 0.5–1°C or more and their resting pulse rate has increased by 10 beats per minute or more, in combination with symptoms such as malaise, myalgia, arthralgia or headache [1]. However, an acute onset of general malaise, especially in combination with pains in the muscles or joints, should also prompt the recommendation of rest, even in the absence of fever [1]. Training is gradually resumed after the infection has resolved, and if any symptoms referable to the heart appear (chest pain, chest discomfort, irregular heartbeat, abnormal breathlessness, abnormal fatigue or exertional syncope), the exercise bout should be stopped immediately [1].

56.5.2.2 Infective Mononucleosis (IM)

Mononucleosis is a special case of URIs that is very common in young individuals (i.e. "kissing disease"). The disease is clinically important in sports medicine, because of the possible long layoff from sports and because of potential serious complications from sporting activity during the infection. IM is caused by the Epstein-Barr virus and typically presents as a URI, with dominating throat pain, fever, headache and malaise. Importantly, a majority of individuals affected by mononucleosis may be asymptomatic (subclinical infection). IM may mimic tonsillitis with swollen cervical lymph nodes and yellow detritus at the tonsils [55]. Treatment with antibiotics is typically not associated with improvement of the clinical picture.

"Tonsillitis", not responding to antibiotics in a young individual, should thus raise the suspicion of IM. To confirm the diagnosis, the physician may use a fast-track antibody test (monospot) or serology. Often the liver may be affected (as shown by increased liver enzymes) and T lymphocytes are increased. The most important complication may be enlargement of the spleen and loss of its architectural stability, increasing the risk of splenic rupture secondary to abdominal trauma [2] or increased intra-abdominal pressure [1, 56]. Data indicate that 50% of splenic ruptures occur without a direct blow to the spleen and the risk of rupture is 0.1–0.5% [3]. The risk for rupture is highest in the first 3 weeks but is very rare after 28 days [2].

Athletes with IM with splenomegaly should refrain from doing sport for at least 3 weeks, but may be out of training for 6–8 weeks, or even longer depending on if and to what extent the spleen is affected. Full fitness is often reached only after 3 months of training [3]. Contact sports are contraindicated until the spleen has returned to its normal size. The size of the spleen has to be followed, clinically or by repeated imaging using ultrasound. In addition, all blood tests should return to normal (leukocytes, liver tests), and the athlete should be symptom-free, before resuming intensive training. In severe cases, IM may put an end to a whole season, while many cases give little symptoms and cause a shorter absence.

56.5.2.3 Dermatological Infections

Secondary to URI, the most common infections in athletes are skin infections, affecting 8–21% of all consultations at US college level [57]. Three main types of microbes typically cause these infections: viruses, bacteria and fungi.

Regarding fungal skin infections, the most common is tinea pedis (athlete's foot), affecting a majority of athletes presenting with skin infections [58], tinea corporis and tinea versicolor. All of these fungal infections may be treated using oral or local antifungal tablets or cream, respectively. The main preventive methods include sufficient hygienic precautions (keep the skin dry between toes) and not to share towels with teammates, for instance. These fungal infections rarely put a barrier to training or play, but tinea corporis should be treated for at least 72 h before play.

The bacterial infections include impetigo, caused by streptococci, and secondary infections such as folliculitis, cellulitis and abscesses. Full body shaving has become popular and may give rise to folliculitis in armpits and groins, often due to *Staphylococcus aureus*. Another common secondary infection is bacterial contamination of an athlete's foot or of a small wound around the toes or foot. Secondary to infections, the local lymph nodes may swell and even be accompanied by fever. This may include the groin lymph nodes secondary to foot infection. The athlete could be treated with antibiotics and should refrain from playing until recovered. If an infection is resistant to treatment, MRSA (methicillin-resistant *Staphylococcus aureus*) should be suspected and evaluated. Treatment includes incision and drainage of a lesion and appropriate covering. Proper antibiotic treatment for up to 10 days and healing of the wound are required for return to sport.

Regarding viral skin infections, the most common type is herpes virus infections, typically herpes labialis, caused by the HSV-1 virus. A special case of herpes infection is herpes gladiatorum, affecting the face and neck of athletes in some close contact sports (25% of wrestlers and rugby players [59]). The transmission is direct contact, and the athlete should not compete with active lesions, having at least 48 h of treatment with antiviral treatment, before returning to competition. All lesions should be covered.

