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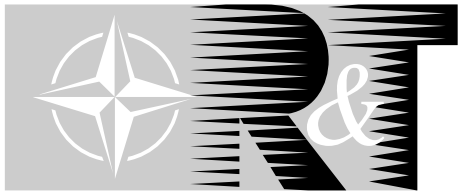

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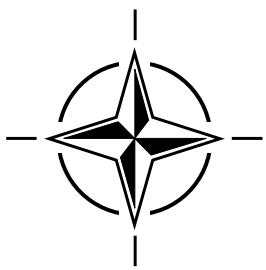
RTO LECTURE SERIES 223

Sleep/Wakefulness Management in Continuous/Sustained Operations

(La gestion des rythmes veille/sommeil lors des opérations continues/soutenues)

The material in this publication was assembled to support a Lecture Series under the sponsorship of the Human Factors and Medicine Panel (HFM) and the Consultant and Exchange Programme of RTO presented on 17-18 June 2002 in Fort Rucker, Alabama, United States, on 24-25 June 2002 in Warsaw, Poland, and on 27-28 June 2002 in Paris, France.



Published November 2002

Distribution and Availability on Back Cover

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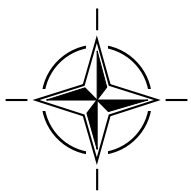

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The total spectrum of R&T activities is covered by the following 7 bodies:

- AVT Applied Vehicle Technology Panel
- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS Studies, Analysis and Simulation Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These bodies are made up of national representatives as well as generally recognised 'world class' scientists. They also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

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Published November 2002

ISBN 92-837-1073-8

Printed by St. Joseph Print Group Inc.
(A St. Joseph Corporation Company)
1165 Kenaston Street, Ottawa, Ontario, Canada K1G 6S1

Sleep/Wakefulness Management in Continuous/Sustained Operations

(RTO EN-016 / HFM-064)

Executive Summary

Synthesis

1. The first lecture emphasises that a soldier is, first of all, a human being. If he fails to respect his biological rhythms, his vigilance and performance deteriorate. During sustained/continuous operations (SUSOPS and CONOPS), this may compromise successful mission completion. If we want to preserve the soldier in these potentially hazardous operational conditions, the sleep/wakefulness cycle should be managed as well as possible.
2. The second lecture emphasises the importance of individual differences. These are due to specific sleep characteristics, the level of training in SUSOPS and CONOPS, and the knowledge we have of our own capability to alleviate the effects of sleep loss or jet lag syndrome.
3. The third lecture describes the penalising effects of sleep deprivation. First, the methods that are available to measure sleepiness and fatigue are described. Then, the effects of fatigue on performance are highlighted. Overall, sleep deprivation adversely affects performance, but the degree to which it does so depends on the nature and duration of the task, and on the amount of prior wakefulness.
4. The fourth lecture concerns the effects of jet-lag. The symptoms begin to occur with four hours of jet lag and increase in quantity and intensity with jet lags of up to twelve hours. Jet lag effects depend on the direction of the flight and on environmental and individual parameters. Jet lag is caused by desynchronisation of the biological rhythms compared to the external synchroniser (“Zeitgeber”).
5. The fifth lecture focuses on measures to counteract the effects of SUSOPS and CONOPS. A very natural measure is to take a nap. Napping strategies are described. After naps, the sleep inertia period has to be taken into account.
6. Physiological and pharmacological countermeasures are presented in the sixth lecture. Food containing high quantities of glucose and lipids increase drowsiness. Conversely, small meals containing high quantities of protein increase vigilance. Physical exercise may be helpful, and the influence of light has also been demonstrated. Pharmacological approaches are compounded by the fact that the effects of drugs may vary across individuals, and may be modified by stress, heat or cold, etc. Therefore, the use of medication should be restricted as much as possible, and possible side effects on task performance should be taken into account. The challenge is to prescribe a safe and effective substance.
7. In the seventh lecture, the advantages but also the side effects of amphetamines are discussed.
8. In the eight lecture, a new galenic form of caffeine is introduced and its interest in SUSOPS and CONOPS is demonstrated.
9. Modafinil, a new and very powerful substance, is introduced in the ninth lecture. It appears to enhance vigilance as powerfully as amphetamine, without its side effects, but the prescription of this substance is still reserved for the treatment of specific diseases.
10. Hypnotic substances are also used for sleep-wakefulness management. The tenth lecture discusses benzodiazepines and non-benzodiazepines, and their properties and side effects are highlighted.
11. Strategies to alleviate jet-lag are presented in the eleventh and last lecture. Measures like phototherapy and adapted social environments are discussed, and problems associated with the use of chronobiotic substances (e.g., melatonin) are examined.

