

IN-DEPTH REVIEW

Offshore industry shift work—health and social considerations

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Abstract Shift work is an integral part of many offshore jobs. While a considerable body of evidence exists concerning the impact of shift work in general, much less research has been directed specifically at the offshore workplace. This brief review attempts to highlight some of the work that has particular application to this environment, relating to physical health, psychosocial well-being and safety. Shift working has been an integral part of the offshore environment since the beginning of the industry, but it is only in the recent years that substantial effort has been directed towards the potential problems (or benefits) in this specific environment. It is clear that the offshore working community presents unique situations that need to be addressed specifically rather than managed as direct extensions of routine onshore shift work. Some unique features of the offshore workplace are identified and a number of possible areas for further research are highlighted.

Key words Health effects; offshore industry; shift work.

Introduction

The offshore workforce is an important contributor to the UK and global economy. In the UK sector of the North Sea alone, ~20 000 people are employed [1], generating in excess of £20 billion annually. Most of these workers will be operating in shifts, and many will be engaged in complex and safety critical activities. Maintaining health, safety and efficiency is paramount as is the need to avoid loss by attrition of a highly skilled workforce.

Shift work has the potential to impact a number of areas: safety—of the worker, his colleagues and plant; efficiency and productivity; long-term health and social/home life.

Shift work—background

Work patterns offshore vary both in overall duration and in internal structure. An offshore ‘tour’ (total time offshore in one stretch) may be 7, 14 or 21 days, while shift patterns of, for example, 14 days, 14 nights, 7 nights followed by 7 days (7N/7D) and 7 days followed by 7 nights (7D/7N) are all encountered [2–4]. The pattern may vary from operator to operator, from platform to platform and may depend on the type of work performed, e.g. mainte-

nance, control room operator and driller. Time off tour at home also varies. Two weeks on and 2 weeks off are probably most frequent in the UK sector, but in the Norwegian sector, 2 weeks on (i.e. offshore at work) and 3 weeks off (at home) are also found [3].

Humans, like other animals, are subject to circadian rhythms ultimately dependent upon internal clocks but synchronized, or entrained, to the environment by external zeitgebers (or ‘time-givers’), which act as cues to ‘set’ the clock. The suprachiasmatic nucleus (SCN)–pineal axis, secreting melatonin, is the master clock, but internal rhythms can and do run out of sequence with each other when external cues are disrupted [5–8].

When allowed to free run (without external zeitgebers), the SCN settles at a rhythm usually just in excess of 24 h. Thus, in time, the free-running rhythm will become out of synchrony with the external environment. Light is the principal zeitgeber responsible for maintaining the rhythm in which, for man, wakefulness occurs during the daytime and sleep at night, and this probably has a very long evolutionary history. Unfortunately, modern working patterns, offshore and elsewhere, demand a 24 h working society, and the design of shift patterns has been historically determined more by work requirements than health considerations, although the latter have only been explored in the offshore environment in recent years.

Circadian rhythms are demonstrated experimentally by various markers that follow a cyclical pattern—plasma melatonin [and its urinary metabolite 6-sufametyoxymelatonin, (aMT6s)], temperature, plasma cortisol and others [2,9].

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When an individual undertakes activity outside his normal wake/sleep pattern, desynchrony occurs both between the different internal clocks and between these and the external environment. Directly or indirectly, it is likely that most of the untoward effects of shift work are due to this dysynchrony.

Barnes *et al.* [9] demonstrated, using aMT6s, that offshore oil workers adapted to night shift within a week, in contrast to generally accepted evidence that adaptation to night work was poor or slow. This was attributed to the special environmental conditions offshore and the shift schedules adopted. This finding of rapid adaptation to night shift offshore has been confirmed several times, although later work by Barnes *et al.* [10] indicate that this response may be seasonal, with night workers showing little adaptation in November compared to March (North Sea environment). Gibbs *et al.* [2], also using aMT6s, confirmed the tendency to night shift adaptation during the first (night shift) week of a 7N/7D rotation, but also showed, significantly, that there was very little adaptation (or readaptation) during the following week of day work. This was confirmed in the large study by Gibbs *et al.* [4] for the Health & Safety Executive (HSE).

Safety

Impaired performance due to fatigue has been widely described, including marked lack of attention to detail and even microsleeps in which the individual is momentarily asleep and unaware [11–13]. At one extreme, decreased performance due to fatigue has been implicated in major disasters such as Exxon Valdez, Three Mile Island, Bhopal and Chernobyl [14–16]. While many of these are from other industries, there is little reason to suppose that the risks are any less credible in the offshore environment. As always, a momentary lack of attention can lead to immediate harm to the employee or a bystander.

