A review of the impact of shift work on occupational cancer: Part 2 – Mechanistic and Health and Safety Evidence

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INTRODUCTION

The International Labour Office (ILO) defines working in shifts as a "method of organisation of working time in which workers succeed one another at the workplace so that the establishment can operate longer than the hours of individual workers" (International Labour Organisation, 1990). In 2007, a Working Group of the International Agency for Research on Cancer (IARC) classified shift work that involves circadian disruption as probably carcinogenic to humans (Group 2A) (Straif, Baan, Grosse, & Secretan, 2007) . In their consideration of the experimental evidence, the IARC working group noted that several different rodent models had been used to test the effect of circadian rhythm disruption on tumour development. In most of these studies the effect of constant light, dim light at night, and simulated chronic jet-lag was to increase tumour incidence. No effect was seen for pulses of light at night or constant darkness. The working group also considered studies investigating the effect of reduced nocturnal melatonin concentrations or removal of the pineal gland and most showed increases in the incidence or growth of tumours (Straif et al., 2007).

Exposure to light at night disturbs the circadian rhythm and suppresses melatonin production in rodents and causes deregulation of the circadian genes involved in cancer-related pathways. The clear evidence for carcinogenicity in studies using experimental animals and the limited evidence in humans contributed to the decision of the IARC working group (Straif et al., 2007). They identified that measurement of biomarkers at single time points would be of limited value because of considerable intra-individual variation over time, although assessment of circadian gene expression might provide novel insight into circadian regulation and may differ by shift schedule and time of day.

Epidemiological research in relation to shift work and cancer has mostly focused on breast cancer with limited studies being carried out on other cancers including prostate cancer and colon cancer. One of the most recent studies covering breast cancer being Travis et al., (2016), who did not identify an association between night work and breast cancer occurrence based on three prospective studies and a meta-analysis including a further seven prospective studies. However, there are a number of concerns with regard to this study including the older age of the people included, the time lapse since carrying out any night work as well as the use of the categories 'ever worked night shift' versus 'never worked night shift' which give little indication of the frequency or duration of the night shifts worked. The systematic review by McElvenny et al., (2017) that included both retrospective and prospective

studies (N=25) suggested that while the relative risk has reduced over time from 1.5 to 1.2; this elevation could be due to uncontrolled confounding or misclassification of exposure.

Epidemiological research on other cancers has included examination of prostate, colon, endometrial, non-Hodgkin's lymphoma, ovarian and biliary tract cancers as examined in the review by McElvenny et al., (2017). From 19 papers, the evidence linking prostate cancer and night shift work was found to be limited, and the same can be said for the other cancers reviewed. Much of this links to the fact that few high quality studies have been carried out to address any of these cancers.

One of the main issues that still remains around the research examining associations between cancer and night shift work is the characterisation of which aspects of shift work should be captured in future studies. These were highlighted by Stevens et al., (2011) who recommend that different aspects of shifts including shift scheduling, rotation, number of years on a particular shift and shift intensity, all be included in data collection.

Although there may be uncertainty about the relationship between cancer and shift work, there is still a need to think about the health of those working night shifts and how this can be maintained. Shift work is associated with other health issues which may indirectly be associated with cancer occurrence. This paper presents a review of the mechanistic evidence from the last 10 years on the carcinogenicity of shift work. The evidence from animal experiments is not considered. It also presents suggestions for possible management interventions for those responsible for the long-term health of shift workers. This latter objective additionally makes use of current shift work policies and practices of regulators, employers and trades unions.

METHODS

The general approach to the identification of the relevant mechanistic evidence and health and safety epidemiological literature was to identify studies published from 2005 to 2015. The search strings employed in September 2015 were respectively:

("shift work" OR shift-work OR shiftwork OR "night work" OR ("work patterns" and (rotat* OR shift))) AND ("breast cancer" OR "prostate cancer" OR "colon cancer" OR "endometrial cancer" OR "bladder cancer" OR "ovarian cancer" OR "gastro-intestinal cancer" OR (hormone-dependent AND cancer) OR cancer OR (womb AND cancer) OR (uterus AND cancer)) AND ("systematic review" OR review OR

meta-analysis OR “cohort study” OR case-cohort study” OR “case-control study” OR “intervention study” OR “experimental study”)

and

(“shift work” OR “shift-work” OR “shiftwork” OR “night work” OR (“work patterns” and (rotat* OR shift))) AND (“breast cancer” OR “prostate cancer” OR “colon cancer” OR “endometrial cancer” OR “bladder cancer” OR “ovarian cancer” OR “gastro-intestinal cancer” OR (hormone-dependent AND cancer) OR cancer OR “colorectal cancer” OR (womb AND cancer) OR (uterus AND cancer)) AND (mechanism OR mechanistic OR pathway OR "phase shift" OR "sleep disruption" OR “sleep disorder” OR “sleep-wake cycle” OR “sleep-wake schedule” OR "lifestyle factors" OR chrono-disruption OR chronodisruption OR “biological night” OR “biological clock*” OR “circadian dis*” OR “circadian rhythm” OR (low* AND "Vitamin D") OR (low* AND melatonin) OR (“light at night”))

The search terms were selected on the basis of relevant terms used in major shift work and cancer studies. Search terms were tested by running the searches in Proquest Dialog databases, which included Current Contents, EMBASE, Scisearch, BIOSIS Previews, PsychInfo, and Toxfile, and separately in PubMed, since this database usefully highlights any search terms not found in the searches through the use of Mesh Terms. Since trial searches in PubMed appeared to identify the relevant mechanistic materials, the mechanistic searches were carried out using this database. Bibliographic information, including abstracts, was saved in a RefWorks database. Additional searches were run in PubMed to identify relevant papers, but only a few additional references were found. A subsequent search of Google Scholar using the keywords health and safety, cancer, and shift work identified relevant health and safety papers. Organisational policies covering shift work were identified through Google searches.

Following the screening of the titles and abstracts the full papers were obtained for the ‘included’ papers. At this stage the data extraction sheet was developed to include sections on:

- Screening for relevance
- Research questions being addressed
- Additional notes and comments

The team of five reviewers (DMM, JOC, AD, CA, JWC) undertook a pilot of the data extraction sheet with a sample of papers. From this slight modifications were made to the data extraction sheet.

Five reviewers undertook the data extraction and each publication was reviewed independently by two reviewers. Initial evaluation of each paper identified if they fitted the inclusion criteria or not (see Table 1.). Any inconsistencies were dealt with by consultation with a third reviewer.

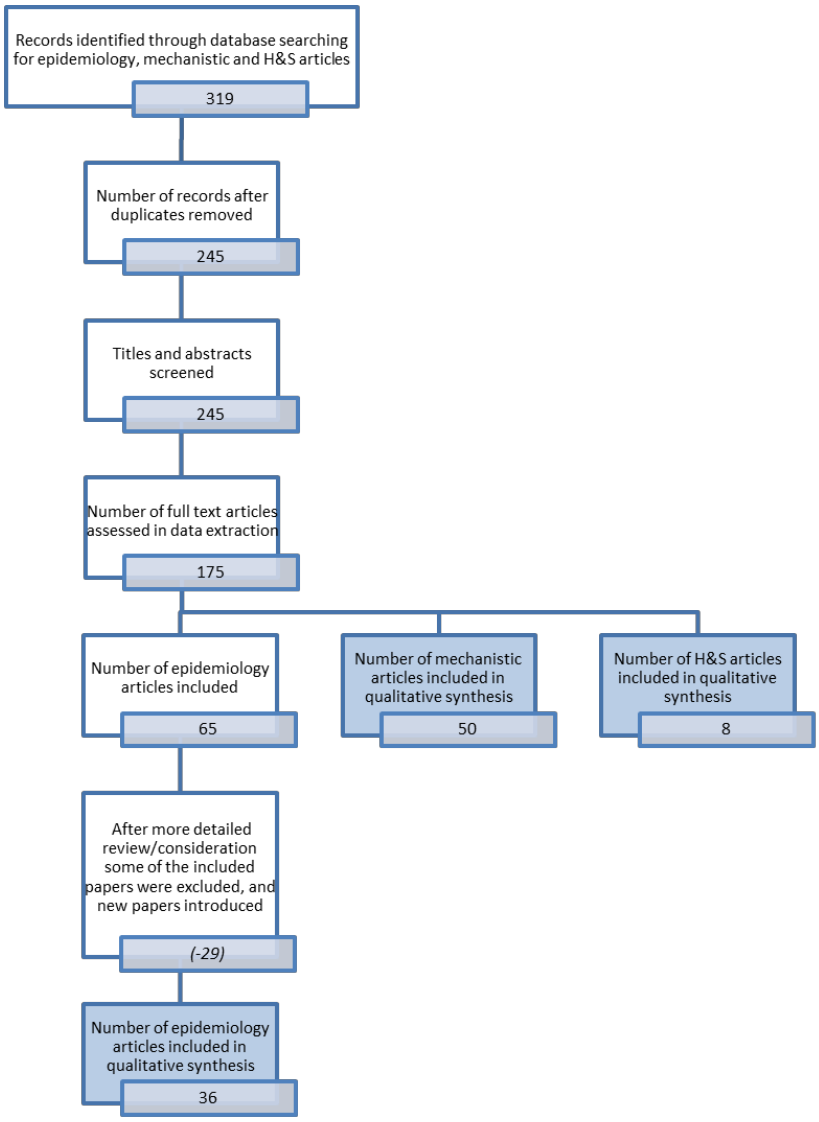
For both searches for research papers, citations in the included papers were searched for additional papers. Where papers were earlier updates of later studies, these were obtained in case they contained relevant methodological material.

