COPING WITH JET LAG AND PROTECTING ATHLETE HEALTH WHEN TRAVELLING

– *Written by Dina C Janse Van Rensburg, Audrey Jansen van Rensburg and Martin P Schwellnus, South Africa*

INTRODUCTION

Global travel and international competition are inevitable for the modern-day athlete and sports team. Jet lag can cause disarray for the individual athlete as well as for the whole team. Jet lag is caused by rapid transmeridian travel across different time zones, and is generally considered as a syndrome where the internal body clock is out of sync with the destination time zone. Its impact depends on the duration and direction of flight, the flight schedule, and individual differences. Jet lag tends to be transient and can result in physiologic disturbances and a complicated set of physical symptoms[1,2].

Furthermore, in the short-term, at the new location, the traveling athlete is exposed to diverse allergens or strains of pathogenic organisms, unfamiliar environmental conditions (temperature, humidity, altitude, pollution), and variation in diets that may lead to a higher burden of illness[3,4].

Knowledge regarding the preparation and management strategies to assist travelling athletes and teams are therefore essential for the accompanying physician and support staff. The aim of this article is to firstly equip the travelling athlete and -team with a methodical approach during the pre-travel-, flight- and post-travel periods in order to minimise the effects of jet lag[1,2] and to secondly give practical advice on strategies to manage the risk of illness during traveling – protecting athlete health[3,5,6].

A. THE MANAGEMENT OF JET LAG INCLUDES PRE-TRAVEL, IN-FLIGHT JOURNEY, AND POST-TRAVEL PERIODS

Pre-travel period:

Pre-travel strategies to mitigate jet lag can be complicated due to the athletes' constrained schedules and limited options of flight selections[7]. Choice of flight-times and the period of layover when travelling will assist with effective adaptation[1,8,9].

In the seven days prior to travel, modified training routines with reduced training volume and intensity should be adopted[7], and the adjustment of training times to the destination time zone can be considered. Adequate sleep (typically defined as six to eight hours per night) is important and

several studies have highlighted that good sleep results in better sports performance[10-14]. Sleep debt should therefore be reduced to the minimum. Evidence also exists that shifting the sleep schedule at one hour per day towards the destination time zone is effective to assist with phase advance or -delay, but may be impractical[7,15].

Pre-departure pearls include:

- Get enough sleep to avoid sleep deprivation (six to eight hours per night).
- Reduce training volume & intensity (seven days prior to departure).
- Consider travel schedules, to assist sleep-wake cycle .
- Shift bed- and mealtimes one to two hours earlier before travelling east & one to two hours later before travelling west to adapt to local time at the new destination time zone (effective pre-adaptation).

During journey:

The in-flight management period of the journey is crucial for recovery and adaptation, and to prepare for the destination. A few factors need to be considered, including travel fatigue and jet lag, hypoxia due to reduced cabin pressure and infection risk due to the confined environment.

In a study by Waterhouse et al[2], individuals with a short interval between their last full sleep before their flight and their first one at their destination, had less jet lag than those whose interval between full sleeps were longer. Physicians can also strategically use sedatives and/or melatonin to facilitate sleep, but only if athletes have used these substances before.

During journey pearls to mitigate travel fatigue and jet lag include[1]:

- Comfortable shoes and clothing.
- Avoid large meals.
- Keep hydrated.
- Avoid alcohol and caffeine.
- Adjust watch to destination time.
- Maximum rest/sleep.
- Follow sleep/wake pattern of destination.
- Minimal distractions (e.g. electronic devices).
- Stretch and walk when awake.

Physical performance may not only be impacted by circadian rhythm disruption, but also by hypoxia suffered during airline travel. During routine commercial flights the cabin is only pressurised to a reduced atmospheric pressure of 2438 m altitude, resulting in a decrease of arterial oxygen partial pressure (PaO_2) from 95 mmHg to 60mmHg, and a 3–4% decrease in systemic oxyhaemoglobin saturation. This may lead to mild hypoxia[16]. It is plausible to consider that time spent on long-haul flights should be seen as time spent at altitude with similar consequences[17-18]. Furthermore the cabin is a closed environment with fellow passengers and specific areas like tray tables posing a high risk for infection[19-21].

