

IN-DEPTH REVIEW: SHIFT WORK

Preventive and compensatory measures for shift workers

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Abstract Shift systems are known to be associated with a variety of psychosocial and physiological problems that can affect the health of workers. This review focuses on measures that can be taken to optimize the well-being of shift workers and to identify ill-health at an early stage. The discussion includes specific aspects of the design of shift systems, taking account of variation in the views and circumstances of employees, and strategies to combat sleepiness at work and elsewhere. Although an ideal shift system does not exist, a wholistic approach comprising education of managers, employees and their families can ameliorate some of the health consequences.

Key words Alertness; coping strategies; ergonomic design of shift systems; health care; night work; participation; shift work; sleep; social support; working conditions.

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Introduction

Different shift systems may cause different social and health problems, while under a given shift system, some workers may have problems whereas others have none. There is no single optimum solution. The first step should always be to ask ‘Can the amount of shift work or night work per person be reduced, e.g. by shorter working weeks, years, or working life, or, alternatively, by shift systems including more day work?’ [1].

If this is not possible, a variety of strategies can be used by the company and the shift worker to prevent or reduce the problems caused by shift work (Figure 1).

Preventive and compensatory measures

Shift system design and artificial light

Although there is no ideal shift system, the ergonomic recommendations shown in Tables 1–4 may help to improve existing systems.

The first recommendation is mainly based on the finding that fewer consecutive night shifts cause less disturbance of the circadian physiological functions and no significant accumulation of sleep deficits [2]. The worst solution seems to be weekly (or longer) backward rotation, i.e. a week of night shifts, a week of evening shifts and a week of morning shifts, whereas a fast forward rotation (e.g. 2 days of morning shifts, 2 days of evening shifts and 2 days of night shifts) seems to be the best solution for rotating shift systems [3–5].

The alternative approach of having many night shifts in succession and accelerating circadian adaptation with the help of bright light during night shifts is advocated by other authors [6,7]. In a study of simulated night shifts, a combination of the following interventions induced the greatest phase delay in the circadian clock: bright light during the night shift, wearing dark sunglasses while travelling home (to avoid natural sunlight), melatonin medication and sleeping in a darkened room after a night shift, i.e. with the bedroom windows covered with black plastic [8]. The phase shifts of circadian rhythms in different studies vary widely. In most studies, bright light exposure enhanced alertness. However, in some laboratory studies, the morale and motivation of some individuals deteriorated in the morning hours [9], and even detrimental effects of bright light exposure on performance [10] were observed.

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Summing up numerous studies involving bright light, Czeisler and Dijk [7] state that there is still ‘an urgent need for longitudinal studies of bright light application in real-life settings’.

Many studies concerning the extension of shifts from 8 h to 9, 10 or 12+ h (for recommendations, see Table 2) have been published with contradictory results [11–14]. Risks include increasing fatigue, errors, accidents, toxic exposure, moonlighting during larger blocks of leisure time, higher incidence of major injuries off the job and more symptoms of burnout [15–19]. Positive aspects of

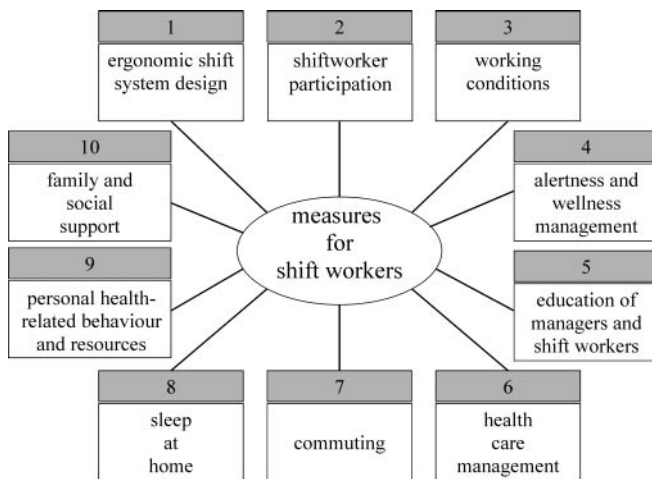


Figure 1. Preventive and compensatory measures for shift workers.

shift systems with longer shifts relate to family and social life as these provide more time off and reduce commuting time [11,20].

The recommendation to allow adequate time off (Table 2) between shifts is based on time budget studies. These studies show that shorter rest periods of 8, 9 or 10 h reduce sleep duration during these periods drastically, e.g. to 3 or 5 h [21–23]. Kurumatani *et al.* [24] found a very high correlation between the length of the off time between shifts and sleep duration.