At this point the mechanistic and health and safety paper methodologies differed slightly in how they progressed due to a more detailed review/consideration during this process. For the mechanistic papers, the included papers from the data extraction process were considered. Publications that did not provide new knowledge were excluded at this point. The health and safety papers that were included as a result of data extraction were the papers originally found from database searches (Figure 1).

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria
Published 2005 onwards, English Language
Exclusion Criteria
Published pre-2005, non-English language.
Results looking at all cancers combined.

Figure 1 Flow diagram of study selection



RESULTS

Mechanistic studies

Assuming the association is causal; to enable reliable interventions to reduce the cancer risk from working at night it may be helpful to understand something of the potential disease causation mechanisms. Should a causal association between night shift work and breast cancer be established, it would be unrealistic to ban women from working at night but it may be acceptable to advise on modifying other established environmental or lifestyle factors to reduce breast cancer risk. In this section we summarise the key causal mechanisms that have been hypothesised and evaluate the evidence to support each.

The IARC working group highlighted two important mechanisms that may be involved in causing cancer: first, that exposure to light at night supresses the normal night time production of the hormone melatonin and, secondly, that epigenetic changes in the genes that control circadian rhythm may promote cancer risk, for example inactivation of circadian PERIOD genes (Straif et al., 2007) . The working group further cited the association between sleep deprivation and the suppression of natural killer (NK) cells, which have been shown to have the ability to kill tumour cells (Zamai et al., 2007).

Fritschi et al., (2011) discussed other possible mechanisms for causation of breast cancer from shift work: phase disruption, sleep disturbance, reduced synthesis of vitamin D because of lower exposure to sunlight for night shift workers and lifestyle factors such as poor diet (Fritschi et al., 2011). It is plausible that all of these putative mechanisms may be associated with each other and so while the biological process involved may be different it could be difficult, in practice, to disentangle them in an epidemiological study.

Melatonin, which is produced in the pineal gland acting via the suprachiasmatic nucleus, varies rhythmically throughout the day, regulating the expression of clock genes and promoting the onset of sleep. Autonomous circadian clocks, also controlled by the suprachiasmatic nucleus, are also present in cells in peripheral tissues (Kelleher, Rao, & Maguire, 2014). Exposure to light during the 'biological night' supresses the production of melatonin and it has been hypothesised that this may increase the risk of breast cancer. Animal experiments have fairly consistently shown that melatonin can inhibit the growth of mammary tumours (Blask et al., 2005; Stevens, Brainard, Blask, Lockley, & Motta, 2013; Van Dycke et al., 2015). Blask et al., (2005), was the first to clearly demonstrate in an

animal model with human breast cancer xenografts, that increasing intensities of light during each of the normal dark period produced a dose-related suppression of nocturnal melatonin levels in the blood and a stimulation of tumour growth. It was originally argued that in women, lower circulating melatonin levels might cause or be associated with higher oestrogen concentrations, but it is clear that the mode of action would likely have to be more complex and, for example, Langley et al., (2012) found no association between melatonin and sex hormone levels in a population of nurses working rotating shifts.

Melatonin is known to inhibit the proliferation of human breast cancer cells (Vriend & Reiter, 2015). More recently, melatonin has been shown to induce apoptosis in a wide range of different tumours, including breast cancer (Bizzarri, Proietti, Cucina, & Reiter, 2013). It has an antioxidant effect that frustrates tumour initiation (Haus & Smolensky, 2013). However, a decrease in melatonin levels also affects the endocrine producing cells in the gonadotropic axis resulting in increased circulating oestrogen concentrations, which over a lifetime is a risk factor for breast cancer (Haus & Smolensky, 2013). Support for a role of melatonin in carcinogenesis is provided from studies showing the tumour promoting effects of removing the pineal gland in experimental animals (Greene, 2012). Hill et al., (2015), argue that the available data provides the 'strongest understanding and support for the mechanisms underpinning the epidemiological demonstration of elevated breast cancer in night shift workers'.

The scientific evidence is mixed as to whether circulating melatonin is reduced in night shift workers. The main urinary metabolite of melatonin is 6-sulfatoxymelatonin (aMT6s) has been shown to be decreased in night shift workers during the night compared to dayshift workers and to remain decreased on days when night shift workers slept at night (Davis, Mirick, Chen, & Stanczyk, 2012). Bhatti, Cushing-Haugen, Wicklund, Doherty, & Rossing, (2013) also found decreased aMT6s concentrations in night shift workers, but noted that the difference between day and night shift workers was smaller amongst workers of Asian origin compared to white workers. For nurses working on a rotating shift schedule there was a similar pattern of melatonin production regardless of whether working days or nights (Grundy, Tranmer, Richardson, Graham, & Aronson, 2011). In addition, in this study illuminance was only weakly associated with reduced urinary melatonin levels (range <1 to 20 lux). The authors suggest that the rapidly rotating shift pattern investigated (two 12-hour days, two

12-hour nights, 5 days off) or exposure to low light levels while working at night may not importantly disrupt melatonin synthesis.

Basler et al., (2014), carried out a meta-analysis of five prospective case-control studies of breast cancer where there were measurements of a urinary metabolite of melatonin. Overall there was a statistically significant reduced risk of breast cancer amongst the women in the highest quartile of exposure compared to those in the lowest quartile; with a 2-year time lag between the measurement of melatonin and the cancer diagnosis. However, in a large cohort of US nurses, a nested case control study involving 600 breast cancer cases and 786 matched controls was used to investigate the association between aMT6s and cancer risk (Brown et al., 2015). Most of the cases were premenopausal cancers. Melatonin metabolite concentrations were not significantly associated with total breast cancer risk, and further investigation of the time between sample collection and diagnosis showed no effect on the risk estimates. Other epidemiological studies where melatonin had been measured have produced mixed results in terms of association with breast cancer risk (Brown et al., 2015).

Further supportive evidence of the possible role of melatonin is provided by Pukkala, Ojamo, Rudanko, Stevens, & Verkasalo, (2006) who investigated the risk of cancer with visual impairment, and showed that breast cancer risk in women decreased with the degree of visual impairment, with blind women having about two-thirds the risk of women with good sight. There was a similar although less consistent trend in risk for prostate cancer in men. Flynn-Evans, Stevens, Tabandeh, Schernhammer, & Lockley, (2009), found a significantly lower prevalence of breast cancer in blind women with light perception than in blind women who could not perceive light (odds ratio 0.43; 95% CI, 0.21–0.85). The increased risk of breast cancer amongst female flight attendants has been seen as supportive of a causal role of chronodisruption, but this group have several other risk factors for breast cancer, e.g. higher nulliparity, alcohol consumption, taller size, that could explain at least part of this observed risk (Winter, Blettner, & Zeeb, 2014). Also, a recent study of US flight attendants found no association with flight-related circadian-disruption exposures and this study concluded that the risk excess appeared to be largely explained by differences in parity and age at the birth of the woman's first child (Schubauer-Berigan et al., 2015). Cosmic radiation exposure in flight attendants is also a potential confounder on these results.