During journey pearls to mitigate hypoxia and an increased risk of infection[20]:

- Understand the impact of lower cabin air humidity, altitude and hypoxia in the athlete.
- Beware of seat location or contact areas for infection risk and take prevention (Also refer to section on protection of athlete health, and specifically Table 5):
  - sitting in an aisle seat,
  - proximity to ill passengers,
  - contact areas: head rest, tray tables, arm rests, seat controls, seat belt buckle, toilet flush button, bathroom stall lock, drinking fountain buttons, etc.),
  - overhead air vent.

Post-travel (at destination):

The post flight period of substantial jet lag disturbance extends from two to four days on arrival. During this time, the athlete's

activities (including meals, sleep, rest, and recovery) need to be strategically planned by the support team to accommodate rapid circadian adjustment. The direction of travel is very important as, in most individuals, the body's circadian rhythm is naturally longer (approximately 24.2 hours) than the set 24-hour light–dark cycle of one day. As a result, it is easier for individuals to adapt to a longer day than to a shorter one[22-24]. The impact of travelling eastward is therefore more detrimental than travelling westward for most individuals. The fastest rate of adapting to the new destination time zone is approximately half a day per time zone crossed when travelling west, or 1 day per time zone crossed when travelling east[7,22,25].

The direction of travel may also have implications for training and preparation for matches. A hypothesis related to circadian rhythm of performance is that

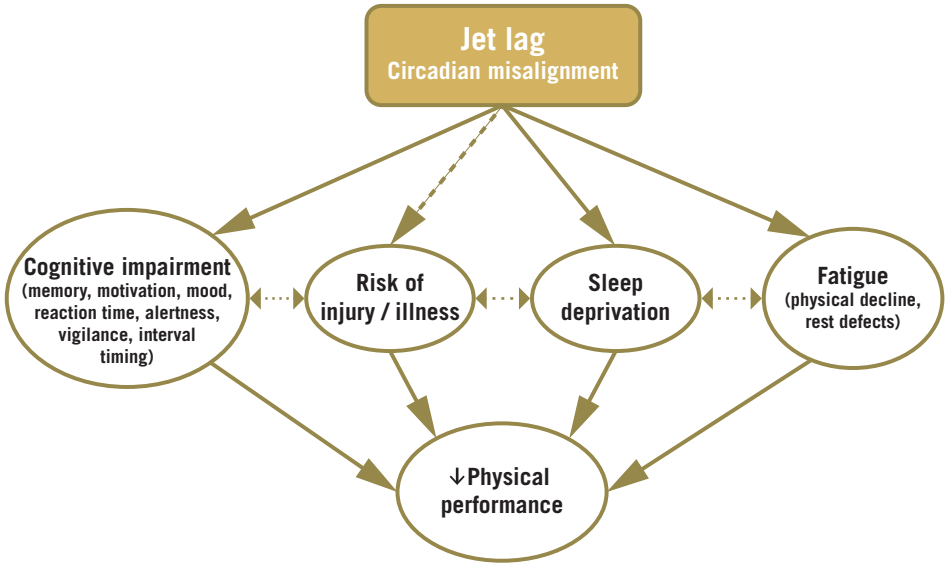

Figure 1: Impairments as a consequence of circadian desynchronization.

Table 1

Sleep disturbance:	• *Daytime sleepiness* • *Night-time sleep interruption, insomnia* • *Intermittent fatigue* • *Avoid long naps - it anchors the body clock to the departed time-zone* • *Altered and irregular sleep-wake cycles* • *Difficulty falling asleep and staying asleep travelling west* • *Difficulty waking up and staying awake traveling east* • *Changes in sleep-wake cycles are transient - normal sleeping patterns tend to restore before internal body temperature returns to normal*
Gastrointestinal (GIT) disturbance:	• *Indigestion may lead to heartburn, nausea* • *Diarrhoea may give rise to dehydration* • *General bowel irregularities, constipation, discomfort* • *Para-athletes have varying severity*
Cognitive implications:	• *Changes in mood, depression, not feeling refreshed* • *Decreased cognitive skills, impaired concentration and memory* • *Reduced reaction time, poor eye-hand coordination* • *Low motivation, morale, increased stress, anxiety* • *Reduced vigilance & alertness, decreased performance*
Other implications:	• *Plasma insulin fluctuation and blood glucose response to time of meals (important in diagnosed diabetics)* • *Inappropriate meal times may impact metabolic function and lead to neural and behavioural changes as well as appetite and metabolism disruption* • *Inhibited sleep may cause altered neuromuscular performance with impact on concussion and musculoskeletal injury* • *Menstrual cycle abnormalities*