There is no optimum solution for the timing of shifts (Table 3), and there seems to be no way of improving the timing of one shift without affecting another shift negatively [25,26]. However, an early start of the morning shift may shorten sleep before the morning shift, thus increasing fatigue as well as the risk of errors and accidents during the shift [12]. For further information on the design of shift systems, see e.g. [12,28–31].

Shift worker participation

To design a tailor-made shift system, a compromise has to be found between the company’s goals, the workers’ wishes and relevant ergonomic recommendations. Every large organizational change may give rise to scepticism, doubts, fear or even resistance in everyone concerned, i.e. the workers, workers’ representatives, and the lower and middle management. Therefore, the implementation strategy of a new shift system is as important for its acceptance as the new model itself [27,31–35].

Table 1. Ergonomic recommendations regarding the sequence of shifts [31]

Criterion	Recommendation	Expected effects when the recommendations are fulfilled (↓ reduce, minimize, avoid; ↑ improve)
Maximum number of consecutive shifts		
Night shifts	(1) Few night shifts in succession (maximum of 3) (2) Avoid permanent night work	Problems of adaptation of circadian rhythms ↓ Accumulation of sleep deficits ↓ Social contacts ↑ Potential long-term health effects ↓ Accumulation of sleep deficits ↓ Social contacts ↑
Morning shifts	(3) Few morning shifts in succession (maximum of 3)	Accumulation of sleep deficits ↓
Evening shifts	(4) Few evening shifts in succession (maximum of 3)	Social contacts ↑
Direction of rotation (MEN = forward rotation, phase delay; NEM = backward rotation, phase advance)	(5) Forward rotation	Problems of adaptation of circadian rhythms ↓
Particular sequence of shifts		
N–M	(6) At least 2 days off after last night shift	Reduction of sleep before morning shift ↓
N–N	(7) Avoid N–N	Problems of adaptation of circadian rhythms ↓
–M–E–N–	(8) Avoid single working days between days off	Disruption of blocks of leisure time ↓

M = morning shift; E = evening shift; N = night shift; – = day off.

Table 2. Ergonomic recommendations regarding the duration and distribution of working time [31]

Criterion	Recommendation	Expected effects when the recommendations are fulfilled (↓ reduce, minimize, avoid; ↑ improve)
Maximum number of consecutive working days	(9) Maximum of 5–7 working days (see also recommendation no. 10)	Accumulation of fatigue ↓
Duration of shift	(10) Extended shifts (>8 h) are only acceptable if <ul style="list-style-type: none"> • the nature of work and the workload are suitable • there are sufficient breaks • the shift system is designed to minimize the accumulation of fatigue • there are adequate arrangements for cover of absentees • overtime will not be added • toxic exposure is limited • a complete recovery after work is possible 	Accumulation of fatigue ↓ Accidents ↓ Potential long-term health effects ↓
Time off between two shifts	(11) There should be adequate resting time (>11 h) between two shifts	Reduction of sleep ↓

Table 3. Ergonomic recommendations regarding the position of working time [31]

Criterion	Recommendation	Expected effects when the recommendations are fulfilled (↓ reduce, minimize, avoid; ↑ improve)
Start of morning shift	(12) Not too early (i.e. 06:30 h better than 06:00 h, 06:00 h better than 05:00 h, and so on)	Reduction of sleep ↓
End of evening shift	(13) Not too late (i.e. 22:00 h better than 23:00 h, 23:00 h better than 24:00 h, and so on) In special cases very early end (e.g. 18:00 h on Saturday)	Reduction of sleep ↓ Social contacts ↑
End of night shift	(14) As early as possible	Number of sleeping hours during night time ↑
Work on weekends	(15) Avoid work on weekends (16) Some free weekends with at least 2 consecutive days off (if recommendation no. 15 cannot be fulfilled)	Social contacts ↑ Social contacts ↑

Based on the authors' experience with the introduction of new shift systems in various companies, the most important elements in the process of introducing a new shift system are: worker participation, information and communication, champions of change, adequate project management, evaluation of the effects on the company and the workers, and more time than people usually admit.

The working time preferences and needs of shift workers may vary considerably, depending, for example, on age, gender, personality, children, hobbies, and phase of life. This being so, each shift worker should enjoy a certain flexibility involving shift swapping, participation in overtime and holiday management, a choice between different working time models, or even individualized duty rotas [29,36–41].

Working conditions

Rosa's conclusion [14] concerning extended work shifts holds true for all kinds of new shift systems. He states that 'appropriate attention should be given to staffing levels, workload, job rotation, environmental exposures, emergency contingencies, rest breaks, commuting time, and social or domestic responsibilities' (p. 51). A combination of high workloads or inadequate staffing levels with shift work may enhance the negative effects of shift work on health, alertness and performance [15,17,42–44]. Recommendations concerning the design of shift worker jobs have been given by, for example, Moore-Ede [29].