Erren & Reiter, (2013), highlight that individual tendency to be awake or asleep is determined by both genetic (a polymorphism in the PER3 gene appears to be associated with those who have preference for being awake in the evenings) and environmental factors such as age, sex, use of stimulants such as caffeine, use of electronic screens during the evening, and outdoor electric lighting (Vollmer, Michel, & Randler, 2012). Personal factors are often used to categorise people into three different 'chronotypes': early types (larks), normal types, and late types (owls). They argue that shift workers who work at times that mismatch their chronotype will suffer greater health impact than those whose chronotype matches their schedule. Hansen & Stevens, (2012), showed in a nested case-control study that women who were classed as a morning-type and worked a high number of night shifts (more than 884 shifts cumulatively) had the highest risk of breast cancer (odds ratio 3.9 with 95% CI 1.6 – 9.5, compared to morning types who did not work nights). The risk for women who were evening types was not significantly raised, even amongst those with the highest cumulative exposure (odds ratio 2.0, 95% CI 0.7 – 5.8). The risk for evening types was lower and there was no observed increase in risk for women who were classed as 'normal' types. The authors argue that if chronotype is confirmed as a risk for breast cancer in night shift workers then this should be used in selecting people for night shift work.

Hoffman et al., (2010), reported statistically significant associations between single nucleotide polymorphisms associated with the CLOCK genes and breast cancer risk, which were modified by oestrogen receptor/progesterone receptor (ER/PR) status. Where there was more than one risk allele present the risk was only significantly increased in those with positive ER/PR status. Zienolddiny et al., (2013), in a large study of Norwegian nurses, showed that in women with long-term working for three consecutive night shifts, the risk of breast cancer was reduced in those with some variant alleles of CLOCK, PER3 and several other genes or melatonin signalling pathways. However, the associations were not reproducibly found in women who had worked four on more consecutive nights. Zhu et al., 2011, identified that long-term shift work exposure promotes hypomethylation of CLOCK and hypermethylation of CRY2 genes. In a small study (10 day workers and 10 long-term shift workers), Shi et al., 2013 identified circadian-relevant epigenetic changes in shift workers. They argued that these changes suggest that long-term night shift work results in down-regulation of miR-219, which may result in the down-regulation of immunomediated antitumor activity and an increase in

breast cancer risk. While these studies add some support for the causality of night work for breast cancer they shed little light on the causal mechanism.

Shorter sleep duration is common amongst night shift workers, although sleep duration is not clearly related to circulation melatonin concentrations (Fritschi et al., 2011). In recent research studies and a meta-analysis of sleep duration and cancer risk there was no evidence that short duration of sleep was associated with an increased risk of breast cancer (Girschik, Fritschi, Erren, & Heyworth, 2013; Zhao et al., 2013). Similarly, Qian, Brinton, Schairer, & Matthews, (2015) found no association between self-reported sleep duration and breast cancer overall, but identified a significantly reduced risk for oestrogen positive (ER+) and progesterone positive (PR+) receptor breast tumours for short sleep duration. This pattern is contrary to what would be expected if the risk was linked to melatonin status and shift work, and the results have been criticised externally because of potential bias in the exposure measurements (Qian et al., 2015; Yang, Wang, Deng, Zhao, & Fan, 2015). Hurley, Goldberg, Bernstein, & Reynolds, (2015), in a study of over 100,000 Californian teachers, found that compared to average sleepers, long sleepers (10+ hours per night) had a small increase in risk for the group of oestrogen-mediated cancers that included breast cancer, but no increased risk amongst short duration sleepers (<6 hours). Overall, there is little persuasive evidence for shorter sleep duration being an important cause of increased breast cancer amongst shift workers.

An IARC working group has considered the evidence for a causal link between vitamin D status and cancer (IARC Working Group on Vitamin D, 2008). From a meta-analysis of observational studies they found a risk of colorectal cancer and colorectal adenoma with low serum 25-hydroxyvitamin D (25(OH)D) levels. However, there is no conclusive evidence to suggest that vitamin D is involved in breast or prostate cancer aetiology. Subsequently, Bauer, Hankinson, Bertone-Johnson, & Ding, (2013), carried out an exposure-response meta-analysis of prospective epidemiological studies to assess the association between circulating 25(OH)D and breast cancer risk, stratified by menopause status. They found no association for premenopausal women, but amongst postmenopausal women there was a decreased risk of breast cancer for those with 25(OH)D levels above about 30 ng/ml. There was no apparent increased risk for those with low vitamin D status. Wang & Yu, (2013), carried out a similar meta-analysis using data from prospective cohort and nested case-control studies. They also did not find any risk associated with 25(OH)D in premenopausal women, but they showed that in

postmenopausal women each 10 ng/ml increase in circulating 25(OH)D concentration was associated with a statistically significant 3.2% reduction in breast cancer risk. Ward, Berry, Power, & Hypponen, (2011), investigated the association between working patterns and vitamin D status in over 6,000 adults in Great Britain at age 45 years. They found 25(OH)D concentrations were 8% lower in female night workers compared with others (equivalent to a difference of 1.7 ng/ml), but there were no statistically significant differences between male day and night workers. A recent review and meta-analysis of randomised controlled clinical trials provided no evidence that vitamin D supplementation reduced the risk of breast cancer in postmenopausal women (Sperati et al., 2013). Based on the available evidence it seems unlikely that low vitamin D status from night shift work is an important risk factor for breast cancer.

It has been argued that shift working can promote stress, fatigue, physiological dysfunction, and poor health choices such as smoking, increased alcohol consumption, lack of exercise and poor diet (Caruso, 2015; Dorrian & Skinner, 2012). In addition, the timing of eating may affect the ability of the body to metabolise the food, with gain in body weight being greater when food was available in the evenings compared to mornings. Several studies have shown that shift workers are more likely to be obese than other workers (Bushnell, Colombi, Caruso, & Tak, 2010; Ramin et al., 2015; van Drongelen, Boot, Merkus, Smid, & Beek, 2011), and obesity is a risk factor for postmenopausal breast cancer and is associated with poorer outcomes for this disease (Allott & Hursting, 2015; Dobbins, Decorby, & Choi, 2013). Disruption of peripheral circadian clocks may be linked to the development of obesity because of the effect on metabolism (Antunes, Levandovski, Dantas, Caumo, & Hidalgo, 2010; Lowden, Moreno, Holmback, Lennernas, & Tucker, 2010), e.g. food consumed between midnight and 6am may be less effectively metabolised. Consumption of alcohol is causally associated to pre- and post-menopausal breast cancer, including at low intake levels, e.g. around 10g alcohol equivalent to 1–2 drinks per day. It has been suggested that the critical risk period may be during early life and the pattern of consumption may be important, with one epidemiological study reporting that binge drinkers had an increased relative risk for breast cancer compared to other women of 1.33 (Scoccianti, Lauby-Secretan, Bello, Chajes, & Romieu, 2014). Active smoking, particularly amongst women who start before the birth of their first child, is also associated with increased risk of breast cancer (Gaudet et al., 2013). Women who have worked night shifts are more

likely to have used oral contraception and hormone therapy for the menopause (Wang et al., 2012) 2012), which may also increase risk of breast cancer.

What is evident from the body of research is that the potential for confounding and at times the poor control of confounders within research studies does require that research studies (both mechanistic and epidemiological) should be treated cautiously especially when considering individual studies rather than systematic reviews and meta-analyses.

Findings from the papers relating to health and safety

Within the research identified for this review a number of different interventions have been suggested and the more important ones are presented below (full list in Table 2). The interventions are discussed in relation to the current evidence available and where possible their feasibility in the workplace.