Table 1: Implications of circadian rhythm disruption.

performance peaks in the evening, and the time of competition may be a critical factor affecting performance post-travel. Winter et al reported that in early afternoon baseball competitions, the teams travelling east-to-west will have a disadvantage over time zone adapted teams in the west, since the game would occur closer to the travelling team's local bedtime[26].

Furthermore, travelling between the northern and southern hemispheres causes disorientation due to changes in winter-summer climate and a shift in timing (sunrise and sunset). Travellers also experience variation in natural lighting and the amount of solar irradiation with seasonal changes – predominantly during mid-winter/mid-summer when light variances are greatest and less in autumn/spring[2].

Due to circadian rhythm disruption, the traveling athlete may in the short-term be exposed to sleep disturbances, a change in mood and fatigue levels and a possible higher burden of illness and injury. However, additional research is needed to support this. The duration and severity of symptoms experienced by the individual athlete, depend on the number of time zones crossed[27], and the direction of travel[18]. This may potentially have a negative impact on physical performance[28,29] as is explained by Figure 1 and further discussed in Table 1.

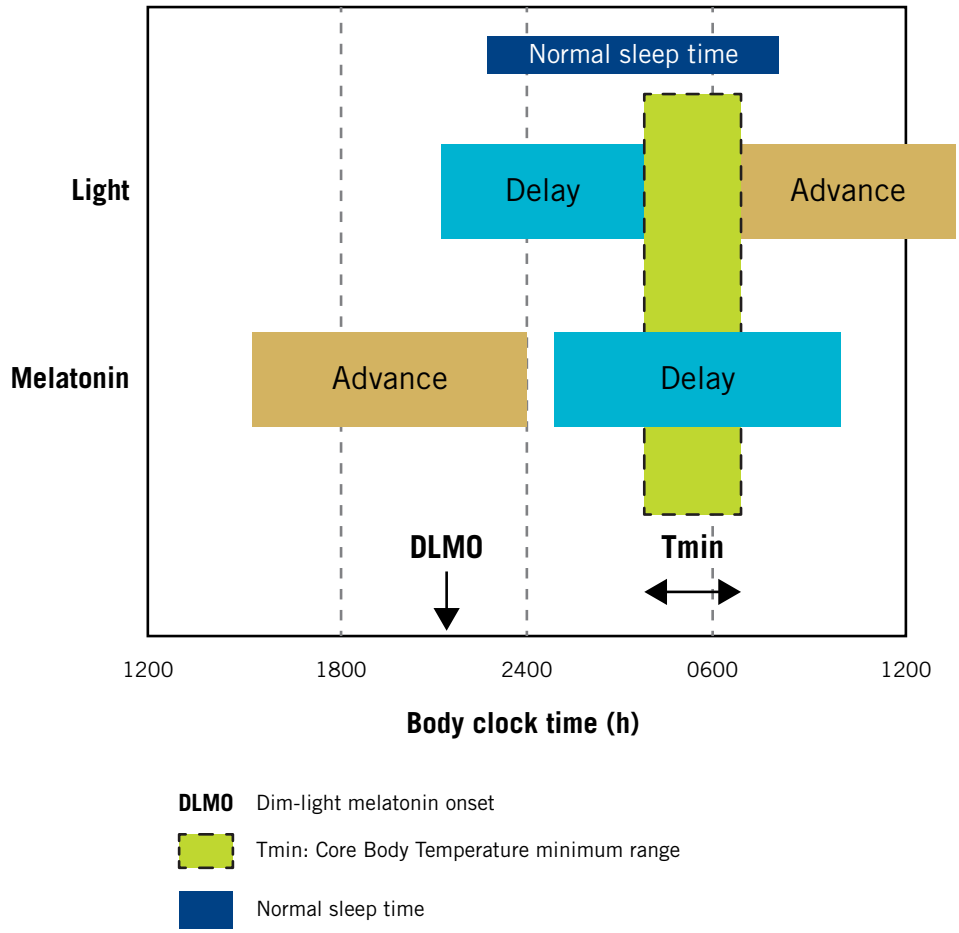

Figure 2: Phase shifts (advances or delays) of the body clock as produced by exposure to light and exogenous melatonin ingestion, at different times of the day (Adapted from Waterhouse et al[2]).

Optimising the timing of interventions to counteract jet lag is complicated by some challenges:

The circadian phase is synchronised to the local solar light–dark cycle and promotes alertness during the day, and sleep at night. The challenge remains to determine the best timing of an intervention for circadian re-entrainment after time-zone shift[9]. In the clinical setting several measures are currently used to evaluate the human circadian system. These include wearable wrist-watch accelerometer, melatonin and cortisol biomarkers (hourly urine, saliva or blood samples for 1 to 2 days) and core body temperature measurement (rectal probe, oesophageal probe or ingested telemetry pill monitoring)[30-34].

There are significant intra- and inter-individual variation in the ability to tolerate circadian phase misalignment. An individual's chronotype preference (evening-types vs morning-types) may affect their travel responses, and adaptation rates to eastward and westward travel[32,35]. Chronotype is partly influenced by our environment, but the differences in circadian rhythms are also linked to individual genetic variances[36-39].

Incorrect timing of interventions may induce a phase-shift in the wrong direction and pharmacologic interventions may cause side effects.

Management strategies for jet lag:

A combination of scheduled light therapy, light avoidance, and melatonin therapy can be implemented as fatigue countermeasures[1]. The phase shifts of the body clock (advance and delay) created by light and exogenous melatonin ingestion at different times during the day is illustrated in Figure 2.

Additionally, the careful use of a nap that coincides with the circadian nadir (lowest point in each 24-hour cycle) to reduce cumulative sleep debt and consequent fatigue, and caffeine according to each individual's need can improve the alertness of the athlete and reduce symptoms of fatigue.

Effective management strategies that are described in scientific literature, can be divided into pharmacological and non-pharmacological interventions, and are summarised in Table 2.

Post-travel (at destination) pearls include:

- Take a shower on arrival at destination.
- Take a brief nap, if feeling exhausted.
- Time-zone transitions < 8 hours east, promote a phase advance of the body clock.
- Time-zone transitions < 8 hours west, promote a phase delay of the body clock
- For journeys > 9 time zone hours east, it is more convenient to adjust by phase delay.
- The direction of adjustment may have implications for training and preparation for matches.
- Most important determining factors are timely light exposure, physical exercise and melatonin administration.

Table 2

Non-pharmacological	• *Light exposure early evening & first part of the night (on home, not destination time) induce adjustment by phase delay following westward travel* • *Light exposure early morning & second half of the night (home, not local time) induce adjustment by phase advance following eastward travel* • *Avoid exposure to blue light shortly before bedtime (laptops, tablets, TVs, LED, etc.)* • *Optimize quantity and quality of sleep. Perform quiet activities before going to sleep (reading)* • *Sleep in a quiet and comfortable room* • *Disciplined approach to food & hydration (avoid exotic/spicy meals)* • *Shift meal times to destination time* • *Caffeinated drinks increase destination daytime alertness - avoid after midday* • *Low intensity exercise session for first few days after a long flight while jet lag effects are most severe* • *Optimum exercise time, amount & type needed to effectively reset circadian clock has not been established* • *Athletes are likely to engage in physical exercise as part of normal training for competition & can strategically plan time & intensity of training as per the strategy for light exposure*
Pharmacological	• *Melatonin has both hypnotic and chronobiotic properties, and is beneficial in rapid resynchronization and for promoting sleep in intercontinental jet travellers. Concerns re. timing and dosage, legal status in different countries, World Anti-Doping Agency rules* • *Strategic use of sedatives (hypnotics) to improve sleep e.g. Zolpidem®* • *Stimulants can be used, e.g. slow-release caffeine early morning at local time. Avoid stimulants (caffeine, nicotine, , alcohol) before bedtime*

Table 2: Non-pharmacological and pharmacological Interventions[9,22,40].

