Jet Lag and Travel Fatigue: A Comprehensive Management Plan for Sport Medicine Physicians and High-Performance Support Teams

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Abstract: The impact of transcontinental travel and high-volume travel on athletes can result in physiologic disturbances and a complicated set of physical symptoms. Jet lag and travel fatigue have been identified by athletes, athletic trainers, coaches, and physicians as important but challenging problems that could benefit from practical solutions. Currently, there is a culture of disregard and lack of knowledge regarding the negative effects of jet lag and travel fatigue on the athlete's well-being and performance. In addition, the key physiologic metric (determination of the human circadian phase) that guides jet lag treatment interventions is elusive and thus limits evidence-based therapeutic advice. A better understanding of preflight, in-flight, and postflight management options, such as use of melatonin or the judicious application of sedatives, is important for the sports clinician to help athletes limit fatigue symptoms and maintain optimal performance. The purpose of this article was to provide a practical applied method of implementing a travel management program for athletic teams.

Key Words: sleep, circadian rhythm, jet lag, travel fatigue

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INTRODUCTION

Jet lag is a syndrome of symptoms manifested by physiologic adaptations that occur when the body is shifted into a new time zone. Travel fatigue is a more complex summation of physiologic, psychologic, and environmental factors that accrue during an individual trip, accumulating over the course of a season and reducing the athlete's capacity to recover and perform.

Despite the lack of generalizable research, over the last 40 years, investigators in applied chronobiology and jet lag research have come to conclusions regarding the management of jet lag and travel fatigue.[1–9] Sleep deprivation has been identified as a key factor that exacerbates the magnitude and duration of jet lag symptoms.[10] Exogenous melatonin, light therapy, and light avoidance techniques are potent shifters of the circadian phase. However, there are vast interindividual and intraindividual variations in the response to these interventions,[8] making it difficult to provide a general therapeutic advice. The most effective management strategy is preflight adaptation to the destination time zone, although the practical application of this method is limited in sport.[11] Education addressing behavioral management of jet lag has been strongly recommended.[9]

The present approach to management tends to be anecdotal and can lead athletes to use pharmacologic agents indiscriminately. Sleep deprivation is used to drive circadian adaptation without regard for the negative effects. The timing of light exposure and light avoidance are not considered when traveling. Furthermore, no routine strategies are implemented for recovery opportunities during travel.

Athletes have much to gain from basic sleep education. Reilly et al[9] summarized the implications of jet lag and travel fatigue on athletic performance and recommended the development of educational programs aimed at setting guidelines for interventions. The present article outlines an approach that incorporates interventions for the management of jet lag and travel fatigue.

JET LAG VERSUS TRAVEL FATIGUE

Distinguishing between jet lag and travel fatigue has implications for travel schedule planning and athlete health monitoring. Jet lag is the consequence of circadian desynchronization and resolves with resynchronization at a rate of 1 day per time zone (Figure 1). Jet lag tends to be episodic and characterized by gastrointestinal disturbance (heartburn, indigestion, diarrhea), sleep disturbance, intermittent fatigue, and impaired concentration. Travel fatigue accumulates over the course of a season and requires ongoing monitoring of the athlete to detect and correct the consequences (Figure 1). Travel fatigue tends to be characterized by persistent fatigue, recurrent illness, changes in behavior and mood, and loss of motivation.

A more sophisticated view of jet lag and travel fatigue takes into account the direction of travel, number of time zones crossed, frequency of trips, and length of season (Figure 2). The concept of "time zone differential" is introduced to account for the circadian factors of "time of day"[12,13] and jet lag that occur on an episodic basis and is a function of direction and distance traveled. The concept of "recovery