As identified in the review of mechanisms, melatonin has been implicated in the causal pathways relating to breast cancer. A number of potential interventional approaches have been suggested as a result of this. The phase-shifting and sleep promoting effects of melatonin are not totally understood, but measurement of serum levels of melatonin shows a circadian rhythm with the highest plasma levels reported between three and four in the morning. Boivin, Tremblay, & James, (2007), identified that oral supplements of melatonin can be used to promote daytime sleep and this effect was greater in participants with difficulties in getting to sleep. However, this effect is only found when internal melatonin levels were low. Additionally, studies in shift workers did not see an improvement in daytime sleep quality when melatonin was administered (Boivin et al., 2007; Haus & Smolensky, 2006; Schernhammer & Thompson, 2011). Thus the use of supplemental melatonin to improve daytime sleep quality in night workers does not seem to be an effective method, based on the studies to date, especially as there is still a lack of understanding of effective dosage in such workers or the safety of such an intervention and possible long-term health consequences (Schernhammer & Thompson, 2011). Exposure to light at night does cause disruption to melatonin levels. This can be seen as a positive in relation to those working night shifts where reduced melatonin levels were measured and daytime sleeping was improved (Boivin et al., 2007). There appear to be two schools of thought in relation to bright light at work for those working night shifts. The first is to filter the

shorter light wavelengths out (below 540 nm) to counteract melatonin suppression (Boivin et al., 2007; Schernhammer & Thompson, 2011). Alternatively, Fritschi, (2009) suggests the use of blue lamps causes melatonin suppression. Further research is required to identify which is less damaging to the individual; attempting to cause a phase-shift in melatonin production, which may reduce sleepiness at work, or allowing the melatonin cycle to continue without disruption. Where there is consensus in relation to light exposure, is to try and reduce exposure to light on completion of the shift and in the sleeping area by using dark glasses (where it is safe to do so) and blackout blinds (Fritschi, 2009; Schernhammer & Thompson, 2011). Although melatonin has been implicated in the mechanism of shift work and breast cancer, there is still limited knowledge of what is preferable in relation to either phase-shifting the melatonin cycle or trying to prevent disruption of the melatonin cycle. Phase-shifting may reduce sleepiness while at work, and though this decreases accident risk, there is no guidance available at the current time in relation to safe dosage of melatonin. However, other suggestions of reducing illumination levels to keep the melatonin cycle in place do bring other hazards such as reduced visibility in the workplace and increased sleepiness.

In the last 40 years there has been a large body of research carried out in relation to the design of shift systems to promote safe and healthy work; although this has not been in relation to the prevention of workplace cancer. Those research studies that have considered shift design in relation to cancer have examined this from a more theoretical standpoint in relation to the potential mechanisms of cancer from shift work. Fritschi, (2009) identified that there is no simple solution when designing shift work due to the differences that individuals have in response to sleep loss, sleep disruption and for some, transition across time zones. There does appear to be consensus in relation to trying to minimise the impact of shift work on circadian disruption (Haus & Smolensky, 2006; Reed, 2011). Thus in trying to avoid internal desynchronisation, no more than 4 night shifts at a time should be scheduled (Haus and Smolensky 2006). Reed (2011) highlights the importance of trying to minimize circadian disruption. Grundy et al., (2011) suggest that the rapidly rotating shift pattern investigated (two 12-hour days, two 12-hour nights, 5 days off) or exposure to low light levels while working at night may not importantly disrupt melatonin synthesis. It is not just the timing of the shifts in a rotating system that is important, it is also important to consider the length of shifts and the break allowance within each shift (Fritschi, 2009). These should be designed to allow task recovery within each shift as well as time for recovery between shifts.

Yong & Nasterlack, (2012), suggested that measures to counteract the negative effects of shift work are more “eminence-based” than “evidence-based”. Their recommendations including selecting individuals who are more tolerant to shift work as well as using systems that are forward rotating (morning, afternoon then night shift). Erren, Pape, Reiter, & Piekarski, (2008) suggest that prevention of chronodisruption could be achieved by simply asking individuals “Compared to other people, how would you rate your coping with transmeridian travel and or shift work?” Shift schedules can probably be organised in ways that aim to minimise the associated health risks. A number of authors recommend the use of fast forward rotating shift systems (Costa, 2010; Yong & Nasterlack, 2012), with no more than one or two subsequent nights shifts can be supported on the basis of our experience (Yong & Nasterlack, 2012) In addition, the length of shift time and the breaks allowed within the shift can also be an important influence on health and wellbeing.

Tsai, Luckhaupt, Sweeney, & Calvert, (2014) examined adherence to breast, cervical and colon cancer screening by women who worked shifts other than day shifts. In a sample of 9009 females, adherence to screening tests was evaluated for workers aged 50-74 for breast cancer; 21-65 years for cervical cancer and 50-75 years for colorectal cancer. Participants were interviewed and a description of the hours they worked was obtained. The analysis identified that workers on alternative shifts were 35% ($p<0.001$) more likely to be non-adherent to breast cancer screening and 10% ($p<0.05$) for colorectal cancer screening. No significant differences were identified for cervical cancer screening but this was a younger population. The paper by Tsai et al., (2014) broke the data down into different sectors and identified that those employed on alternative shifts in manufacturing; health and social care; arts, entertainment and recreation; hotel and food services; food preparation and service; office and administrative support; production and personal care were significantly more likely to not adhere to breast screening recommendations. For colorectal cancer screening, those employed on alternative shifts in manufacturing, hotel and food service, transportation and material moving, food preparation and servicing and production were more likely to be non-adherent to screening.

These data are important in highlighting that for individuals not working day shifts and in particular sectors are less adherent to cancer screening regimes. There may be several reasons for this including ability to access services when not working. Thus improving access to screening services,

perhaps facilitated by employers, would appear to be an obvious solution. There has been discussion about the use of screening tests including mammography for breast cancer and an IARC working group confirmed that for women aged 50 to 69 that remains a net benefit in attending cancer screening sessions (Scoccianti et al., 2014). As a result of this the employer could play a role in facilitating employees to attend screening sessions. Further considerations could be made for those who are at a genetically increased risk of breast cancer.

A number of pharmacological interventions have been suggested to improve wakefulness and reduce accidents. Boivin et al., (2007) examined the use of psychostimulants (modafinil) to reduce sleepiness in 209 workers. This study found that there were significant improvements in subjective and objective measurements of sleepiness, and increased sleep latency compared to the placebo group. Caffeine as a stimulant has also been examined by taking before the onset of night work. Boivin et al., (2007) identified that having a nap before starting a night shift and taking 300 mg of caffeine improved performance on vigilance tasks. However, day time sleep length was reduced because of the nap. The use of hypnotics such as benzodiazepines as a means of improving daytime sleep was also reported (Boivin et al., 2007; Haus & Smolensky, 2006). The use of temazepam was found to increase the length of daytime sleep but compared to controls, the differences became smaller as the number of night shifts increased; possibly due to adaptation of the sleep cycle in the control group (Boivin et al., 2007 Rosenberg & Dogrhamji 2011). However, before using such drugs, medical assessment of the severity of sleep problems must be carried out. At this juncture, the use of pharmacological intervention has been limited and although does show some potential, the benefits and potential costs of such pharmaceutical interventions must be properly evaluated.

The review by Antunes et al., (2010) identified that being overweight or obese is more prevalent in shift workers when compared to day workers. Furthermore, there is evidence that shift workers gain weight more often than day workers. Their review focuses on the fact that there is evidence to show that shift work is associated with an increased risk of obesity, diabetes and cardiovascular disease. There may be dietary advice required by shift workers but understanding the reasons why shift workers gain more weight may allow a better understanding of the impact of shifts on metabolism. As mentioned previously, the timing of eating may not coincide with the ability to metabolise food e.g. food consumed between midnight and 6am may be less effectively metabolised. As obesity is a risk

factor for postmenopausal breast cancer, managing weight must be a concern for those managing shift workers. Those involved in night work and their employers need further evidence and advice on diet, time of eating, lifestyle behaviours and sleep hygiene. The importance of health surveillance and health promoting activities has been highlighted by a number of authors (Costa, 2010; Yong & Nasterlack, 2012). As Pan, Devore, & Schernhammer, (2015) points out, there has been no high quality evaluation of these interventions in relation to the health of shift workers including any potential cancer risk.