There is specific evidence for increased injury specifically from within the North Sea offshore environment, although some study results appear inconsistent. An analysis by Parkes and Swash [17] for the HSE demonstrated significantly higher rates of serious injury (relative to 3 day absence injuries) for night shift compared to day shift, independent of ‘days into tour’. This same study also showed increased severity of injury once shifts extended beyond 12 h in duration or the tour of duty beyond 2 weeks.

Forbes [18], looking at drill crew accidents, with exposure rates specifically accounted for, found no evidence of a cumulative effect of fatigue over a 2 week tour (more accidents being recorded in the first week), but there was evidence of a deleterious effect of the mid-tour shift changeover.

Work from 1990, by Lauridsen and Tonnersen [19], elicited an increased injury rate for the early shifts of

the night shift, whether nights constituted the first or second week of the tour. Collins *et al.* [20] in their review find significant evidence that rotating shift schedules affect alertness and performance.

Fatigue in shift work has at least two elements—a direct effect from lack of synchrony (the brain in effect telling the individual it is time to be asleep at 3 a.m., while the work schedule demands full concentration) and the effect of sleep loss itself consequent upon poor sleep quality (itself associated with shift work and due, in part, to dysynchrony). It has been demonstrated that as little as 1 h sleep loss can impair alertness [11]. While reports of poor sleep quality and increased sleep latency are generally common among shift workers and are understandable in terms of circadian disturbance, it is of note that night workers offshore actually report better sleep than their onshore counterparts in some studies [21]. This is possibly related to better isolation from daytime disturbance and reduced distance to travel to bed after night shift than onshore. It reflects similar findings from work in Antarctica [22]. In sharp contrast, however, a study from the Campos Basin in Brazil reports significant sleep problems in shift workers, including reduced quality, increased sleep latency, frequent disturbance and tiredness when awake [23].

Although strictly, not ‘at work’, attention should also be directed to the risks of workers driving home after offshore shift work. While it is reasonable to assume that the most significant risk in this regard is associated with driving immediately after night shift, i.e. coming onshore after a 7D/7N rotation, work on circadian adaptation indicates that, in the 7N/7D rotation, workers who adapt to the night shift in the first half of the rotation do not readapt to their normal ‘day’ circadian rhythm during the subsequent 7 days and thus are presumably driving home with disturbed rhythm [2].

The type of rotation is largely governed by production or work constraints. Accommodating three 8 h shifts is difficult in terms of crew numbers required and 12 h shifts are the rule. As it happens, shift workers tend to prefer these hours. There are consistent reports of 12 h shifts providing greater overall satisfaction, sleep quality and better mood than 8 h shifts [24,25]. However, worker satisfaction does not necessarily correlate with either safety or efficiency. There is concern that errors may increase towards the end of a 12 h shift [24,25]. In addition, it has been demonstrated that older workers fare less well on 12 h shifts (and, indeed, often with shift work altogether) [21,26]. This latter evidence could obviously be significant in future, with the present perceived deficit in young recruits to the industry.

In terms of the shift rotation, it is almost invariably more popular to perform the night shift block (7N) at the beginning of the offshore rotation, followed by 7 days. The benefit of this to the worker is that he is, in theory at least, already back in day rhythm immediately before

going off rotation and returning home, while the traditionally difficult swap-over period from night to day shift occurs while at work.

Long-term health

There have been significant reviews on the health effects of shift work in general and night work in particular [2,27–30]. No adverse overall effect on mortality has been demonstrated [2]. The most consistent health effects appear to be in the areas of gastrointestinal disease, sleep disturbance and cardiovascular disease [27,30]. The evidence for an association between shift work and gastric and duodenal ulcer appears compelling, although an association with increased incidence of *Helicobacter* has not been convincingly demonstrated [30]. Peptic ulcer has been postulated to be linked to increased smoking, caffeine and alcohol intake, but only the first of these has been convincing. In addition to frank peptic ulcer, reports of ‘gastrointestinal disturbance’ are very common in association with night work, often in association with a general feeling of malaise.

In terms of cardiovascular disease, Nicholson [30] quotes a relative risk factor for shift workers of between 1.3 and 1.7, although this increases to 2.3 and 2.7 when associated with obesity or smoking, respectively. Evidence for an increase in blood pressure is inconsistent and where found has been difficult to separate from possible effects of short-term stress [30].