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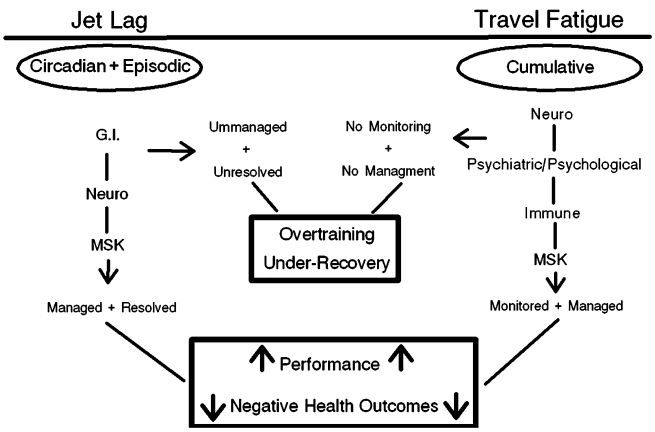

FIGURE 1. Jet lag and travel fatigue symptoms and management algorithm. The symptoms of jet lag are a function of circadian desynchronization and largely episodic, whereas the symptoms of travel fatigue are cumulative and chronic. The goal is to minimize jet lag symptoms by effectively addressing circadian resynchronization while monitoring the athlete for cumulative fatigue, managing the impact of travel, and preventing the health consequences associated with travel.

window" accounts for the time available for recovery and is dependent on the distances traveled, frequency of trips, and length of the season. There is evidence that time of day and "circadian advantage"[12,14] affect performance but do not result in jet lag, while time available for recovery[13] has been shown to correlate with improved performance.

TRAVEL MANAGEMENT PROGRAM

The Travel Management Program is a comprehensive approach to the management of jet lag and travel fatigue that encompasses the preflight, in-flight, and postflight periods. Performing a brief sleep history during the medical and collecting a month's worth of sleep logs will help to establish whether the athlete has a sleep problem and help to determine who is more susceptible to jet lag and travel fatigue.

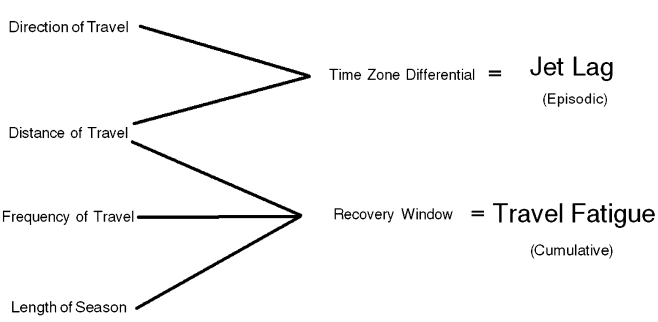

FIGURE 2. A conceptual model of jet lag and travel fatigue. Several factors influence the time zone differential and the recovery window associated with jet lag and travel fatigue. Time zone differential is a circadian phenomenon that accounts for time of day factors and circadian resynchronization that affects performance. The recovery window refers to time available for athletes and teams to recover from competition and travel in preparation for upcoming competition throughout a season.

Preflight Component

Preflight adaptation can be difficult because of schedule restrictions but is generally considered within 7 days of travel.[15] Teams could adopt modified training routines that incorporate reduced volume and intensity. Furthermore, it may be advisable to adjust training to the destination time zone a few days before departure. Choosing an evening flight for travel eastward (ie, from North America to Europe), and the use of layovers for travel across 10 or more time zones, will aid with effective adaptation.[5,9] Above all else, an emphasis should be placed on getting enough sleep before travel to reduce sleep debt.

In-Flight Component

The management of in-flight activities during travel is critical. The athletes must be provided with concrete interventions to assist them in using the flight for recovery and adaptation. Advising the athletes to adjust their watches to the destination time zone as soon as they board the plane will assist them in preparing for the destination. A comfortable environment should be created by using pillows and supports while distractions (eg, electronic devices) should be minimized. Eyeshades and earplugs should be used to aid rest, and noise-canceling listening devices should be used to help relaxation, not overstimulating the athlete. Accordingly, in-flight meals should be eaten on the destination schedule. Accomplishing this may be made easier by having the athletes bring their own meals aboard. Maintaining proper hydration should be made a priority. Sleep onboard should occur according to the destination schedule. To facilitate this, the strategic use of sedatives and/or melatonin (see Interventions: Pharmacological) to facilitate sleep is recommended.

