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Medical Effects of Night Shifts

Introduction

Air Traffic controllers more or less all over the world, are working during the night when the body is prepared for sleep. Economic growth, and competition through increased utilisation of the 24-hour day, is generally resulting in more traffic. In general the need for ATC-services during the night varies from the controller who has to be on duty for military preparedness with only occasional traffic, or is on stand by duty and have to hurry to work if called upon during the night, to controllers who are facing an ever increasing number of flights to handle during night hours. The latter due to general growth in aviation worldwide, with exceptional growth in the overnight freight market. Some areas of the world have very heavy traffic volumes during night hours. (e.g. the Middle East and the North Atlantic)

Controllers have been coping with problems related to night shifts for decades, without the support of scientific data indicating a connection between work hours, sleepiness/fatigue and incidents and accidents. The controllers' task in the future is seen more as an Air Traffic Manager role, with even stronger demands for vigilance in monitoring the traffic flow on more complex and automated ATC-systems. This need for increased vigilance in an occupation which has unique demands in relation to the level of concentration and precision required, and the consequences of human error, seen in the light of psychological effects of night shifts is of importance for IFATCA. This combination of an increasing demand for ATC-service during the night and widespread use of automation will continue to escalate in the next century, further increasing the risk of fatigue-related accidents. Fatigue management and prevention of fatigue-related catastrophes need to become a sustained priority for government, industries, labour, and the public. (David F. Hinges, Co-Director, Unit for Experimental Psychiatry, University of Pennsylvania School of Medicine, Journal of Sleep Research (JSR) 1995).

In recent years, there has been a growing interest among scientists in identifying a connection between work hours, sleepiness and incidents/accidents, and establish possible countermeasures. There are increasing amounts of scientific data indicating that such connections exist.

However, it is not possible to link one cause as the exact answer, because of individual differences, and a number of factors which act together in affecting human performance. It is important to note that when scientists use the word accident, it is use to signify that something unintentional happened that either lead to, or could have led to, property damage, injuries and/or fatalities. In this paper, when the term accident is used, we are referring to the scientists' meaning of the word, unless otherwise stated. When the term incident is used it is to signify an unintentional occurrence that could result in an aviation incident or accident.

Working night shifts affects the human performance in a way that lowers the general performance level of the controller. This degrading of performance is lowering the safety margins of the ATC system, and the reasons why this occurs must be understood, and appropriate countermeasures taken to compensate for this degrading in the short term (before and during

the particular night and the following day). The long-term (over the years) effect of working night shifts, such as generally reduced health, will also be discussed.

A large number of studies have shown that accidents have a considerably higher probability of occurring in the late night hours. Many of the recent major accidents (Three Mile Island, Chernobyl, Exxon Valdez, Bhopal Chemical plant explosion, space shuttle Challenger etc.) have been clearly linked to work-hour induced fatigue or sleepiness. According to NASA research, 21% of all aircraft accidents are related to fatigue. Controllers accustomed to working night shifts are well aware of attacks of drowsiness and the urge to sleep while on duty and sleeping problems the following day(s). It is now possible to link such problems to scientific studies on sleepiness in work related accidents. We will discuss these findings from a controller's viewpoint, and include suggestions for appropriate countermeasures.

Discussion

What is sleep, and what causes sleepiness?

There are two types of sleep, REM and non-REM sleep. (REM 3D Rapid Eye Movement). Non-REM sleep can be divided into four different stages. Sleep stages can be identified by recordings of differences in EEG-waves of brain activity. In non-REM sleep we have stage 1, stage 2 and stage 3 and 4. Stage 3 and 4 is often referred to as Delta sleep. The dividing into stage 3 and 4 has no practical purpose, and they are thus referred to as one stage. REM sleep is not divided into Stages. Deep sleep is associated with Delta-sleep, and usually occurs after 30-45 minutes of sleep. REM sleep is often associated with dreaming. REM sleep and non-REM sleep alternates with approximately 90-minute intervals, and the duration of REM sleep normally varies from a few minutes early in the night to more that 30 minutes towards morning.