56.5.2.4 Gastrointestinal Infections

Athletes frequently travel to training or competition, thereby having the risk of acquiring gastrointestinal infections, such as gastroenteritis. This ailment is typically caused by viruses (rotavirus or similar enteroviruses). The preventive measures include (oral) vaccination before travel and/or oral treatment by norfloxacin before and after symptoms. Vomiting, fever and diarrhoea are typical symptoms, and the treatment is directed at fluid replacement, as the risk of dehydration is increased. Rest and antipyretics may also be required. The athlete should only return to sport when having no remaining symptoms. A practical guideline is 48 h after the last diarrhoea or bout of vomiting. In the clinical situation, this advice is important to follow, as this will aid to prevent transmission of the infection.

56.6 General Recommendations to Prevent Acute Infective Illness in Team Sports

Due to acute infective illness, players often lose weeks of training each year or will miss an all-important match after months of preparation. Prevention of illness is of utmost importance in elite sports.

56.6.1 Individual Precautions

Personal hygiene is not only the most important but also the most practical and easiest preventative strategy. Most URT infections are transmitted through airborne droplets (sneezing and coughing) and by contact (direct skin contact or indirect contact with sporting equipment) [1]. The most important preventative measure to stop transmission of URT is frequent handwashing [2, 5] and avoiding contact between the hands, eyes and nose, as this is a primary route of introducing viruses into the body [34]. Other measures include covering the mouth and nose with the cubital fossa (elbow pit) when sneezing or coughing [60], avoiding direct skin-to-skin contact [5] and avoiding contact with ill individuals [2, 34]. Sharing of water bottles, towels and sporting equipment should be strongly discouraged [2, 5]. Regarding infections spread by vectors (insects, mots), an additional advice is to wear clothing covering the arms and legs during training sessions when travelling in tropical areas, particularly at dusk and dawn. To wear open footwear when using public showers, swimming pools and locker rooms prevents dermatological infections. Individual strategies that facilitate good quality sleep such as napping during the day and correct sleep hygiene practices at night are recommended. Avoid excessive and binge drinking of alcohol, as this impairs immune function for several hours, particularly after strenuous training or competition. Practice the principles of safe sex and use condoms, to prevent sexually transmitted disease (STD) [6].

56.6.2 The Role of the Medical Staff

The medical and administrative support staff should develop, implement and monitor illness prevention guidelines for athletes and screen for airway inflammation disturbances (asthma, allergy and other inflammatory airway conditions). They should identify high-risk athletes and take preventative precautions during competition periods. This may include arranging single room accommodation during tournaments for athletes with known susceptibility to respiratory tract infections. Consider protecting the airways of athletes from being directly exposed to very cold (<0 °C) and dry air during strenuous exercise by using a facial mask. The medical staff should adopt measures to reduce the risk of illness associated with international travel. Update athletes' vaccines needed at home and for foreign travel and take into consideration that influenza vaccines take 5–7 weeks to take effect. Intramuscular vaccines may have some side effects. It is therefore advised to avoid vaccinating just before competitions or if symptoms of illness are present. Vaccinations during the winter months [1, 2, 5, 34] may reduce respiratory illness by 30–50% [60], although this is somewhat debated.

The use of sensitive measures to monitor an athlete's health can lead to early detection of symptoms and signs of illness, early diagnosis and appropriate intervention. Athletes' tendency to continue to train and compete despite the existence of physical complaints or functional limitations, particularly at the elite level, highlights the pressing need to use appropriate illness monitoring tools.

56.6.3 Management of Combined Stress and Load on the Athlete

It is recommended that coaches and support staff schedule adequate recovery. Particularly after intensive training periods, athletes should have a detailed individualised training and competition planning, including post-event recovery measures (encompassing nutrition and hydration, sleep and psychological recovery) [6]. Sleep disruption has also been linked to immune depression [34], and efforts should thus be made to get adequate sleep [2, 3, 5]. Sports governing bodies have the responsibility to consider the competition load and hence the health of the athletes when planning their event calendars. This requires increased coordination between single- and multisport event organisers and the development of a comprehensive calendar of all international sports events. Psychological load (stressors) such as negative life event stress and daily hassles can significantly increase the risk of illness in athletes. Practical recommendations should be centred on educating athletes, coaches and support staff in proactive stress management [61].

56.6.4 Nutritional Strategies

Inadequate nutrition may contribute to impaired immunity [2, 3, 5, 25, 34]. Compounds, which are discussed as having a role in prevention of disease, are described briefly below. However, none of these strategies are substitutes for eating a well-balanced diet.