Postflight Component

The postflight period stretches from 2 to 4 days on arrival. During this time, the activities of the athlete (including meals, sleep, rest, and recovery) are strategically planned by the support team to accommodate rapid circadian adjustment. In cases where this cannot be done, the implementation of fatigue countermeasures becomes essential. The most effective intervention in these situations should be a combination of scheduled light therapy, light avoidance, and melatonin. Additional fatigue countermeasures include the judicious use of napping and caffeine, both of which can synergistically improve the alertness of the athlete and reduce symptoms of fatigue.[16] In individuals with a history of insomnia and fatigue, the appropriately timed use of sedatives and caffeine (see Interventions: Pharmacological) can effectively manage these disturbances. The management of symptoms should be dealt with according to each individual's need and should include the use of all measures required.

INTERVENTIONS

The practical management of jet lag and travel fatigue requires a host of pharmacologic and circadian interventions and supplementary clinical therapies (Table).

TABLE. Jet Lag and Fatigue Management Intervention Strategies

	Direction of Travel			
	East		West	
Interventions	**<3 Time Zones**	**≥3 Time Zones**	**<4 Time Zones**	**≥4 Time Zones**
Jet lag				
Pharmacologic	Postflight: medium-acting and medium half-life hypnotic*[5]	3-mg to 5-mg melatonin, 30 minutes before bed[17,18] In-flight: ultra short-acting and short half-life hypnotic*[5] Postflight: medium-acting and medium half-life hypnotic*[5]	Postflight: medium-acting and medium half-life hypnotic*[5]	3-mg to 5-mg melatonin, 30 minutes before bed[17,18] In-flight: ultra short-acting and short half-life hypnotic*[5] Postflight: medium-acting and medium half-life hypnotic*[5]
Circadian phase shifting	Meals and bedtime 1-2 h earlier, 2 d before departure (optional)[5,12]	Meals and bedtime 1-2 h earlier, 2 d before departure (optional)[5,12] Seek/avoid light according to jet lag calculator†	Meals and bedtime 1-2 h later, 2 d before departure (optional)[12]	Meals and bedtime 1-2 h later, 2 d before departure (optional)[5,12] Seek/avoid light according to jet lag calculator†
Jet lag symptom management				
GI irregularities	Antacids, bismuth subsalicylate, etc	→	→	→
Headache	Analgesics and anti-inflammatory	→	→	→
Decreased mental performance	Strategic use of caffeine (see Fatigue Countermeasures: Caffeine)	→	→	→
Decreased physical performance	Modified training routines (see Fatigue countermeasures: training)	→	→	→
Sleep disturbance	Sedatives and sleep hygiene (see Pharmacologic interventions)	→	→	→
Travel fatigue				
Pharmacologic	No intervention required. Use clinical judgment.	3-5 mg melatonin, 30 min before bed[17,18] In-flight: ultra short-acting and short half-life hypnotic*[5] Postflight: medium-acting and medium half-life hypnotic*[5]	No intervention required. Use clinical judgment.	3-5 mg melatonin, 30 min before bed[17,18] In-flight: ultra short-acting and short half-life hypnotic*[5] Postflight: medium-acting and medium half-life hypnotic*[5]
Fatigue countermeasures				
Feeding	No changes	Smaller, more frequent, recovery content meals on destination schedule	No changes	Smaller, more frequent, recovery content meals on destination schedule
Hydration	Maintain extra hydration	Maintain extra hydration	Maintain extra hydration	Maintain extra hydration
Training	No intervention required	Reduced for 2-4 d postflight	No intervention required	Reduced for 2-4 d postflight
Sleep hygiene	Maximize rest and sleep during travel	Maximize rest and sleep during travel	Maximize rest and sleep during travel	Maximize rest and sleep during travel
Naps	20-30 min at the circadian nadir	20-30 min at the circadian nadir	20-30 min at the circadian nadir	20-30 min at the circadian nadir