Earlier the scientists' opinion was that deep sleep was the most important stage for rest-recovering. Today experts points to the composition of all stages as equally important for recovery. Sleep loss of as little as 2 -3 hours a night can contribute to sleepiness for several days, following in a cumulative manner (Carskadon and Roth 1991; Dinges et al. 1994). The main cause of sleepiness during irregular work hours is the biological clock and the homeostatic regulation of sleep and wakefulness (Professor Skerstedt, Karolinska institute, Stockholm, (JSR 1995). The biological clock is 'controlled' through neurobiological processes regulating circadian rhythms and the drive to sleep.

The circadian rhythms (circa 3D approximately, dian 3D day, i.e. ca. 24 hours) follow a pattern slightly longer than 24 hours. Because sleep is restricted at normal times of sleep during the 24-hour period during which a night shift is conducted, sleepiness can be the result. Nightshifts often start after an extended time of wakefulness (10 - 16 hours instead of 1 of 2 hours as in day work). In addition, poor daytime sleep due to circadian interference makes it difficult to regain sleep loss. When all these factors are operative, the increase of fatigue becomes extreme and sustained wakefulness virtually impossible (Professor Skerstedt, Karolinska Institute, Stockholm, (JSR 1995). The terms 'sleepiness' and 'fatigue' are often used synonymously and can have a number of meanings. In this paper we use the term 'sleepiness' to indicate the result of sleep loss to an extent that makes the controller wanting to sleep even though he or she is at work.

Recovery from sleepiness is normally achieved with a good night's sleep. The term 'fatigue' means the degrading of human performance because of sleepiness caused by the effects of

working too long, or following too little rest, and being unable to sustain a certain level of performance on the controller task. Fatigue is usually associated with, or accompanied by, a feeling of exhaustion above the normal experience of sleepiness. Recovery from serious fatigue may take a significant amount of time off duty. The interaction between the circadian rhythms and the drive for sleep determines the level of alertness and performance. Thus sleepiness and the diminished performance that follows fatigue will occur in the brain of every human, regardless of training, occupation, education, motivation, Skill level, intelligence, or the commitment of the person to maintain high levels of waking alertness. (Dinges, JSR 1995). There is ample evidence of impaired safety due to work-hour-induced fatigue. (Professor Skerstedt, Karolinska institute, Stockholm, JSR 1995).

Individual differences, age and gender.

One-site studies of shiftwork show considerable differences in sleepiness between workers. Effects of differences in circadian phase (some are early morning types, others are evening types, or 'night owls'), physical fitness, sleeping habits, eating and drinking habits, personal and family life style are all factors to be considered. It is important to know that the interaction of these (and other) factors influences an individual's exposure to fatigue. At the time of writing, there is insufficient scientific evidence to conclude that certain personality types should not become shiftworkers, but generally speaking the evening type adapts better to sleep disturbances related to shift work. Preventive advice to future shiftworkers is recommended. (Dr. Mikko Herme, JSR 1995).

Age is one of the most cited factors affecting sleep. As age increases, the flexibility of the biological clock is reduced. This can be seen in the young student studying all night, and attending class the next morning, and making up for the sleep loss by sleeping until noon during the weekend, compared to the grandfather who 'cannot function' without his afternoon nap, even though his grandchildren pay him a rare visit. Elderly people show many age-specific changes in sleep timing and structure. Older individuals have an earlier circadian rhythm. This may explain why older individuals tend to get sufficient sleep more easily before an early morning shift. In addition, older people tend to divide their need for sleep between shorter nights and an afternoon nap. Additionally, changes in social and family life, with fewer domestic responsibilities, better housing (and sleeping) conditions and more experience of the different coping mechanisms about how to manage night shifts, can indicate that older workers are coping better with the effects of nightshifts, than their younger colleagues.