Two papers within the review examined napping when working shifts as a means of improving alertness. Boivin et al., (2007) describe these as prophylactic naps (naps taken prior to night shifts) and recuperative naps (those taken during night shifts). Prophylactic naps have the potential to counteract sleep deprivation and have been found to improve alertness during work time (Boivin et al., 2007). However, consideration has to be made of the negative impact that napping can have when awakening from sleep and "sleep inertia", in situations where immediate wakefulness is required. The potential hazard from sleep inertia should be evaluated. Bracci et al., (2013), examined the impact of recuperative napping on nurses working night shifts. Measurement of urinary melatonin and 17-β-estradiol found that 17-β-estradiol levels were higher in participants who did not nap during night shifts. Although this was a small study it may indicate that napping should be encouraged where possible on night shifts. While napping can be used to reduce sleep debt in a 24-hour period, this is not always going to be a solution in all workplaces.

There appears to be an exposure-response effect between cancer risk relating to the cumulative years of work occurring within the research reviewed. If this is confirmed by future research it indicates that individuals may well be advised to restrict night working after a specific time period has elapsed. At the current time an exact figure cannot be given, but in line with other research in relation to different health risks including cardiovascular disease and gastro-intestinal ill health and age, night work after 50 years of age should be limited; however this may be of no help if cancer is a latent effect of an earlier exposure.

In relation to workplace hazards, there is a duty of care in relation to exposure to hazards and risk reduction measures. Shift work and night work can be considered a hazard and as such health screening for those working nights is essential. While there is guidance available on evaluating sleep

and giving guidance on ‘sleep hygiene’; further discussion is needed as to other areas of health that should be examined. In supporting the health and wellbeing of night workers it is important that structured and sustained health promotion programmes specifically tailored to night workers are provided internationally (Yong & Nasterlack 2012).

Policies and Guidance Documents

A number of guidance documents were identified as part of the data gathering stage of this review (see Table 3). The guidance provided on the whole does acknowledge the potential link between shift and night work and cancer. However, at the current time very little information is provided in relation to prevention. It is perceived that this is because of a lack of understanding of the mechanisms behind shift work and cancer, although the melatonin pathway does appear to be the most feasible. What the guidance does provide is information on other health aspects including health assessments, maintaining good health behaviours and the importance of risk assessments by employers. It is hoped that maintaining health and wellbeing in this occupational group that levels of other cancer risk factors (such as obesity or smoking) can be reduced.

DISCUSSION

Based on our examination of the mechanistic evidence, the most likely causal mechanism for a breast cancer risk amongst night shift workers, should one exist, is suppression of melatonin because of exposure to light at night, although the risk may be modified by other factors such as chronotype. However, it is also plausible that there may be direct or indirect causal pathways because of the general tendency for shift workers to be obese, and have other lifestyle risk factors for breast cancer.

For those studies that examined potential interventions relating to health and safety, it was apparent that the research in this area is fragmented and groups of researchers have examined various aspects of either the melatonin cycle or pharmacological interventions. Furthermore, at the current time, there is limited research in relation to prevention of cancers and much of the research is focused on improving sleep or reducing sleepiness or other lifestyle factors that may be implicated in the development of other cancers.

In relation to melatonin, the usefulness of this drug as a supplement depends on individual blood levels of melatonin and there is lack of information on optimum dosage levels and the timing of doses. This is balanced against the argument of using light to lower melatonin levels when working at night as a means of improving wakefulness, but this has the potential to result in chronodisruption. What the research does agree on is that to improve ease of going to sleep in the day, reduction of exposure to light on the way home and during sleep is essential.

There appear to be a number of agreements in relation to shift design and that the fast forward rotating shift system (morning, afternoon, night) is of more benefit. Although shift length can also be a factor, as can break allowance within shifts. An important point may also be to identify individuals who are able to cope better with shift work at the outset as there may be a healthy survivor effect occurring within the shift working population. This could have the impact of under-reporting of health issues because a number of people who are diagnosed with cancer in later life stopped shift working earlier and so may not be included in the enumerated cohorts, if they are cross-sectional in nature.

Health surveillance and workplace health promotion are important issues in maintaining the health of the shift work population. When examining the precursors to cancer, obesity is one such risk factor and as Antunes et al., (2010) highlighted, being overweight or obese is more common in shift

workers. Whether this is due to metabolism or other factors is still being discussed, but the importance of healthy diet and sufficient physical activity cannot be understated and employers can have a role in providing that advice and opportunities for workers on all shifts.

Lack of adherence to cancer screening was also identified in shift workers undergoing breast, colon and cervical cancer screening. The paper by Tsai et al., (2014) highlights that workers on alternative (non-daytime shifts) shifts were less likely than day workers to attend breast cancer screening sessions. The reasons for this have not been fully examined but there may be a need to improve access to cancer screening services and to specifically facilitate those involved in night work to attend.

CONCLUSIONS

The main candidate mechanisms for the increased cancer risk are suppression of nightly melatonin production, with its known anti-carcinogenic properties, from exposure to light at night and/or poorer lifestyle opportunities for night workers resulting in higher than average levels of obesity.

A number of interventions have been tried out in practice, none of which appears to have been properly evaluated for efficacy or effectiveness in relation to reducing breast cancer risk. Measures to reduce exposure to natural light when returning home to sleep during daylight would appear to have benefits in aiding sleep. Given that shift workers tend to be less compliant than non-shift workers, employers should be encouraged to facilitate shift workers access to national cancer screening programmes. Putting shift workers over 50 years of age under appropriate health surveillance to detect breast cancer and ensuring regular health assessments are carried out, would also seem appropriate, but employers could play a positive role in facilitating access to such services, especially in sectors including manufacturing, health and social care, entertainment and recreation and hotel and food service environments. Health promotion, in which employers actively provide healthy eating options in the workplace, opportunities to exercise and discourage tobacco smoking and alcohol consumption need to have particular prominence among night shift workers. Managers and employers should access and use the wealth of advice that is currently available in relation to shift work; it may reduce cancer risk even if that is not its primary focus. We also believe that measures to

alter shift patterns to make workers more alert and which are primarily to prevent accidents and improve the accuracy of work, may have the indirect benefit of reducing cancer risk. Although this requires evaluation, we believe that a responsible employer should seek to implement these interventions now.

There remains a need for further epidemiological investigation of the potential carcinogenic effects of night shift work through high quality studies that have well characterised working patterns (up to the standards required by the IARC working group) and can adequately control for other risk factors for breast cancer. Factors that disrupt the circadian rhythm including sleep disturbance and ability to adapt to shift work remain worth investigating. Regular monitoring of melatonin metabolites in urine would also be useful adjunct to any study.

REFERENCES

Allott, E. H., & Hursting, S. D. (2015). Obesity and cancer: Mechanistic insights from transdisciplinary studies. *Endocrine-Related Cancer, 22*(6), R365-86.

Antunes, L. C., Levandovski, R., Dantas, G., Caumo, W., & Hidalgo, M. P. (2010). Obesity and shift work: Chronobiological aspects. *Nutrition Research Reviews, 23*(01), 155-168.

Basler, M., Jetter, A., Fink, D., Seifert, B., Kullak-Ublick, G. A., & Trojan, A. (2014). Urinary excretion of melatonin and association with breast cancer: Meta-analysis and review of the literature. *Breast Care, 9*(3), 1-1.

Bauer, S. R., Hankinson, S. E., Bertone-Johnson, E., & Ding, E. L. (2013). Plasma vitamin D levels, menopause, and risk of breast cancer. *Medicine, 92*(3), 123-131.

Bhatti, P., Cushing-Haugen, K. L., Wicklund, K. G., Doherty, J. A., & Rossing, M. A. (2013). Nightshift work and risk of ovarian cancer. *Occupational and Environmental Medicine, 70*(4), 231-237. doi:10.1136/oemed-2012-101146 [doi]

Bizzarri, M., Proietti, S., Cucina, A., & Reiter, R. J. (2013). Molecular mechanisms of the pro-apoptotic actions of melatonin in cancer: A review. *Expert Opinion on Therapeutic Targets, 17*(12), 1483-1496.

Blask, D. E., Brainard, G. C., Dauchy, R. T., Hanifin, J. P., Davidson, L. K., Krause, J. A., . Zalatan, F. (2005). Melatonin-depleted blood from premenopausal women exposed to light at night stimulates growth of human breast cancer xenografts in nude rats. *Cancer Research, 65*(23), 11174-11184.