Worrying reports of increases in reproductive problems linked to shift work, such as low birth weight, spontaneous abortion, pre-term delivery and possibly pre-eclampsia have appeared [30]. While the great majority of offshore workers are male, the increasing percentage of women offshore will warrant further investigation in this area. Reports of an increase in breast cancer among long-term night shift workers have appeared [31], possibly linked to suppression of melatonin secretion by light exposure during night shifts.

Parkes [29] discusses and analyses the important effect of confounding between effects of shift work, *per se* and job type.

Reviews of health in the offshore community itself (as apposed to general shift work) have appeared in recent years [4,20,32–34]. The healthy worker effect is always prominent in shift work studies, and this is accentuated in offshore populations who are subjected (in the North Sea working region at least) to regular and stringent medical fitness reviews. A note of caution here, however, is the fact that the lifestyle and relatively high pay of offshore work could tend to keep workers in such activity even when the health effects would dictate otherwise. In translating shift work studies to the offshore environment, it is also important to differentiate analysis based on night workers or rotating shift workers on ‘permanent’ shift

work from that addressing particularly the offshore environment with long periods ‘off shift’ as found in the 14:14 or 14:21 patterns in the North Sea. Clearly, offshore workers have regular periods of 2–3 weeks to ‘recover’ from each 2 week period of disturbance. Work specifically indicating the mitigating effect of such recovery periods as compared to the permanent shift worker is lacking, however.

In addition to effects of ‘steady-state’ shifts, it is important to be aware of the potential disruption and possible effects on health when a shift system changes completely [35].

One interesting area is that of body mass index (BMI) in offshore workers. Parkes [34] reports a follow-up study looking at the BMI in an offshore population in 1995 and again in 2000. There was no significant change in the BMI during this period, but interestingly, while the 1995 offshore population had demonstrated a BMI in excess of the general UK population, this difference had disappeared by 2000. In effect, the offshore population had remained static, but the BMI of the general population had caught up. While raised BMI in the offshore population remains a concern, it is perhaps consoling to think that dietary education, better catering and increased fitness offshore may have at least had a stabilizing effect on weight. In their review of general shift work and health (i.e. not offshore), Nicholson *et al.* [30] state that there is no overall evidence for increased BMI as a result of shift work *per se*.

Gibbs *et al.* [4] in their work for the HSE report an increase in triacylglycerol in the offshore workforce on shifts, which could be significant in long-term cardiac health. General diet seemed little affected except for a decrease in protein intake and increase in carbohydrate intake during night shift. Again it is worth noting that the offshore environment is different from many onshore shift work operations in that properly prepared food, including cooked meals, is available for night workers, who are not, therefore, dependent upon snacks.

Psychological health

Comparison of studies of psychological response to shift work has, to some extent, been limited by the variety of research methodologies employed and theoretical framework applied.

Offshore workers have reported, in self-report studies, higher levels of free-floating anxiety and higher scores on the General Health Questionnaire, despite also demonstrating a stable extravert personality usually associated with less anxiety [see review 20]. Other work has indicated relatively high levels of job dissatisfaction and problems with the repeated work/leave adjustment cycle [20].

In recent years, the proportion of medical illness evacuations has risen relative to accidents, and evacuations for

mental health and stress related problems have been reported at ~5% of total evacuations [17].

Gogstad found 15% of sickbay consultations to be for 'personal concerns' [36 quoted in 20], while Parkes and Swash [17] give a figure of 6.7% of consultations for 'other illnesses' including mental health problems.

Sutherland found mental health to be generally better on smaller, fixed platforms, when compared to drilling rigs and larger installations [37, quoted in Collins, 20]. There appeared to be a sharp rise when persons on board exceeded 60. Location may also be important, with more remote platforms in the North Sea having more problems. Job type also generated different outcomes, with maintenance workers having more mental health problems than production personnel or drillers. In terms of sickbay consultations in relation to shift, there are generally more consultations from those on night shift, but actually for minor accidents rather than for mental health issues.

It is important to note that offshore personnel may be reluctant to consult the sickbay medic on the platform for psychological issues, and there are few data on medical consultations during the onshore leave period, an area that probably requires further exploration.

The importance of separating effects of shift work from job type (or location), highlighted by Parkes [29,38], has already been mentioned. She points out that, among other effects, it would be possible for separate health effects due to shift work and job type to either compound or reduce each other. It seems that few studies have sufficiently addressed this issue.