However, studies indicate that sleep disturbances in shiftwork start to increase after the age of 40 - 50 years (Foret et al. 1981, Skerstedt and Torsvall 1981, Parkes 1994, JSR 1995). But changes in sleep length and structure with age many not be relevant for the estimation of sleep problems - changes in alertness and performance are more important. Several studies have found a deterioration in health after many years of shiftwork for some shiftworkers. This deterioration in health may have a negative influence on performance. (e.g. Angersbach et al. 1980, Costa et al 1981, Kundi et al 1986). However, adequate longitudinal studies are lacking. It can be argued that a worker can organise his or her work in a way which is adjusted to his of her functional capacity. This is absolutely not the case for air traffic controllers. Consequently a relevant question will be; is the long-term strain taken into consideration when retirement age and possibilities for less demanding work for older employees are determined? This is strong medical evidence to support existing IFATCA Policy on Retirement and Pension. (IFATCA Policy on Retirement and Pension, page 4151)

According to most studies, female shiftworkers usually suffer more from sleep deficit and complain more about difficulties falling or staying asleep, mid-sleep awakenings, tiredness, irritability and fatigue accumulation (Dirkx 1991). According to Oginaska et al. (1993), female shiftworkers suffer more frequently from drowsiness at work, especially during the early morning shift. As expected, young women suffer more from disturbed sleep because of child care responsibilities (Lee 1992). Women may need 90 minutes more sleep than men per every 24 hours. Despite this the gender differences in shiftworkers' sleepiness are likely to be due women's primary burden of both household and child care. Studies which have controlled for these factors, have found that the sex of the subjects does not affect the sleep of shiftworkers (Beerman and Nachreiner 1994). In addition, the tendency over large parts of the world is that responsibility for childcare are more equally divided between both father and mother. On the other hand, after a divorce, the mothers tend to be the ones who are taking care of the children on a daily basis.

Design of duty rosters, speed and direction of shift rotation.

More often than not it is the social aspects of how duty rosters are designed that are of most concern for controllers. IFATCA Policy on the issue exists, and should be used as reference. The information put forward in this paper suggests that controllers should be more concerned about the medical effects of duty rosters design than the social aspects alone.

On demand callouts on duty vs. planned night shifts.

Generally speaking, most controllers find it better to be in their own bed during part of the night, and occasionally be called upon, rather than to stay at work with little or nothing to do, except for the occasional flight some nights (ambulance, SAR etc.). However, studies show that both sleep duration and fragmentation of sleep also reduces daytime alertness, even with relatively long intervals without wakening. This is a strong argument for establishing planned night shifts, with the provisions to sleep at the workplace, even though the traffic numbers are not clearly indicating demand more than a certain number of nights during a typical year. On demand call-outs from standby duty also affects the controller's family and their daytime alertness will also suffer from fragmentation of sleep. If a unit have more than a certain number of on demand callouts on duty, implementation of planned night shifts should be considered.

Consecutive night shifts vs. rotating shift work.

Several studies have been conducted on differences of consecutive nightshifts; e.g. a week of night shifts, vs. rotating shifts. For jobs including cognitive tasks and which involve a high memory load and high degree of concentration, such as ATC, most studies conclude that rapidly rotating shift systems are the most preferable (Monk and Embryo, 1981). The body is resultant to circadian adjustment, and as a result controllers working consecutive night shifts accumulate a sleep deficit which can result in fatigue, and even 'night shift paralysis' (Folkard and Condon. Night shift paralysis in ATCOs, 1987). For the same reason, and the fact that the body resists to 'accelerate' its circadian rhythm, the direction of rotation and speed of rotation might also influence fatigue. Shifts should rotate rapidly in a morning, evening, and night direction. After the night shift, an off duty period of 16 hours is needed from a sleep recovery point of view. Some shift schedules have as little as 8 hours between shifts. The effects of such quick changeovers have been examined in some studies, and showed that sleep was clearly reduced. NASA recommends a minimum of 10 hours between shifts. An early morning shift followed by

a night shift the same day and a night shift followed by an evening shift the same day is probably the combinations that will give the most pronounced deficit. Such sleep deficits can cause serious fatigue, and quick changeovers should therefore be avoided. (Kecklund and Skerstedt, JSR 1995). (IFATCA Policy on Hours of Work, page 4.1.3.1.)