Recommendations

1. The physiology of the sleep-wakefulness cycle should be respected as much as possible.
2. It is recommended to have a thorough knowledge of the physiology of sleep-wakefulness cycle and of one's own capabilities.
3. The best remedy against sleep loss is sleep: physiological countermeasures should be used as a first step.
4. If more is needed, medical advice should be sought in order to determine the best pharmacological aid, in the context of the future operational situation.

Concluding Remarks

We spend a third of our life sleeping. We need to properly manage the sleep-wakefulness cycle in our daily life as well as in SUSOPS and CONOPS in order to keep our vigilance and performance levels optimal. We are responsible for our own safety and sometimes for that of our crews and friends. We have to be persuaded of the importance of the sleep-wakefulness cycle management in SUSOPS and CONOPS and we have also to persuade our colleagues, as well as our commanders of this reality.

La gestion des rythmes veille/sommeil lors des opérations continues/soutenues

(RTO EN-016 / HFM-064)

Synthèse

Synthèse

1. La première conférence met l'accent sur le fait que le combattant est avant tout un être humain. S'il ne respecte pas ses rythmes biologiques, sa vigilance et ses performances vont se détériorer. Au cours d'opérations continues (CONOPS) et soutenues (SUSOPS) cela peut mettre en cause le succès de la mission. Si nous voulons protéger le combattant dans cet environnement opérationnel potentiellement dangereux, le cycle veille/sommeil doit être géré le mieux possible.
2. La deuxième conférence souligne l'importance des différences entre individus. Elles sont dues à des caractéristiques de sommeil très spécifiques, mais aussi au niveau d'entraînement aux CONOPS et SUSOPS et enfin à la connaissance de chacun de ses propres capacités susceptibles de limiter les effets de la perte de sommeil ou du décalage horaire.
3. La troisième conférence permet de décrire les effets pénalisants de la perte de sommeil. Les méthodes disponibles pour mesurer la somnolence et la fatigue sont présentées avant de voir l'incidence de la fatigue sur les performances. D'une façon générale, la perte de sommeil a un effet négatif sur les performances mais suivant un degré qui dépend de nature et de la durée de la tâche et de la longueur de la période d'éveil précédente.
4. La quatrième conférence a pour sujet le décalage horaire. Les symptômes commencent à apparaître à partir de 4 heures de décalage et augmentent en quantité et en intensité jusqu'à des décalages de 12 heures. Les effets du décalage horaire dépendent de la direction du vol (est ou ouest), de l'environnement et de paramètres individuels. Le décalage horaire est dû à la désynchronisation des rythmes biologiques confrontés à une synchronisation extérieure (« Zeitgeber »).
5. Le sujet de la cinquième conférence porte sur les mesures pour contrer les effets des CONOPS/SUSOPS. La première mesure naturelle est de faire une sieste et des conseils sur les meilleures façons de faire la sieste sont présentés tout en sachant que la période d'inertie qui suit toute sieste doit être prise en compte.
6. Les contre mesures physiologiques et pharmacologiques sont abordées au cours de la sixième conférence. Une alimentation riche en glucose et lipides facilite la somnolence et réciproquement, des repas légers avec une forte teneur en protéines contribuent à la vigilance. Tout exercice physique peut être utile tout comme la lumière dont l'influence sur le sommeil a été démontrée. Les approches pharmacologiques sont rendues complexes par le fait que les effets des médicaments varient d'un individu à l'autre et peuvent être modifiés par le stress, la chaleur ou le froid etc. L'usage des médicaments doit donc être limité au maximum, en prenant bien en compte l'incidence des effets secondaires sur les performances. La difficulté est de prescrire une substance à la fois efficace et sure.
7. Les avantages mais aussi les effets secondaires des amphétamines sont abordés dans la septième conférence.
8. Au cours de la huitième intervention, une nouvelle forme naturelle de caféine est présentée avec la démonstration de ses effets en opérations continues / soutenues.
9. Un nouveau produit très efficace, le Modafinil est présenté lors de la neuvième conférence. Il apparaît comme un stimulateur de vigilance aussi puissant que les amphétamines mais sans effets secondaires. La prescription d'une telle substance reste cependant réservée au traitement de maladies bien spécifiques.
10. Les produits hypnotiques sont également utilisés dans la gestion des rythmes éveil/sommeil. La dixième conférence fait le point des benzodiazepines et non-benzodiazepines en soulignant leurs propriétés ainsi que leurs effets secondaires.