Social impact

Early work indicated significant problems for the social life of offshore North Sea workers and, indeed, offshore workers elsewhere (e.g. Brazil [33]). The vast majority are men (up to 97%), and of these, the greater number are married and with children [39]. With the gradually ageing offshore workforce, it would be expected that this age profile would shift upwards. It appears to have done so, but significant numbers still have young children.

It is clear that a system in which a worker is engaged in work in a relatively isolated community for 2 weeks at a time, followed by 2 weeks time off at home, could predictably be associated with problems for the family unit. Indeed, at one time, the term 'intermittent husband syndrome' was coined to summarize the overall picture [39]. Areas of difficulty for the spouse at home include social isolation (sometimes to the extent of feeling like, and being treated like, an intermittent widow), lack of support in home decisions, concern for the offshore partner's safety, the uptake of work by the home spouse and child-rearing issues [27,39]. However, the most difficult issue appears to be the significant and repeated mutual adaptation required upon the return of the offshore partner every 2 weeks [39]. This is 2-fold, with the home partner some-

times resenting the intrusion of a husband who tries to take over when she has been taking all the decisions and managing well for 2 weeks, or conversely, the tendency of some offshore workers to return onshore exhausted and not participating in home life at all for the first few days. A picture of edginess/resentment upon return, followed by a period of 'normality' and then a shorter period of 'pre-departure edginess' again, seems commonplace [39]. Reports of the anticipation of departure being much worse than the actual absence are also found (a feeling probably not peculiar to the offshore industry, but common in any career where periodic absence occurs). Of particular interest is the very high concern expressed by spouses about the safety of their offshore partner even despite the major strides in safety improvement in the last two decades [39].

Issues with children seem to show a biphasic pattern, with very young and late teenagers causing most concern. The former become distressed by the parental absence (and may show signs of rejection when the offshore parent does return), while the older ones may adopt a distant attitude. At the other extreme, it is clear that for some families, the routine absence of one parent is seen as engendering independence and resilience in the children.

One very significant issue in these studies is self-selection and 'survivor syndrome' [39].

Recent changes in the industry may well be having an impact on family and social interaction. The more frequent availability of telephone conversation is one such change, with up to 63% of onshore partners reporting daily conversations with the offshore worker, although the frequency does reduce with duration of marriage [13].

The very significant increase in safety culture in the offshore industry must have a positive impact on spouse stress, but it is noteworthy that safety of the partner offshore and a safe return are still very significant concerns.

The increase in working partners onshore is also apparent, and this, while being of benefit to the partner herself, can cause conflict during the onshore leave periods when the offshore worker may be disinclined to fully 'do his bit' and perhaps expects to be the centre of attention. This is probably exacerbated when the offshore worker is on a 7D/7N rotation offshore and returns home directly from a week of night shifts.

Conclusion

Shift working has been an integral part of the offshore environment since the beginning of the industry, but it is only in recent years that substantial effort has been directed towards the potential problems (or benefits) in this specific environment. It is clear that the offshore working community presents unique situations that need to be addressed specifically rather than managed as direct extensions of routine onshore shift work. Specific examples include the tendency for night shift workers offshore

to actually adapt to the night-phase shift offshore and the relatively good sleep quality reported during night work.

Some excellent reviews are available addressing the offshore environment specifically, but much interesting work still remains to be done. For example:

- The work by Gibbs *et al.* [2], which has demonstrated the adaptation to night shift, has, equally, demonstrated a failure of some workers to subsequently re-adapt (as demonstrated by phase-shift markers) during the subsequent week of days. What does this imply for safety during that post night shift week and, indeed, for workers driving home upon leaving the field?
- In regard to adaptation to shift changes, if the industry does indeed see a tendency towards a greater average age of worker offshore, can we expect future problems as older workers struggle to cope with adaptation/re-adaptation and alertness?
- There is the need to ensure clarity in offshore studies over what is due to shift work *per se* and what is more directly related to job characteristics [29].
- The offshore lifestyle, while undoubtedly challenging, does hold great attraction for many, with among other issues, the free period onshore on leave, the camaraderie offshore and the pay. How do long-term offshore workers (and their families) adapt and cope when they have to change to 'regular' onshore work?
- In some circumstances, there can be the perception of a two-tier workforce, with oil company employees perhaps enjoying considerably better support and job security than their contractor colleagues. How, if at all, does this impact the contractors themselves and the culture, efficiency and morale offshore?

Conflicts of interest

None declared.

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