Effects of timing of shifts on sleepiness and sleep duration.

Studies show that even moderate sleep restrictions may increase sleepiness. When sleep duration is reduced to below 5 hours, the negative effects on sleepiness and performance is clear (Wilkonson 1966: Johnson 1981, Carskadon and Roth 1991; Gillberg and Skerstedt 1994). Thus sleep duration will determine much of the morning shift sleepiness. It seems to be impossible to improve the timing of one shift without affecting another shift negatively. If there is an early shift-change time between night and morning shifts problems will occur in connection with the morning shift. A late shift-change time will give problems in connection with the night shift. The ideal solution is to advance the end of the night to 05.00 hours or earlier and stop working between 05.00 hours and 07.00 hours, at which latter time the morning shift should start. Unfortunately, this does not seem possible in ATC. An acceptable compromise has to be found, where sleep duration is not too short (>5 hours for all shifts) and sleepiness at work not too severe.

Which respect to the off duty time between shifts it appears that close to 16 hours is needed and that quick changeovers should be avoided. There is, however, a need for more experimental studies with different timings if shifts and off duty time. In Particular, the knowledge of how sleepiness is affected by the timing of the morning shift is clearly incomplete. There is also a need to consider individual and social factors (age, family situation, early morning types or 'night owls', travel time to work etc.). Possibly the latter variables can help us to understand controllers' different preferences with respect to the timing of shift and off duty time.

Overtime, extended workshifts and excessive fatigue.

Research demonstrating increased fatigue with long workshifts, and a lack of substantial research on other factors which may modulate fatigue, indicate that schedules requiring long workshifts should be instituted with caution.

This is particularly the case in ATC since the job does not allow a wide margin of error. Any situation where increased fatigue, decreased sleep, or performance loss can be demonstrated it is a situation where the margin for error is reduced, albeit by some unknown amount, and should be avoided in ATC. Due to controller shortage in many areas of the world, there is an extensive use of overtime throughout. The allocation of this overtime should be done with limitations of human performance in mind. In the health/safety domain, overtime has been associated with lower self ratings of health status, lower birth weight or gestational age in children of women working overtime (Marbury 1992), and increased medical indications of stress response. Frequent overtime work was associated with increased alcohol abuse among men (Kawakami et al. 1993) and higher suicide rates. The combination of overtime and night shifts clearly increase the risk for fatigue among controllers, because resting periods are reduced, and the possibility for sleep-loss recovery may be reduced accordingly. In addition, overtime work influences the ability to participate in domestic responsibilities, thus adding to the total stress level.

Short term countermeasures.

Strategic naps

Controllers' shift rotation should be of the rapid rotating type and because, generally, less manpower is needed during night times compared to day times, it is normally not applicable to divide the work force in to three shifts of equal size, as often is seen in the 24 hour manufacturer industry. We also know that fatigue increases with number of consecutive night shifts. Considerable effort should be done, by all means available, to reduce the possibility for controller fatigue, due to the unique demands in respect of the level of concentration and precision required, and the consequences of failure of the controllers' work. Implementation of napping in mainly linked to three major factors. Approval and encouragement from management, physical arrangements (relief controller and adapted rest area) and sleep inertia in conjunction with emergencies. In addition, IFATCA Policy on Night Work must be considered. (Reference page 4131)