11. Des conseils pour contrer le décalage horaire sont présentés dans la onzième et dernière conférence. Des mesures comme la photo-thérapie et des environnements sociaux adaptés pourront faire l'objet de discussions et les problèmes liés à l'utilisation de substance chronobiotiques (comme la mélatonine) seront examinées.

Recommandations

1. La physiologie du cycle éveil/sommeil doit être respectée dans toute la mesure du possible.
2. Pour les combattants, il est recommandé d'avoir une connaissance approfondie de la physiologie de leurs cycles éveil/sommeil mais aussi de leurs capacités propres.
3. Le meilleur remède contre la perte de sommeil reste le sommeil et dans un premier temps, il est souhaitable de n'utiliser que des mesures physiologiques.
4. Si elles se révèlent insuffisantes, il faut solliciter un avis médical de façon à trouver l'aide pharmacologique la plus adaptée au contexte de l'environnement opérationnel.

Conclusion

Nous passons plus d'un tiers de notre vie à dormir. Il nous faut gérer d'une manière optimale notre cycle éveil/sommeil dans la vie courante comme dans les opérations continues ou soutenues de manière à garder notre vigilance et nos performances au plus haut niveau. Nous sommes responsables de notre propre sécurité et parfois de la sécurité des équipages et des amis qui nous sont confiés. Nous devons être conscients de l'importance de la gestion des cycles éveil/sommeil lors d'opérations continues et soutenues et il est de notre devoir d'en persuader non seulement nos collègues mais également nos responsables.

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REPORT DOCUMENTATION PAGE

1. Recipient's Reference	2. Originator's References	3. Further Reference	4. Security Classification of Document
	RTO-EN-016 AC/323(HFM-064)TP/39	ISBN 92-837-1073-8	UNCLASSIFIED/ UNLIMITED

5. Originator Research and Technology Organisation
North Atlantic Treaty Organisation
BP 25, F-92201 Neuilly-sur-Seine Cedex, France

6. Title
Sleep/Wakefulness Management in Continuous/Sustained Operations

7. Presented at/sponsored by
the Human Factors and Medicine Panel (HFM) and the Consultant and Exchange Programme of RTO presented on 17-18 June 2002 in Fort Rucker, Alabama, United States, on 24-25 June 2002 in Warsaw, Poland, and on 27-28 June 2002 in Paris, France.

8. Author(s)/Editor(s)	9. Date
Multiple	November 2002
10. Author's/Editor's Address	**11. Pages**
Multiple	146

13. Keywords/Descriptors

Sleep deprivation
Stress (physiology)
Fatigue (biology)
Drugs
Amphetamines
Physiological effects
Human factors engineering
Military operations
Pharmacology
Continuous operations (CONOPS)
Caffeine
Work/Rest cycles
Stress management
Hypnotics and sedatives
Sleep
Pharmacology
Modafinil
Sustained operations (SUSOPS)
Stimulants
Circadian rhythms
Jet lag
Sleep loss
Sleep management
Sleep Wakefulness rhythm

14. Abstract

To preserve a good level of vigilance and performance, we have to respect our sleep-wakefulness cycle. The sustained and continuous operations induce disturbances of this biological rhythm, such as sleep loss, jet-lag.... There is an antinomy between the physiological requirement and the operational requirement. To be able to continue the mission but also to preserve our security and the security of the crew we need an appropriate sleep-wakefulness management. This Lecture Series presents the physiological, ergonomic and pharmacological possibilities to reach these goals.

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publié par le National Technical Information Service
Springfield
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Imprimé par Groupe d'imprimerie St-Joseph inc.
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1165, rue Kenaston, Ottawa (Ontario), Canada K1G 6S1

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Printed by St. Joseph Print Group Inc.
(A St. Joseph Corporation Company)
1165 Kenaston Street, Ottawa, Ontario, Canada K1G 6S1

ISBN 92-837-1073-8