- The rule is to modify behaviour rather than use medication to facilitate adjustment.

B. PROTECTING ATHLETE HEALTH

Protection of the health of the athlete starts before travel commences. Essential points to consider are listed in Table 3.

Important factors that need to be considered at the destination are different environmental conditions and culture, as well as the availability of medical facilities and services as explained in Table 4.

Athletes are exposed to an increased risk of illness and injury during travel and participating at events. During the 2016 Olympic Games in Rio de Janeiro it was reported that overall, 8% of the athletes incurred at least one injury, and 5% an illness. This was slightly lower than in the Olympic Summer Games of 2008 and 2012[43]. Accumulation of evidence shows the incidence and characteristics of sports injuries and illnesses that occur during sports events varies substantially between sports, perhaps demonstrating the need to tailor preventative measures to the specific context of each sport[3,43-52].

Furthermore para-athletes are a unique group with a wide variety of medical conditions, including intellectual or sensory (e.g. visual) or physical (e.g. amputation, spinal cord injury, cerebral palsy) impairments. They are often disabled, not only by their physical or intellectual impairments, but by a society that does not accommodate difference. Some common medical issues will prevail in relation to the impairment types that need to be considered as part of medical provisions at events. Over the course of time, epidemiological studies to monitor injury and illness in para-athletes have been initiated at both Paralympic Summer and Paralympic Winter Games[45,53].

In an article by Janse van Rensburg et al. describing epidemiology, risk markers and preventative strategies among para-athletes, the key points were[6]:

- The para-athlete has a documented risk of contracting an illness at times of key sporting events.
- Illness patterns are consistent for the Summer and Winter Paralympic Games.
- Illness mainly affects respiratory, dermatological, and digestive systems.
- Sporting code (specifically athletics) may be an important extrinsic risk marker for illness.
- Age and sex are not accountable as risk markers.

> ***The prevention of illness in athletes involve implementation of behavioural, lifestyle and medical strategies in order to limit the transmission of infections.***

Table 3

Medical screening	• *Past medical history (asthma, allergies, diabetes, etc.)* • *Current health status (any acute illness/injury)* • *Current medications and restrictions (acute or chronic)*
Special needs (e.g. para-athletes)	• *Number of accessible disabled aircraft seating, transportation of guide dogs and additional luggage/equipment & charges* • *Accessibility of shower- and dressing rooms, public transport at destination, competition and training facilities* • *Special medical needs including pressure sores, acclimatisation, body temperature regulation, stump–socket interface, urinary tract infections*
Journey planning	• *Documentation requirements - passport, visa, insurance* • *Best flight options include time and duration of flight, arrival time, lay-over time, direction of travel (east vs. west)* • *Countermeasures related to seat selection, isolation of symptomatic athletes on the plane, wiping high risk contact areas (travel medicine literature)*
*Vaccinations**	• *Depending on destination e.g. yellow fever*
*Chemo-prophylaxis**	• *Depending on destination and taking into consideration certain endemic areas e.g. malaria, chikungunya virus, zika virus, etc.*
Other	• *Preventative clothing/equipment* • *Insect repellent* • *Destination country pharmaceutical legislation (e.g. travelling with codeine)*

**Centers for Disease Control and Prevention (CDC) publish a fully revised and updated version of 'Health Information for International Travel' (commonly called the Yellow Book) every two years as a reference for health professionals providing care to international travellers. It contains the most current travel health guidelines, including emerging infectious disease threats, pre-travel vaccine and antibiotic recommendations, destination-specific health advice, and easy-to-reference maps, tables, and charts[41].*

**World Health Organization (WHO) is a specialised agency of the United Nations concerned with international public health, working with 194 member states, across six regions, and from more than 150 offices[42].*

Table 3: Essential points to assist in journey planning.