Approval and encouragement from management and physical arrangements

One of the largest benefits of a shift rotation of the rapid rotating type is that the workers don't have to alter their circadian rhythm as a consequence of night work. Recovering from impaired main sleep (sleep loss during the night shift) is done by sleeping the following day. Many controllers have problems going to sleep the following night. This is often a result of sleeping too long during the day after night shift, and thus disturbing the circadian rhythm. To reduce this effect, a better way of recovery for sleep loss can be by supporting the impaired main sleep with a short sleep during the night. This can be called anchoring of the circadian rhythm. (Minors and Waterhouse, 1981). In addition to reducing the negative effects of sleep loss the day or days after a night shift, a short nap may serve to maintain alertness at acceptable levels during night shifts. (Gillberg 1986, Dinges et al.1988, Rosekind, Muzet, JSR 1995). This is especially important if the night shift is responsible for handling late night/early morning rush hours with an increasing amount of traffic at the time when the body is 'crying for sleep'. (Often identified as the period between 05.00 and 07.00 hours). With this knowledge in mind management should have a strong interest in discussing introduction of napping as a strategic countermeasure to reduce the overall stress and pressure put on controllers.
Unfortunately, despite these positive effects which are documented by several studies, acceptance of napping seems to be difficult for cultural reasons and work ethics. Both managers and some controllers seem to suffer from the notion that napping is an indicator of lack of ambition and low professional ethics. In addition, managers might want to increase the number of hours on duty, because controllers are allowed to sleep and rest while at work (not at the control positions of course). This will only add to the possibility of developing chronic fatigue. Another obstacle is the fact that a widespread notion is that one just cannot fall asleep 'at will'. Sufficient time to settle for sleep must be provided. The medical evidence brought forward in this paper strongly supports IFATCA Policy on working times during night shifts. A controller should not work more than 5 hours without relief. If one combines this policy with the encouragement to establish a routine of napping, great improvements in both night-time and daytime alertness should be expected. To secure a successful introduction of napping as a systematic countermeasure, an adequate number of relief controllers and adapted as well as accepted rest areas have to be provided.

Sleep inertia

Sleep inertia, which is the decay in general performance caused by the feeling of grogginess, disorientation and sleepiness than can accompany an awakening from deep sleep, is a potential negative effect of napping. The time to overcome these effects can vary from a few minutes to 35 minutes, though most negative effects normally dissipate in about 10-15 minutes (Skerstedt et al. 1989, Dinges 1989). Two factors seem to be of importance to the severity of these effects; duration of sleep and circadian time of nap (Skerstedt and Gilberg 1979, Dinges et al. 1987, Langdon and Hartman 1961). Sleep inertia is more pronounced if awakened from Slow Wave Sleep (SWS) than from REM sleep. Thus, sleep inertia is less likely to be a factor if the nap is taken towards the end of the night shift (around 04.00) when the body temperature is at its lowest under which SWS does not occur. If the nap is restricted to less than 60 minutes, the amount of SWS will be less than if a longer sleep is allowed. Relief times should take sleep inertia into consideration so as to provide for at least 15-30 minutes of wakefulness before returning to the working position. This constitutes a problem in case of emergencies. However, research indicates that sleep inertia can be significantly reduced or even eliminated by such factors as intense motor activity and a high level of motivation (Muzer et al. JSR, 1995). It is obvious to all familiar with ATC that both of the listed factors are very much present in ATC-handling of an emergency.

Relief controllers

For many controllers the traffic volume during night shifts is much lower than during day shifts. That often means relief is not available, and other factors, such as weather, break down of equipment, as well as occasional traffic peaks, can make the controllers' tasks more complex than the normal working situation during day shifts. On top of this comes the degrading of human performance caused by sleepiness and fatigue. Controllers, and management, should carefully consider staffing levels during night shifts to comply with IFATCA Policy (4131 Para. 3.2.4.). For the controllers who experience very heavy traffic loads during the night shifts, additional relief should be considered as an appropriate countermeasure to sleepiness and fatigue in order to increase the safety margins. Each units' ability to establish napping as a strategic countermeasure is clearly linked to the availability of relief controllers. It is important that management is made aware of the fact that the expenses of introducing an extra controller during night shifts, actually can be a valuable investment, not only in respect of avoiding an accident because of fatigue, but also in less sickness caused by fatigue.