Alertness and wellness management

A variety of measures can help to enhance alertness

Table 4. Ergonomic recommendations regarding the short-term deviations from the set shift system [31]

Criterion	Recommendation	Expected effects when the recommendations are fulfilled (↓ reduce, minimize, avoid; ↑ improve)
Short-term deviations from the set shift system		
Induced by the employer	(17) Avoid short-term deviations (18) 'Rules of the game' concerning time of advance notice and compensation (19) Co-workers fix their working time themselves and make themselves responsible for doing their tasks on time ('time autonomous group')	Possibility to plan leisure activities ↑ Possibility to plan leisure activities ↑ Compatibility of work and private life ↑
On request of the employee	(20) Make flexibility possible (e.g. flexible start and finishing times, change of shifts, time window, time autonomous group)	Compatibility of work and private life ↑

during night shifts, e.g. opportunities to contact colleagues, on-duty naps, exercises, adequate light levels, a cool workplace, music (with emergency cut-off) and breaks.

On-duty naps during night shifts are more common in Japanese industry than in the Western world [45]. The positive effects of naps during night shifts on alertness and performance have been demonstrated in many studies [46–48]. However, there are two potential negative consequences of naps: sleep inertia and the reduction of subsequent sleep periods [49,50]. Kogi [47], who gives five rules of thumb for successful on-duty napping by night workers, concluded that 'While napping is a useful strategy, we should not regard it as a decisive means of alleviating the night workload and fatigue'.

Some companies provide opportunities for muscular activity in sedentary jobs. Just 'taking a stroll, doing a single isometric routine, or spending a few minutes on an exercise bike can be effective' [29]. In some cases, exercise equipment has been installed in control rooms or in fitness rooms near the workplace. Shapiro *et al.* [51] propose a list of 10 on-the-job exercises without exercise equipment.

During night shifts, a main meal break to be taken at ~00:00–01:00 h and a shorter break at ~03:00–04:00 h are recommended by Wedderburn [28]. Romon-Rousseau *et al.* [52] found that alertness during the night shift was better after a protidic meal than after a carbohydrate meal or no food. If the best solution, that of keeping the cafeteria open all night, is not feasible, it is recommended that vending machines selling health food be installed, or microwave cookers.

Education of managers and shift workers

Pisarski *et al.* [53] have shown that social support—including supervisor support—structural work/non-work conflicts and coping strategies had complex, interrelated

effects on the psychological and physical health of female nurses. However, many managers have no experience with shift work, and no detailed knowledge about the potential problems of shift workers and their possible solutions. Therefore, Moore-Ede [29] recommends employers to 'Recognise the value of shift work experience when you hire managers and superiors' and 'Expose your new managers to a shift work lifestyle for several shift cycles'.

Although management is responsible for promoting the health of shift workers, there is no widespread awareness of the problem. Consequently, as Monk and Folkard [54] stated,

The first major breakthrough required in management education is to convince a company's senior decision maker that a more enlightened approach to shift work will almost certainly save the company money, making it more productive and competitive. As hiring, selection, and training costs rise, it can make strong economic sense to have a contented and well-coping shift workforce, as opposed to a poorly coping one with high turnover and absenteeism rates.

To educate shift workers, Monk and Folkard [54] recommend a 'Shift Work Awareness Programme'. Some companies offer training sessions for shift workers and their spouses or partners. In addition to these sessions, some companies provide individual counselling at 2 year intervals, for instance, or publish newsletters for shift workers (e.g. quarterly). Training programmes cover many topics, such as circadian rhythms, sleep disorders, the impact of shift work on family and social life, alertness strategies, safe driving, nutrition, physical activity, coping with stress, and experiences of other companies with new shift systems (see also [55]).

Health care management

Shift work, in particular night work, may have specific

negative effects on health [56–59]. In addition to the other measures presented in Figure 1, health care management should include:

- medical surveillance of shift workers;
- availability of company medical staff during the night shift;
- ensuring that the company medical staff has up-to-date knowledge of sleep disorders and shift maladaptation syndrome [29];
- consultation with the employer about the design of shift systems and other measures.

ILO Convention No. 171 on night work (International Labour Office, 1990), as well as the European Directive No. 104/1993 concerning ‘certain aspects of the organisation of working time’ (European Council Directive, 1993), states that workers shall be entitled ‘... to undergo a free health assessment before their assignment to night work and thereafter at regular intervals, and in case they experience health problems because of it’ [59,60]. Surveillance aims to assess likely tolerance and to enable early detection of disorders caused or exacerbated by shift work. Guidelines for medical surveillance have been published by, among others, Rutenfranz [61], Costa [62], and Costa and Pokorski [59].