Table 4

Exposed to different environmental conditions including	• *Temperature differences, northern vs southern hemisphere (winter/summer), and individual locations that differ (e.g. tropical vs desert)* • *Altitude changes, from sea level to high altitude or vice versa* • *Low vs high humidity* • *Air, water, light and noise pollution* • *Aeroallergen exposure e.g. pollen in springtime* • *Strains of organisms at destination e.g. Zika virus* • *Availability of drinking water*
Culture	• *Language at visiting country - may need a translator* • *Food at destination e.g. spicy foods* • *Social customs, dress codes and laws of the country*
Local medical facilities	• *What is available? (hospital, medicine, medical disciplines, etc.)* • *Proximity to your accommodation, contact detail*

Table 4: Factors and conditions to consider at the new destination.

Table 5

Personal hygiene:	*a. Athletes are advised to minimise contact with people outside the team and support staff* *b. Avoid shaking hands with people* *c. Avoid crowded areas* *d. Minimise contact with infected people (including children, animals and contagious objects)* *e. Keep a distance from people who are coughing, sneezing or have a 'runny nose' (consider to wear a disposable mask)* *f. Rather cough or sneeze onto the elbow and not on the hands* *g. Always wash hands and nose after sneezing or coughing* *h. Wash hands regularly and efficiently with soap and water (especially before meals, and after direct contact with potentially contagious people, animals, blood, secretions, public places and bathrooms)* *i. Limit hand to mouth/nose contact when suffering from upper respiratory symptoms or gastrointestinal illness (use disposable paper towels, and refrain from touching eyes/nose to avoid viral self-inoculation)* *j. Keep insect repellent and alcohol-based hand wash gel at hand* *k. Do not share drinking bottles, cups, cutlery, towels, etc. with other people* *l. Avoid raw vegetables and undercooked meat, wash and peel fruit before eating, choose beverages from sealed bottles* *m. Wear covered clothing (covering the arms and legs) during training sessions when travelling in tropical areas, particularly at dusk and dawn* *n. Wear open footgear in public showers, swimming pools and locker rooms to avoid dermatological diseases* *o. Follow strategies to ensure good quality sleep e.g. strategic napping during the day and correct sleep hygiene practices at night*
Medical staff responsibilities:	*a. Develop, implement and monitor illness prevention guidelines* *b. Screen for airway inflammation disturbances (asthma, allergy and other inflammatory airway conditions)* *c. Identify and manage high-risk athletes (allergies, upper respiratory tract infections, gastro-intestinal tract problems, competition load)* *d. Vaccinate for at home & foreign travel exposure; preferably out of season, including support staff, be aware of possible side effects:* ▪ *Influenza vaccines (5-7 weeks to take effect)* ▪ *Hepatitis A & B* ▪ *Human Papilloma Virus* ▪ *Tetanus prophylaxis* ▪ *Dukoral for travellers' diarrhoea* *e. Implement on-going illness surveillance systems* *f. Use sensitive tools for sub-clinical signs of illness e.g. non-specific symptoms and signs / selected special investigations* *g. Monitor for early symptoms & signs of overreaching / overtraining* *h. Treat at onset of upper respiratory tract infections (zinc lozenges), to reduce sick days* *i. Screen for serious medical conditions* **i.** *Cardiac:* ▪ *Sudden cardiac death incidence 2.3 to 4.4/100,000 per year in USA* ▪ *Hypertrophic obstructive cardiomyopathy in men & African Americans* ▪ *Coronary artery anomalies, ruptured aortic aneurysm, myocarditis and arrhythmias*