Eating and drinking habits

The body temperature is reduced during night hours. This is also linked to metabolism, which is lower at night than during our most active periods of the day. The body is not prepared for eating heavy meals very late, and doing this will contribute to a feeling drowsiness. The best countermeasure in this respect, is to maintain one's daily eating habits. During night shift, low fat and high-energy food in small quantities is recommended. (Prof. Grete Myhre, Personal Communication, 1996). Dehydration is sometimes a problem when a significant time is spent in control rooms, due to the low relative humidity caused by electronic equipment in such environment. Drinking sodawater is the best way of avoiding dehydration, in addition to properly functioning humidifiers. Caffeine has been shown to increase alertness and improve psychomotor performance during usual shift hours when taken between 22.30 and 01.20 hours. Available data indicate that at approximate dosages of 250-400mg, the beneficial effects persist

until at least 05.30 hours. For most people, caffeine taken at the start of the night shift does not interfere significantly with daytime sleep beginning at 09.00 hours. There is also some evidence that single doses of caffeine at the beginning of a night shift may be more effective inducing alertness than divided doses. (Walsh, Muehlbach and Schweitzer, JSR 1995)

Control room temperature

Because body temperature is reduced during night-hours, a natural reaction would be to increase the environmental temperature (normally set at 22 degrees Celsius) while working during night 'to help the body' sustaining a normal working temperature. That is not the case. A better way to help the body, is to reduce the control room temperature to 20 - 21 degrees Celsius, and wear warmer clothes if one feels chilly.

Hypnotics and the use of bright light.

Hypnotics and the use of bright light may be used to alter the circadian rhythm. Altering the circadian rhythm is not desirable in ATC with rapid rotating shifts. Hypnotics and the use if bright light can, however, be an aid for controllers who have developed serious sleep problems. Treatment with Hypnotics can lead to psychological addiction. Such treatment should be carefully analysed before applied on working controllers. However, the effects of bright light can be utilised in designing a better working environment during night hours. Obviously, the ambient light in control towers must be dim, but approach- and area control rooms should be kept very bright. Rest areas not intended for napping should also have bright light, at the amount of minimum 25 000 Lumen (Czeisler, 1986). Bright light halts the production of the pincal hormone Melathonin. Melathonin does to a certain extent control the circadian rhythm, and can have positive effects on the ability to adjust the circadian rhythms after disruption (J.Arendt et al. JST 1995).

Tobacco

Smoking of tobacco is shown to have stimulating effects on smokers' alertness. However, the demands for tobacco-smoke free areas at the workplace put restrictions on smoking at many places. Smoking can have a positive effects on alertness for smokers, but reduces dexterity and should therefore be avoided. Non-smokers suffer from reduced alertness when they are exposed to tobacco smoke.

Use of drugs and alcohol

Controllers should be aware that the use of sleeping drugs may lead to addiction which in turn can reinforce the negative effects of sleeping problems. It is well known that falling asleep after drinking a large amount of alcohol is fairly easy, but one feels groggy and tired the day after. This is due the fact that under the influence of alcohol, the body falls directly into deep sleep, and not altering naturally through all 4 stages. As mentioned earlier, it is the composition of all stages that are important for sleep loss recovery. However, experience shows that small amounts of alcohol can have a relaxing effect, and thus acts as a sleeping drug.

Long term countermeasures.

Education and self-knowledge

Air Traffic Controllers' education should include theory on this subject in particular, when Human Performance curriculum is determined. A controller who understands the physiological principles related to sleep and circadian rhythms is better prepared to take deliberate actions to meet his or her operational requirements. It is important to note that variations between individuals in how they cope with effects of night shifts depend on several factors.

Personal lifestyle

High or moderate physical fitness seems to reduce sleepiness during night shifts. A study involving a 4 month programme of between 2 and 6 training sessions per week showed that the physical conditioning did not change the circadian adjustment to night work, but increased sleep length and decreased sleepiness, particularly during the night shifts (HE4rmelE4 et al 1988). Further studies (Vitiello et al. 1994) showed that physical fitness training in older adults results in changes similar to those observed in younger individuals in slow wave sleep as well as in amplitude and phase of the body temperature. Individuals living a harmonious physical and social life are generally coping better with the effects of night shifts than individuals with less harmonious lives.