Commuting

Rogers *et al.* [63] studied the effects of shift work on driving to and from work. Shift workers were more tired when driving to and from work than non-shift workers. Sleepiness on the journey home was higher, and driving skills were rated lower after night shifts than after all other shifts. Various measures have been proposed by several authors [29,51,64,65], including the following.

For the employer:

- a company car pool to take workers home;
- offering a place where employees can take a nap before driving home.

For the shift worker:

- keep the interior of the car cool;
- listen to talk or music on the radio;
- vary the route a bit;
- use public transportation;
- move closer to the place of work.

Sleep at home

There is no ‘magic’ prescription for falling asleep quickly or sleeping well. Therefore, every shift worker is left to find out by himself which of the many recommendations work for him. Although most shift workers sleep in the morning after night shifts, sleeping in the morning and in the afternoon both have their pros and cons [28,51]. It is,

of course, important to improve the sleeping environment, e.g. by cutting out noise. The recommendations of Wedderburn [28] include heavy curtains, sound insulation on the doors and windows (or shutters), ear plugs, telephone answering machines, a switch on the doorbell, rules to avoid noisy activities by the family, informing friends, neighbours and relatives about sleep times, and moving to a quieter area to live. Others include making the room as dark as possible, using an air conditioner and sleeping in an adequate bed [51]. It is important to develop regular bedtime habits and to learn to relax in bed. Shapiro *et al.* [51] have developed a check list (‘sleep hygiene chart’) and a long list of ‘tips for making yourself drowsy’, which may be very helpful. Topics covered by the sleep hygiene chart include naps, caffeine, smoking, alcohol and sleeping pills.

In general, the earlier a morning shift starts the shorter the preceding night sleep will be [67]. As Lavie [68] has found, each individual has his own ‘sleep gate’ in the evening, when it is easier to fall asleep. For most shift workers, it makes no sense to go to bed at 19:00 h or so because they cannot go to sleep then. The only counter-measures are to start the morning shift later or to have an extra nap after the morning shift.

Personal health-related behaviour and resources

Although it is very difficult to change one’s behaviour, there are many tips for shift workers about healthy eating, active living and coping with stress.

Many studies have shown that night workers can easily develop digestive problems, may experience appetite changes, and may lose or gain weight [66].

Wedderburn [28] proposed a light main meal at ~00:00–01:00 h and a snack during the sleepy hours of the night shift, i.e. 03:00–04:00 h. This author and Waterhouse *et al.* [57] proposed avoiding large, fatty meals, and instead taking snacks that should be rich in protein rather than carbohydrates.

‘Scientific evidence also supports the use of caffeine to improve alertness on the night shift. General guidelines for the therapeutic use of caffeine would include administration (250–400 mg) within the first 2 h of the night shift . . .’ [69]. Caffeine in the second half of the night shift as well as a heavy meal just before going to bed make it difficult to fall asleep and to sleep undisturbed [28].

Furthermore, a regular eating routine of three meals per day during each day with morning, evening or night shift is recommended [51].

Improved physical fitness may improve sleep length and quality, maintain night shift alertness, and decrease general fatigue [70,71]. However, it is important to avoid excessively strenuous physical exercise before evening or night shifts.

Olsson *et al.* [72] has found that shift workers using active coping strategies have fewer problems than col-

leagues using passive strategies. Pisarski *et al.* [53] have shown that coping strategies, as well as social support and structural work/non-work conflicts, all influence the health and well-being of shift workers. However, besides general tips for coping with stress [51], adequate individual coping strategies have not been specifically recommended for shift workers in any publication.

Family and social support

Support by families, partners and friends, in combination with other factors, may have positive effects on the physical health of shift workers [53]. Families and friends often follow a diurnal pattern that differs essentially from that of a shift worker. 'Communication, sensitivity, time management and compromise are the keys' to better coping with this situation [51]. Flexible shift work arrangements may also help [40,73]. Recommendations for improving family and social life specify balancing sleep and family time, using a large planning calendar to keep everyone in the family in touch with each other's plans, holding regular family meetings, creating time slots for being alone with your partner, and meeting other shift worker families [28,51].

Concluding remarks

There are only a few studies evaluating the effects of using guidelines for shift workers [74,75]. These studies showed that the effects of such guidelines were limited. However, these results might be influenced by confounding factors.

Although adapting the design of shift systems seems to be the most effective of all countermeasures, it is worth trying combinations of all the measures listed in Figure 1 to reduce the psychological, social and health problems of shift workers.

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