Medical staff responsibilities:	**ii.** *Other:* ▪ *Pulmonary embolism, exercise induced asthma, sickle-cell disease* *j.* *Single room accommodation during tournaments for athletes with high competition load, high performance priority or susceptibility to respiratory tract infections* *k.* *Use facial masks during strenuous exercise to protect athlete's airways from direct exposure to cold (<0°C) and dry air* *l.* *Consider zinc lozenges (>75 mg zinc/day; high ionic zinc content) at the onset of upper respiratory symptoms (some evidence of reduced number of days with illness symptoms)*
Nutrition:	a. *Well-balanced diet with sufficient intake of nutrients* b. *Individualised nutrition programs. Avoid essential micronutrient deficiencies* c. *Encourage carbohydrate intake (during & after exercise); carbohydrate & protein (after exercise)* d. *Consider ingestion of probiotic e.g. Lactobacillus or yoghurt* e. *Supplement vitamin C, vitamin D, cystine and theanine* f. *Other: regular consumption of fruits and plants, polyphenol supplements (e.g. quercetin), non-alcoholic beer, green tea etc. to reduce risk of illness*
Manage load:	a. *Detailed & individualised training & competition planning* b. *Detailed post-event recovery plan (encompassing nutrition, hydration, sleep, and psychological recovery)* c. *Monitor and manage competition & training load (external and internal load)* d. *Individualise for intra- and inter-individual variances (variances in the timeframe of response and adaptation to load)* e. *Small weekly increments of less than 10%* f. *Stress management techniques, variation in psychological stressors*

Table 5: General guidelines and advice to athletes, medical staff and athlete support teams to reduce the risk of illness in athletes while competing or training abroad.

Table 6

	Travelling Individual	*Travelling Team*
Positives	• *Individual adaptation possible* • *No room mates, lower potential infection, better sleep* • *Time of exercise, meals, etc. not prescriptive due to team schedule*	• *Shared responsibility, management support* • *Support and motivation from team members*
Negatives	• *No support. All responsibility lies with the athlete including travel arrangements, accommodation, nutrition, medical support*	• *Continuous close contact with team members, higher potential for infection* • *Bed time may be a challenge* • *Difficult to individualise management strategies e.g. training times*

Table 6: Differences between travelling as an individual vs as a Team.

Practical clinical guidelines to reduce the risk of illness in athletes

Illness prevention is a key component to protect the health of the athlete, and practical approaches to prevent illness are essential to reduce the risk of illness that can restrain participation in important competitions. The prevention of illness in athletes involve implementation of behavioural, lifestyle and medical strategies in order to limit the transmission of infections. Nutritional strategies to maintain immunity in athletes, strategies to measure, monitor and manage training and competition load, and methods to detect early signs and symptoms of illness, over-reaching and overtraining are also important. General guidelines while competing or training abroad include advice to athletes, and measures that can be applied by medical staff and athlete support teams (Table 5)[3,5-6].

Although travelling abroad may be considered to equally affect both the individual athlete and the team-sport athlete in a similar way, there are several important elements of concern to consider (Table 6).

CONCLUSION:

The travelling athlete or team may suffer from travel fatigue and jet lag and may be exposed to a variety of insults e.g. allergens, pathogenic organisms and unfamiliar environmental conditions and cultures at the new destination. The extent thereof depends on intra- and inter-individual variation in the ability to tolerate circadian phase misalignment. Although many uncertainties exist on methods to advance or delay the circadian body clock, jet lag is potentially modifiable with strategic exposure to or avoidance of light, administration of melatonin and correct timing of exercise and meals. Furthermore, to ensure uncomplicated travel, environmental conditions need to receive attention and illness preventative measures need to be in place. The key to success remains in meticulous planning.

References

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Dina C. Janse Van Rensburg, M.B.Ch.B., M.Sc., M.Med., M.D., F.A.C.S.M., F.F.I.M.S.

Audrey Jansen van Rensburg, M.Sc.

Section Sports Medicine and SEMLI
Faculty of Health Sciences
University of Pretoria
Pretoria, South Africa

Martin P. Schwellnus, M.B.B.Ch., M.Sc. (Med.), M.D., F.A.C.S.M., F.F.I.M.S.
Section Sports Medicine and SEMLI
Faculty of Health Sciences
University of Pretoria
Pretoria, South Africa

International Olympic Committee (IOC) Research Centre
South Africa

Contact:
christa.jansevanrensburg@up.ac.za