Anchoring of eating and sleeping habits

Several studies indicate that individuals who are able to stay as close as possible to their normal daytime routines regarding eating and sleeping, while coping with the challenges of night shifts, are the ones who experience less adverse effects when it comes to digestion and sleeping disturbances. (Prof. Grete Myhre). Anchoring of eating and sleeping habits is therefore important, and the controllers' families should also be informed of this importance.

Possibilities for less demanding work with increasing age

As discussed earlier, age is one of the most cited factors affecting sleep. As age increases, the flexibility of the biological clock is reduced. Older individuals have an earlier circadian rhythm. Because studies indicate that sleep disturbances in shiftwork start to increase after the age of 40-50 years, and changes in alertness and performance occur, the provision of less demanding work with increasing age should be available.

Frequent medical check-ups (also recommended by European Community (EC) directive 93/104/EC) is mandatory for controllers, but it is an open question whether the medical examiners and the individual controllers have enough knowledge to identify long term effects of night shifts. Controllers who experience sleep disturbances to an extent that influences their ability to function properly in their occupation, should be given the opportunity to carry out less demanding work as part of a recovery from illness plan.

Early retirement

Several studies have found a deterioration in health after many years of shiftwork for some shiftworkers. This deterioration in health could have a negative influence on performance. This

is strong evidence supporting the existing IFATCA Policy on Retirement and Pension reference: page 4151). The question of early retirement due to negative effects of night shifts is a highly individual matter, provided the individual is physically fit for the job. The determination of a general retirement age should take the medical effects of night shifts into account. Earlier retirement should be an option, based on individual needs and preferences.

Conclusions

Responsibility for fatigue management.

The combination of a growing demand for ATC-service during night and widespread use of automation will continue to escalate in the next century, increasing the risk of fatigue-related accidents. Any situation where increased fatigue, decreased sleep, or performance loss can be demonstrated is a situation where the margin for error is reduced, albeit by some unknown amount, and should be avoided in ATC. Fatigue management and prevention of fatigue-related catastrophes need to become a sustained priority for both management and IFATCA member associations (MA's). However, management has the prime role in the provision of a satisfactory working environment, appropriate rostering, rest periods and facilities.

Fatigue and impaired safety

Working night shifts affects the human performance in an way that lowers the general performance level of the controller. This degrading of performance is lowering the safety margins of the ATC-system, and the reasons why this occurs must be understood, and appropriate countermeasures taken to compensate. Even though there are individual differences, sleepiness and the diminished performance capability that follows fatigue will sooner or later occur in the brain of every human, regardless of training, occupation, education, motivation, Skill level, intelligence, or the commitment of the person to maintain high levels of waking alertness. There is ample evidence of impaired safety due to work-hour-induced fatigue.

Individual differences age and gender.

There are considerable differences in sleepiness between workers. Effects of differences in circadian, physical fitness, sleeping habits, eating and drinking habits, personal and family life style are all factors to be considered. At the time there are not enough studies on individual differences to conclude that certain individual types should not become shiftworkers.
Changes in sleep length and structure varies with age, but may not be relevant for the estimation of sleep problems. Changes in alertness and performance are more important in that respect. Deterioration in health after many years of shiftwork is found for some shiftworkers. This deterioration in health could have a negative influence on performance. This is strong support to IFATCA policy on Retirement and Pension. Generally, the older controllers become, the less able they are to cope with night working. Medical evidence shows that there is no connection between the gender of the shiftworker and sleeping problems.