TABLE. *(Continued)* Jet Lag and Fatigue Management Intervention Strategies

	Direction of Travel			
	East		West	
Interventions	<3 Time Zones	≥3 Time Zones	<4 Time Zones	≥4 Time Zones
Light	As required: Mid AM light exposure (30-60 min) Mid afternoon light avoidance	Initial 2 days of arrival: Mid AM light exposure (30-60 min) Mid afternoon light avoidance	As required: Late afternoon light exposure (30-60 min) Late PM light avoidance	Initial 2 days of arrival: Late afternoon light exposure (30-60 min) Late PM light avoidance
Caffeine	50-200 mg as required	50-200 mg, mornings on waking and in the minutes before a nap	50-200 mg as required	50-200 mg, late afternoons and in the minutes before a nap

Therapeutic interventions are based on the direction of travel and the number of time zones or distance traveled from the origin of departure. Travel <3 time zones eastward and <4 time zones westward involves time of day influences and should focus on a specific set of interventions to manage the effects of jet lag and travel fatigue on performance. Longer flights extending ≥3 time zones eastward and ≥4 time zones westward require similar time of day interventions but also involve additional interventions and in-flight/postflight considerations to manage more complex circadian adjustment.

*The physician's clinical judgment should determine the need for a hypnotic based on whether or not the athlete suffers from insomnia with travel.

†Available at: http://www.fleetstreetclinic.com/calc.php.

Pharmacological

Melatonin [available over-the-counter in Canada and United States; available by prescription only in Europe, Australia/New Zealand (most commonly by trade name, "Circadin").[17]] and melatonin receptor agonists act as chronobiotics (phase shifters) and chronohypnotics (sleep induction and maintenance agents).[18] The efficacy of choronobiotic compounds is subject to a high degree of interindividual and intraindividual variability. In a Cochrane Collaboration review, Herxheimer and Petrie[19] compiled effective uses of melatonin in the prevention and treatment of jet lag based on the best evidence derived from clinical practice; our current clinical recommendations are consistent with these strategies. For instance, on transmeridian flights of 5 or more time zones eastward, immediate-release preparations of melatonin in a dose range of 0.5 to 5 mg should be used (3-mg preparations are most readily available). Preflight low doses (0.5-1.5 mg) of melatonin have proved most effective, whereas postflight 3 to 5 mg should be used (there is insufficient evidence to support the use of sustained release over immediate release preparations).[20,21] Doses should be taken 30 minutes before bedtime on the night of travel and on the first 2 to 3 nights on arrival at the destination. This will mitigate the sleep disturbance associated with jet lag while enhancing circadian adaptation.[19] The use of chronobiotic compounds by athletes should occur under the direction of a sports medicine physician who is both acquainted with the use of these drugs and has access to drug-tested product (see World Anti-Doping Agency, list of accredited anti-doping laboratories, www.wada-ama.org/en/Science-Medicine/Anti-Doping-Laboratories/).

Athletes who do not suffer from jet lag or who do not respond to melatonin and experience 1 or 2 days of insomnia on arrival will likely benefit from the use of a traditional medium-acting (20-30 minutes) and medium half-life (6 hours) sedative [eg, zopiclone (Imovane; Sanofi-aventis, Quebec, Canada) or (Zimovane; Sanofi-aventis, Paris, France), not available in the United States), eszopiclone (Lunesta; Sunovion Pharmaceuticals, Inc, Marlborough, Massachusetts), not available in Canada), temazepam (Normison; Pfizer, Inc, New York, New York or Restoril; Sepracor Pharmaceuticals, Inc, Mississauga, Canada)].[17,22] Ultra short-acting (<15 minutes) and short half-life (4 hours) sedatives [eg, zaleplon (Starnoc; Servier Canada, Inc, Quebec, Canada or Sonata; Pfizer, Inc, New York, New York), zolpidem (Sublinox; Valeant Canada, Montréal, Quebec, Canada; Stilnox; Sanofi-aventis; or Ambien; Sanofi-aventis, Bridgewater, New Jersey)][17,22] are very useful for sleep during flight. When using sedatives in-flight, deep vein thrombosis prophylaxis should be reviewed with the athletes prior to the flight.