Boivin, D. B., Tremblay, G. M., & James, F. O. (2007). Working on atypical schedules. *Sleep Medicine, 8*(6), 578-589. doi:S1389-9457(07)00115-3 [pii]

Bracci, M., Copertaro, A., Manzella, N., Staffolani, S., Strafella, E., Nocchi, L., . . . Santarelli, L. (2013). Influence of night-shift and napping at work on urinary melatonin, 17-beta-estradiol and clock gene expression in pre-menopausal nurses. *Journal of Biological Regulators and Homeostatic Agents, 27*(1), 267-274. doi:26 [pii]

Brown, S. B., Hankinson, S. E., Eliassen, A. H., Reeves, K. W., Qian, J., Arcaro, K. F., . . . Schernhammer, E. S. (2015). Urinary melatonin concentration and the risk of breast cancer in nurses' health study II. *American Journal of Epidemiology, 181*(3), 155-162.

Bushnell, P. T., Colombi, A., Caruso, C. C., & Tak, S. (2010). Work schedules and health behavior outcomes at a large manufacturer. *Industrial Health, 48*(4), 395-405.

Caruso, C. C. (2015). Reducing risks to women linked to shift work, long work hours, and related workplace sleep and fatigue issues. *Journal of Women's Health (2002), 24*(10), 789-794.

Costa, G. (2010). Shift work and health: Current problems and preventive actions. *Safety and Health at Work, 1*(2), 112-123.

Davis, S., Mirick, D. K., Chen, C., & Stanczyk, F. Z. (2012). Night shift work and hormone levels in women. *Cancer Epidemiology, Biomarkers & Prevention : A Publication of the American Association for Cancer Research, Cosponsored by the American Society of Preventive Oncology, 21*(4), 609-618. doi:10.1158/1055-9965.EPI-11-1128 [doi]

Dobbins, M., Decorby, K., & Choi, B. C. K. (2013). The association between obesity and cancer risk: A meta-analysis of observational studies from 1985 to 2011. *ISRN Preventive Medicine, 2013*, 680536.

Dorrian, J., & Skinner, N. (2012). Alcohol consumption patterns of shiftworkers compared with dayworkers. *Chronobiology International, 29*(5), 610-618.

Erren, T. C., Pape, H. G., Reiter, R. J., & Piekarski, C. (2008). Chronodisruption and cancer. *Die Naturwissenschaften, 95*(5), 367-382. doi:10.1007/s00114-007-0335-y [doi]

Erren, T. C., & Reiter, R. J. (2013). Revisiting chronodisruption: When the physiological nexus between internal and external times splits in humans. *Naturwissenschaften, 100*(4), 291-298.

Flynn-Evans, E., Stevens, R. G., Tabandeh, H., Schernhammer, E. S., & Lockley, S. W. (2009). Total visual blindness is protective against breast cancer. *Cancer Causes and Control, 20*(9), 1753-1756.

Fritschi, L. (2009). Shift work and cancer. *BMJ (Clinical Research Ed.), 339*, b2653. doi:10.1136/bmj.b2653 [doi]

Fritschi, L., Glass, D. C., Heyworth, J. S., Aronson, K., Girschik, J., Boyle, T., . . . Erren, T. C. (2011). Hypotheses for mechanisms linking shiftwork and cancer. *Medical Hypotheses, 77*(3), 430-436.

Gaudet, M. M., Gapstur, S. M., Sun, J., Diver, W. R., Hannan, L. M., & Thun, M. J. (2013). Active smoking and breast cancer risk: Original cohort data and meta-analysis. *JNCI Journal of the National Cancer Institute, 105*(8), 515-525.

Girschik, J., Fritschi, L., Erren, T. C., & Heyworth, J. (2013). Quantitative exposure metrics for sleep disturbance and their association with breast cancer risk. *Cancer Causes & Control, 24*(5), 919-928.

Greene, M. W. (2012). Circadian rhythms and tumor growth. *Cancer Letters, 318*(2), 115-123.

Grundy, A., Tranmer, J., Richardson, H., Graham, C. H., & Aronson, K. J. (2011). The influence of light at night exposure on melatonin levels among canadian rotating shift

nurses. *Cancer Epidemiology, Biomarkers & Prevention : A Publication of the American Association for Cancer Research, Cosponsored by the American Society of Preventive Oncology, 20*(11), 2404-2412. doi:10.1158/1055-9965.EPI-11-0427 [doi]

Hansen, J., & Stevens, R. G. (2012). Case-control study of shift-work and breast cancer risk in danish nurses: Impact of shift systems. *European Journal of Cancer (Oxford, England : 1990), 48*(11), 1722-1729. doi:10.1016/j.ejca.2011.07.005 [doi]

Haus, E., & Smolensky, M. (2006). Biological clocks and shift work: Circadian dysregulation and potential long-term effects. *Cancer Causes & Control : CCC, 17*(4), 489-500. doi:10.1007/s10552-005-9015-4 [doi]

Haus, E. L., & Smolensky, M. H. (2013). Shift work and cancer risk: Potential mechanistic roles of circadian disruption, light at night, and sleep deprivation. *Sleep Medicine Reviews, 17*(4), 273-284. doi:10.1016/j.smrv.2012.08.003 [doi]

Hill, S. M., Belancio, V. P., Dauchy, R. T., Xiang, S., Brimer, S., Mao, L., . . . Blask, D. E. (2015). Melatonin: An inhibitor of breast cancer. *Endocrine-Related Cancer, 22*(3), R183-204.

Hoffman, A. E., Yi, C. H., Zheng, T., Stevens, R. G., Leaderer, D., Zhang, Y., . . . Zhu, Y. (2010). CLOCK in breast tumorigenesis: Genetic, epigenetic, and transcriptional profiling analyses. *Cancer Research, 70*(4), 1459-1468.

Hurley, S., Goldberg, D., Bernstein, L., & Reynolds, P. (2015). Sleep duration and cancer risk in women. *Cancer Causes & Control : CCC, 26*(7), 1037-1045. doi:10.1007/s10552-015-0579-3 [doi]

IARC Working Group on Vitamin D. (2008). *Vitamin D and cancer.* (No. IARC Working Group Reports; 5). Lyon: IARC.

International Labour Organisation. (1990). *Night work convention. C171*. Geneva: ILO.

Kelleher, F. C., Rao, A., & Maguire, A. (2014). Circadian molecular clocks and cancer. *Cancer Letters, 342*(1), 9-18. doi:10.1016/j.canlet.2013.09.040 [doi]

Langley, A. R., Graham, C. H., Grundy, A. L., Tranmer, J. E., Richardson, H., & Aronson, K. J. (2012). A cross-sectional study of breast cancer biomarkers among shift working nurses. *BMJ Open, 2*(1), e000532-e000532.

Lowden, A., Moreno, C., Holmback, U., Lennernas, M., & Tucker, P. (2010). Eating and shift work - effects on habits, metabolism and performance. *Scandinavian Journal of Work, Environment and Health, 36*(2), 150-162.

Pan, A., Devore, E., & Schernhammer, E. S. (2015). How shift work and a destabilized circadian system may increase risk for development of cancer and type 2 diabetes. *Circadian Medicine,* , 183-209.

Pukkala, E., Ojamo, M., Rudanko, S., Stevens, R. G., & Verkasalo, P. K. (2006). Does incidence of breast cancer and prostate cancer decrease with increasing degree of visual impairment.*17*(4), 573-576.

Qian, X., Brinton, L. A., Schairer, C., & Matthews, C. E. (2015). Sleep duration and breast cancer risk in the breast cancer detection demonstration project follow-up cohort. *British Journal of Cancer, 112*(3), 567-571.