Design of duty rosters, speed and direction of shift rotation

If a unit has more than a certain number, e.g. 10% of available nights, of on demand call-outs on duty, implementation of planned night shifts should be considered. For jobs including cognitive tasks and which involve a high memory load and high degree of concentration, such

as ATC, rapidly rotating shift systems in a morning, evening, night cycle are the most preferable. After a night shift, an off duty period of 16 hours is recommended from a sleep recovery point of view. The effects of quicker changeovers have shown that sleep was clearly reduced. An early morning shift the same day as before a night shift, and a night shift followed by an evening shift the same day are probably the combinations that will give the most pronounced deficit. Such sleep deficit can cause serious fatigue, and quick changeovers should therefore be avoided. IFATCA Policy on Hours of Work (page 4.1.3.1.) provide guidance in the area. It seems to be impossible to improve the timing of one shift without affecting another shift negatively. An acceptable compromise has to be found, where sleep duration is not too short (>5 hours for all shifts) and sleepiness at work not too severe.

Overtime, extended workshifts and excessive fatigue

The allocation of overtime should be carried out with limitations in human performance in mind. The combination of overtime and night shifts clearly increase the risk of fatigue among controllers, because resting periods are reduced, and the possibility for sleep-loss recovery may be reduced accordingly.

Countermeasures

Strategic naps

The positive effects of napping as an effective countermeasure in terms of increasing alertness and anchoring the circadian rhythm are clearly documented in recent research. Implementation of napping should therefore be approved and encouraged from management and controllers. Physical arrangements (relief controller and adapted rest area) must be made available. Sleep inertia in conjunction with emergencies is considered to be manageable, because sleep inertia can be significantly reduced or even eliminated by intense motor activity and a high level of motivation.

Relief controllers

Controllers, and management, should carefully consider staffing levels during night shifts to comply with IFATCA Policy as a minimum. For those controllers who have heavy traffic during the night shifts, additional relief should be considered as an appropriate countermeasure to sleepiness and fatigue in order to increase the safety margins, and to reduce subsequent daytime sleepiness.

Eating and drinking habits, smoking of tobacco

Controllers should try to maintain the daily eating habits regardless of which shift they are working. During night watch, drinking of sodawater is the best way of avoiding dehydration. Drinking of caffeine tend to increase alertness and improve psychomotor performance during usual night shift hours when taken between 22.30 and 01.20 hours. For most people, caffeine taken at the start of the night shift does not interfere significantly with daytime sleep. Smoking of tobacco can have a stimulating effects on alertness, but negative on dexterity. And the demands for tobacco-smoke free areas at the workplace may put certain restrictions on smoking.

Physical working environment

The physical working environment regarding control room temperature lighting, relative humidity, adapted rest areas and facilities for eating and drinking must be designed with night shift demands in mind.

Hypnotics

Treatment with hypnotics can lead to psychological addiction. Such treatment should be carefully analysed before it is offered to working controllers.

Education and self-knowledge

Controllers' education should include theory about the physiological principles related to sleep circadian rhythms, so that they are better prepared to take deliberate actions to meet operational requirements. Individuals living a harmonious physical and social life are generally coping better with the effects of night shifts than individuals with less harmonious lives. Anchoring of eating and sleeping habits are effective ways of coping with some of the effects of night shifts.

Use of drugs and alcohol

Since the use of sleeping drugs may lead to addiction which in turn can reinforce the negative effects of sleeping problems, controllers should be very critical to the use of such drugs. For the same reasons, use of alcohol as a sleeping drug is not recommended. If serious problems are experienced, the affects of the drug intended to be used should be carefully examined.

Retirement

Deterioration in health after many years of shiftwork are found for some shiftworkers. This deterioration in health could have a negative influence on performance. There is strong evidence supporting existing IFATCA Policy on Retirement and Pension. The question of early retirement due to negative effects of night shift, is a highly individual matter, provided the individual is physically fit for the job. The determination of a general retirement age should take the medical effects of night shifts in to account. Earlier retirement should be an option, based on individual needs and preferences, preferably combined with possibilities for less demanding work with increasing age.

Recommendations

It is recommended that this paper is accept as Guidance Material.