56.6.4.1 Vitamin C

In 1 double-blind, placebo-controlled study that was conducted on 92 runners who had entered the 1990 90 km Comrades Ultra-Marathon in South Africa, daily supplementation with 600 mg vitamin C reduced the incidence of postrace URT illness, from 68% to 33% ($p < 0.01$) [62]. A limitation to this study is that the URT illnesses were never proven to be infectious. Furthermore, whether vitamin C supplementation reduces the risk of acute illness during training or in the prerace period has not been studied.

56.6.4.2 Vitamin D

In one prospective cohort study, the influence of vitamin D status on the incidence of respiratory illness and immune function during a 4-month (16-week) winter training period in endurance sport athletes was examined [63]. After 16 weeks, a significantly higher proportion of participants presented with symptoms of an URT illness in the vitamin D-deficient group compared with the optimal vitamin D group (deficient group 67%, optimal 27%, $p = 0.039$) and saliva secretory immunoglobulin A (SIgA) secretion rate was also significantly higher. This study indicating that vitamin D status could influence URT illness has to be confirmed.

56.6.4.3 Glutamine

Several glutamine supplementation intervention studies showed that glutamine supplementation before and after exercise has no detectable effect on exercise-induced changes in immune cell functions [64, 65]. Therefore, the available evidence is thus not strong enough to warrant a recommendation for an athlete to use a glutamine supplement to prevent URT illness.

56.6.4.4 Cystine and Theanine

A small randomised, double-blind, placebo-controlled, parallel-group study in 15 male long-distance runners showed that ingestion of cystine and theanine prevented a reduction in the leucocyte count after a training camp (which was observed in placebo group) and prevented an increase in the neutrophil count and high sensitive CRP after the camp (which was also observed in the placebo group) [66].

56.6.4.5 Carbohydrate Ingestion During Exercise

It has been documented that carbohydrate ingestion by endurance athletes during intensive exercise is associated with an attenuated cortisol, growth hormone, epinephrine response, fewer perturbations in blood immune cell counts, lower granulocyte and monocyte phagocytosis and oxidative burst activity and diminished pro- and anti-inflammatory cytokine response compared to placebo ingestion [67], and this is reviewed by Gunzer [25]. Ingestion of ≥6% carbohydrates during prolonged exercise may maintain the immune function [15], but more research is required to prove that this translates into the reduction of URT illness.

56.6.4.6 Probiotics

There is increasing evidence from a double-blind, randomised, controlled trial and meta-analysis of randomised, placebo-controlled trials that probiotic supplementation can reduce the number, duration and severity of acute infectious diarrhoea and URT infection in the general population [68]. Furthermore, it has been documented that probiotics may reduce gastrointestinal illness in endurance athletes [69].

Take-Home Message

Acute illnesses and infections are the most common medical problem a sport medicine and football team physician will encounter. The recommendations generally stipulate that an athlete can participate in sport when symptoms and signs are only local (blocked nose, runny nose) and with the absence of symptoms and signs of systemic involvement (fever, tachycardia or resting heart rate increase by 10 beats or more, myalgia, malaise, lymphadenopathy, cough, chest pain and shortness of breath). If systemic symptoms are present, rest should be advised until the infection has subsided.

Fact Box 6 Strategies for prevention of illness

Strategy	Action
6.1 Individual precautions	Frequent handwashing Avoiding contacts between the hands, eyes and nose Covering of the mouth and nose when sneezing or coughing Avoiding skin-to-skin contact Avoiding contact with ill individuals
6.2 Medical staff	Develop, implement and monitor illness prevention guidelines Screen for airway inflammation disturbances Identify and manage high-risk athletes
6.3 Management of stress and load	Recovery plan Stress management education (athletes, staff)
6.4 Nutrition	Well-balanced diet with sufficient intake of nutrients (specific nutrients may be targeted)

When the athlete returns from an illness (return to play), exercise should be resumed in successive manner, always considering any symptoms. Special considerations are required for a few conditions. Firstly, no exercise should be allowed when the athlete has gastroenteritis. Secondly, when an athlete has infectious mononucleosis, non-contact sport should only be considered after 3 weeks at the earliest. The athlete may only participate in contact sports once symptoms have abated and the spleen has regressed to its normal size (proven by ultrasonography). The most important steps, however, is to prevent illness/infections by individual preventive measures (hygiene, nutrition, sleep) and by balancing external load (training load, playing load, stress) with adequate recovery.

Top Five Evidence-Based References

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