Ramin, C., Devore, E. E., Wang, W., Pierre-Paul, J., Wegrzyn, L. R., & Schernhammer, E. S. (2015). Night shift work at specific age ranges and chronic disease risk factors. *Occupational and Environmental Medicine, 72*(2), 100-107. doi:10.1136/oemed-2014-102292 [doi]

Reed, V. A. (2011). Shift work, light at night, and the risk of breast cancer. *AAOHN Journal : Official Journal of the American Association of Occupational Health Nurses, 59*(1), 37-45; quiz 46. doi:10.3928/08910162-20101216-01

Schernhammer, E. S., & Thompson, C. A. (2011). Light at night and health: The perils of rotating shift work. *Occupational and Environmental Medicine, 68*(5), 310-311. doi:10.1136/oem.2010.058222

Schubauer-Berigan, M., Anderson, J. L., Hein, M. J., Little, M. P., Sigurdson, A. J., & Pinkerton, L. E. (2015). Breast cancer incidence in a cohort of U.S. flight attendants. *American Journal of Industrial Medicine, 58*(3), 252-266.

Scoccianti, C., Lauby-Secretan, B., Bello, P., Chajes, V., & Romieu, I. (2014). Female breast cancer and alcohol consumption. *Amepre, 46*, S16-S25.

Sperati, F., Vici, P., Maugeri-Sacca, M., Stranges, S., Santesso, N., Mariani, L., . . . Barba, M. (2013). Vitamin D supplementation and breast cancer prevention: A systematic review and meta-analysis of randomized clinical trials. *PLoS ONE, 8*(7), e69269-9.

Stevens, R.G., Hansen, J., Costa, G., Haus, E., Kauppinen, T., Aronson, K.J., Castano-Vinyals, G.,…Straif, K. (2011). Considerations of circadian impact for defining 'shift work' in cancer studies: IARC Working Group Report. *Occupational and Environmental Medicine 68*(2), 154-162.

Stevens, R. G., Brainard, G. C., Blask, D. E., Lockley, S. W., & Motta, M. E. (2013). Breast cancer and circadian disruption from electric lighting in the modern world. *CA: A Cancer Journal for Clinicians, 64*(3), 207-218.

Straif, K., Baan, R., Grosse, Y., & Secretan, B. (2007). Carcinogenicity of shift-work, painting, and fire-fighting. *Lancet Oncology,*

Tsai, R. J., Luckhaupt, S. E., Sweeney, M. H., & Calvert, G. M. (2014). Shift work and cancer screening: Do females who work alternative shifts undergo recommended cancer screening? *American Journal of Industrial Medicine, 57*(3), 265-275.

Travis, R.C., Balkwill, A., Fensom, G.K., Appleby, P.N., Reeves, G.K., Wang, X-S., Roddam, A.W.,….Green, J. (2016). Night Shift Work and Breast Cancer Incidence: Three Prospective Studies and Meta-analysis of Published Studies. *Journal of the National Cancer Institute, 108*(12), doi: https://doi.org/10.1093/jnci/djw169

van Drongelen, A., Boot, C., Merkus, S., Smid, T., & Beek, A. J. (2011). The effects of shift work on body weight change, a systematic review of longitudinal studies. *Scandinavian Journal of Work, Environment and Health, 37*(4), 263-275.

Van Dycke, K. C., Rodenburg, W., van Oostrom, C. T., van Kerkhof, L. W., Pennings, J. L., Roenneberg, T., . . . van der Horst, G. T. (2015). Chronically alternating light cycles increase breast cancer risk in mice. *Current Biology : CB, 25*(14), 1932-1937. doi:10.1016/j.cub.2015.06.012 [doi]

Vollmer, C., Michel, U., & Randler, C. (2012). Outdoor light at night (LAN) is correlated with eveningness in adolescents. *Chronobiology International, 29*(4), 502-508.

Vriend, J., & Reiter, R. J. (2015). Breast cancer cells: Modulation by melatonin and the ubiquitin-proteasome system - A review. *Molecular and Cellular Endocrinology, 417*, 1-9.

Wang, F., & Yu, T. (2013). 353 night-shift work and risk of breast cancer: A meta-analysis. *Occupational and Environmental Medicine, 70*(Suppl 1), A120-A120.

Wang, X., Travis, R. C., Reeves, G., Green, J., Allen, N. E., Key, T. J., . . . Beral, V. (2012). Characteristics of the million women study participants who have and have not worked at night. *Scandinavian Journal of Work, Environment & Health,* , 590-599.

Ward, M., Berry, D. J., Power, C., & Hypponen, E. (2011). Working patterns and vitamin D status in mid-life: A cross-sectional study of the 1958 british birth cohort. *Occupational and Environmental Medicine, 68*(12), 902-907.

Winter, M., Blettner, M., & Zeeb, H. (2014). Prevalence of risk factors for breast cancer in german airline cabin crew: A cross-sectional study. *Journal of Occupational Medicine and Toxicology, 9*, 27.

Yang, W. S., Wang, X., Deng, Q., Zhao, H., & Fan, W. Y. (2015). Sleep duration and breast cancer risk in the breast cancer detection demonstration project follow-up cohort: True associations or bias? *British Journal of Cancer, 112*(11), 1838-1839. doi:10.1038/bjc.2015.130

Yong, M., & Nasterlack, M. (2012). Shift work and cancer: State of science and practical consequences. *Archives of Industrial Hygiene and Toxicology, 63*(2), 153-160.

Yong, M., Nasterlack, M., Messerer, P., Oberlinner, C., & Lang, S. (2014). A retrospective cohort study of shift work and risk of cancer-specific mortality in german male chemical workers. *International Archives of Occupational and Environmental Health, 87*(2), 175-183.

Zamai, L., Ponti, C., Mirandola, P., Gobbi, G., Papa, S., Galeotti, L., . . . Vitale, M. (2007). NK cells and cancer. *The Journal of Immunology, 178*(7), 4011-4016.

Zhao, H., Yin, J., Yang, W., Qin, Q., Li, T., Shi, Y., . . . Nie, S. (2013). Sleep duration and cancer risk: A systematic review and meta-analysis of prospective studies. *Asian Pacific Journal of Cancer Prevention : APJCP, 14*(12), 7509-7515.

Zhu, Y., Stevens, R. G., Hoffman, A. E., Tjonneland, A., Vogel, U. B., Zheng, T., & Hansen, J. (2011). Epigenetic impact of long-term shiftwork: Pilot evidence from circadian genes

and whole-genome methylation analysis. *Chronobiology International, 28*(10), 852-861. doi:10.3109/07420528.2011.618896 [doi]

Zienolddiny, S., Haugen, A., Lie, J. A., Kjuus, H., Anmarkrud, K. H., & Kjaerheim, K. (2013). Analysis of polymorphisms in the circadian-related genes and breast cancer risk in norwegian nurses working night shifts. *Breast Cancer Research : BCR, 15*(4), R53. doi:bcr3445 [pii]

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Table 1 – Research Evidence in Relation to Interventions

Author	**Type of Study**	**What research question(s) does the study address?**	**Type of cancer(s)**	**Description of population**	**What data is provided on shift work?**	**What evidence is provided on the impact of shift working on the risk of cancer?**	**What evidence is provided on the steps that could be taken to reduce the risks of shift working?**	**Outcome Measures e.g., circadian rhythm, cancer, modifications**
Bracci et al. 2013	Cross-sectional study	Investigate urinary 6-sulfatoxymelatonin, serum 17-B-estradiol levels in premenopausal shift nurses at the end of the night shift compared to a control group of daytime nurses.	Breast cancer	184 registered female nurses working in NHS hospital wards in Ancona, Italy. Of these, 31 shift working nurses were recruited and 31 daytime nurses.	Type of shift work.	Shift nurses experience changes in aMT6s levels after a night-shift. Napping habits influence 17-B-estradiol levels at the end of a night shift.	A short nap during night-shifts may exert a positive effect.	aMT6s levels.
Reed (2011)	Review	Shift work, light at night and the risk of breast cancer - a guide to administrative action for health care institutions	Breast cancer	not described	Light at night	N/A	The paper has a section on 'how should health care institutions respond' and a section on 'options and recommendations' including; invoke the precautionary principle, minimizing exposure, scheduling that minimizes circadian disruption, promoting circadian entrainment, matching schedules with propensities and	N/A

							tolerances, environmental lighting,	
Boivin et al 2007) Working on atypical schedules. Netherlands:	Review	Countermeasures to improve adaptation to shift work	N/A	N/A	N/A	N/A	N/A	N/A
Haus and Smolensky (2006) Biological clocks and shift work: circadian dysregulation and potential long-term effects.	Mechanism and H&S review	Review of circadian dysregulation and long-term health effects	Breast; colon	N/A	N/A	None	Adaptation may be possible but not always feasible nor desirable for rapidly rotating workers. Suggestions include the use of bright light and melatonin. Exposure to light at night has been attempted, but required use of dark sunglasses during daytime. Time of food intake may be important in some individuals. In rapidly rotating shifts, the individual should stay on the schedule dictated by their normal habits. Minimize, the number of consecutive night shifts should be no more than 4. The direction of rotation in rapid shifts is also of importance. Forward rotating shifts are more favourable than back rotating ones. Pharmacologic agents such as benzodiazepines may induce sleep and so be helpful in reducing fatigue, but doesn't act on the circadian system.	Circadian dysregulation