Caffeine is used to mitigate the fatigue experienced during the circadian adaptation associated with the normal circadian nadir that corresponds to times of wakefulness and performance at the destination. The strategic use of caffeine [eg, 50-mg to 200-mg pill or beverage (the average 5 oz cup of coffee contains 80 mg of caffeine;[23,24] a 1 oz espresso contains 58 mg of caffeine.[25])] in combination with a 15-minute to 30-minute nap has been shown to be effective in improving cognitive function in sleep-deprived states and at the circadian nadir.[16]

Circadian Phase Shifting

The exposure to light is the most potent circadian phase shifter when dosed at the appropriate time and has also been shown to improve alertness.[26] Light exposure routines are available in standard jet lag calculators. Seasonal Affective Disorder light devices (450-480 nm)[27–29] at approximately 1500 lux are used for this purpose. Additionally, light avoidance maximizes the effect of the associated circadian adaptation. Light-blocking glasses with lenses that have been formulated to block between 80% and 98% of incident light in the blue range are available for this purpose.[30]

Fatigue Countermeasures

Feeding at the appropriate times enhances circadian adaptation. The recommendation is for the athlete to begin eating in accordance with typical meal times at the destination on entering the plane. During the adjustment phases (in-flight and postflight), more frequent and smaller volume, appropriately energy-balanced meals are recommended. Hydration remains a nutritional cornerstone; thus, it is advised that a replacement regimen should be established and monitored during travel.[31]

Attention should be taken to modify training routines with respect to travel. Endurance training should be modified to reduce volume, intensity, and frequency. Most importantly, the timing of the activity should not coincide with the circadian nadir (2-4 PM and 2-4 AM of the departure time zone) until there is full adaptation. Strength training is not considered to be as susceptible to the negative effects of jet lag, but high-volume and high-intensity training may put the athlete at risk for injury. Neuromuscular work is less likely to tax the system and exacerbate the fatigue. The coach should weigh the benefits/risks of training and should not assume that normal training is a necessity.

Before travel, sleep logs can be used to monitor sleep/wake patterns.[32] The athlete should determine the total hours of sleep per week that are required to perform optimally and should ensure that this amount is achieved with a combination of nighttime sleep and regular daytime naps. Importantly, rest—a state of quiet relaxation—should not be confused with napping, a short sleep period. Naps should be 20 to 30 minutes in length in a comfortable position. The use of eyeshades and earplugs is recommended to improve the quality of the sleep state.[6] Caffeine (50-200 mg) should be consumed in the minutes before or after the nap to mitigate the effect of sleep inertia.[33] While abroad, the timing of a nap should coincide with the circadian nadir to reduce cumulative sleep debt and consequent fatigue. When sleep is not necessary, the athletes should learn to rest with their eyes closed in a relaxed position and focus on slow-volume and high-volume breaths to reduce arousal.

CONCLUSIONS

Jet lag and travel fatigue are considered by high-performance athletic support teams to be a substantial source of disturbance to athletes. An evidenced-based approach to the determination of the prevalence of these conditions is difficult to establish. The current strategies are limited to interventions that are based on a modest degree of generalizable evidence. This article provides sports medicine professionals with a practical approach and specific interventions to begin developing a travel management program for individual athletes and teams.

A structured athlete travel program is the first step in establishing an effective approach to travel fatigue and jet lag. Adopting the preflight, in-flight, and postflight model[9] and incorporating a travel fatigue monitoring system will help athletic trainers and coaches and their support staff to address the problem, limit symptoms, and improve performance.

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