Fritschi (2009) Shift work and cancer. England	Mechanisms review	Review of short and long term effects	Breast	N/A	N/A	None	Major differences in individual responses to sleep loss, sleep disruption, and time zone transitions make it impossible to develop a “one size fits all” shift schedule. Other researchers have concentrated on countermeasures that increase sleep duration, promote quick adaptation to night work, or improve subjective wellbeing at work. One possibility is to use our increasing understanding of the physiological control of the sleep-wake cycle to time our exposure to light and darkness for maximum adaptation. Using phototherapy lamps (especially those producing blue light, which is most efficient in resetting melatonin release time), wearing goggles, wearing sunglasses when driving home, and darkening bedrooms or wearing sleeping masks are being tried. Medications that are stimulants, hypnotics, or chronobiotics (substances that control the body clock) are also being used. It may also be possible to screen workers to select those with factors that seem to be associated with better tolerance of shift work, such as being an “evening person,” having better family support, and having fewer responsibilities at home. Shift	Cancer

							lengths should be shorter; rest breaks should be included; and researchers should educate shift workers and employers as to how sleep-wake cycles are controlled and how this knowledge can be used to maximise sleep quality, sleep duration, and alertness at work.	
Schernhammer and Thompson (2011) Light at night and health: the perils of rotating shift work. England:	Epidemiological and Mechanisms review	Editorial for an epi study		N/A	N/A	None	Optimising shift schedules. Genetic screening tests to identify vulnerable populations. The use of exogenous melatonin in night workers. Changing light sources or filtering short wavelength (blue) light. By having night workers wear goggles. Determining which factors relate to shift schedules and what aspects of shift schedules are most detrimental to health.	Cancer
Rosenberg and Doghramji (2011)	Review of treatment options for shift work disorder	Review of the epidemiologic and mechanistic evidence for the health effects of shift work and review of treatment options for shift work disorder	Breast; prostate; skin; ovarian	Various	Various	36% increased relative risk in nurses working nights for 30 years or more. Breast cancer 60% higher in women who worked night shift at least 1 time in the 10 years before diagnosis compared	Napping to reduce urge for sleep. Use of timed bright light during work periods and restriction of morning light using night goggles in night shift workers during the drive home (use of two in combination). Administration of melatonin to improve adaptation to night-shift work. Use of hypnotics for insomnia and use of alerting	Cancer

						to those that did not. Rotating shift workers at significantly increased risk of prostate cancer than day workers, whereas the risk was not significantly increase for fixed night workers in the same study. Shift work has been associated with decreased risks of skin and ovarian cancer.	agents for excessive sleepiness.	
Tsai RJ, et al. (2014)	Cross-sectional	Are shift workers adherent to cancer screening?	Cancer screening	9009 females who provided shift work information	Regular evening shift, regular night shift, rotating shift or some other schedule	27.4% of sample worked alternative shifts. Non-adherence for breast cancer screening was 35%, for colon cancer screening 10% and no differences between those who worked alternative shifts.	Shift work appears to affect attendance at screening appointments	N/A

Table 3 – Guidance Documents

Guidance document	Recommendations/advice
Associated Society of Locomotive Engineers and Firemen. Shift work, lifestyle and health section C. **This is an ASLEF booklet.**	**The DTLR Road Safety Research Report on (road) driver sleepiness found:** • That "caffeine (150mg) is an effective countermeasure to sleepiness, as is a short (less than 15 minutes) nap or doze. The two combined together (caffeine in the form of a caffeinated drink, then a nap) are particularly effective. The efficacy of these treatments will depend on the magnitude of the sleepiness. Even 'relaxing with the eyes closed' is worthwhile". However members need to be aware of the adverse effects of too much caffeine. **How do you risk assess shift schedules?** • The HSE published a report "validation and development of a method for assessing the risks arising from mental fatigue". A "Fatigue Index" is used to assess the risks from the impact of rostering on mental fatigue in safety critical work. o The Fatigue Index requires the calculation of 5 factors: shift start time (F1), shift duration (F2), rest period between shifts (F3), breaks during shifts (F4) and cumulative fatigue (F5). These are added together to give an overall index for the roster. **Impact of shift work and fatigue on safety and on mental and visual acuity:** *(main points/findings from Professor Folkard paper)* • Safe duties are those between 8 and 10 hours (This fits well with ASLEF policy) • Second to fourth hour on duty is a SPAD risk and about 50% of all SPADs occur in this period. This has implications and suggests that longer, but less, turns are safer than shorter, but more turns. (An example would be that 4x10 hours = 40 is actually "safer" than 5x8 = 40 hours, as 4x 2/4 hour peak has one less 2/4 hour SPAD peak risk). • However, there is no real evidence to suggest that risk is significantly increased from working up to 12 hours. • The Report believes that "there is a strong case to be made for developing and piloting a set of guidelines for good practice on one or more TOCs. Drivers and Management's would set guidelines with benefit from expert advice. Trial would last 2/3 years. Then follow up with 6 monthly surveys. • Night turns – should be only 2/3 consecutive turns • Earlies again 2/3 consecutive turns • Rest Periods – minimum 14 hours (Now 12). • PNB's need research to find optimum times and duration. • Commuting time to and from work. No established maximum. DERA suggests max of 1 hour (Eurostar have this already). **Lifestyle training:** *ASLEF action, Reps should take account of:* • Knowledge of the effects of biological rhythms in the planning of shift rostering • Education of shift workers and their families • Environmental design changes, especially those aspects which can improve alertness such as temperature, lighting and comfort levels; • Provide medical advice for shift workers, especially for those with existing medical conditions. • The first and foremost control measure is to eliminate, or reduce as far as possible, the need for shift work. *How to improve sleep and fight "sleep debt":* • Before the first night shift try napping for 2 to 3 hours in the evening; • Inform your family that you need peace and quiet to be able to sleep in the daytime – you could use a "do not disturb" notice; • Make sure that the bedroom is dark and cool; • Think about using earplugs;

	• Remember that tea and coffee are stimulants and also make you want to go to the toilet. Following your last night shift, try sleeping for only 3 or 4 hours, then stay awake all day and go to bed at your normal time. **Advice on nutrition for shift workers:** • Try to develop a regular eating schedule for the shift you are on; • Try to have your main meal of the day in the middle of your awake period and a couple of hours before commencing night duty; • Try to join your family for at least one meal a day, even if it is your 'breakfast' and their supper; • Eat lightly but nutritionally during the night; • Avoid caffeine if possible; • Control your sugar intake. • Take regular exercise, one or two hours before your shift will keep you more alert whilst on duty. • Avoid doing exercise within an hour or two of going to bed, as it increases your alertness and makes falling asleep more difficult. **Shift pattern recommendations (Wedderburn, 1991):** • Minimise permanent nights; • Minimise sequence of nights: only 2-4 night shifts in succession should be worked; • Consider shorter night shifts; • Avoid quick change-overs; • Plan rotas with some free weekends; • Avoid overlong work sequences; • Rotate forward (i.e. clockwise rotation morning/ evenings/ nights); • Avoid early starts.
Associated Society of Locomotive Engineers and Firemen Journal (2012). Stop Working Around The Clock. **ASLEF Journal, published monthly. This issue includes a feature on 'health at work is as important as safety' which includes shift work.**	**Shift working checklist:** • Minimise permanent nights • Minimise sequence of nights, working only 2-4 night shifts in succession • Consider shorter night shifts • Avoid quick change-overs • Plan rotas with some free weekends • Avoid overlong work sequences • Rotate forward (that is, clockwise rotation – morning/ evenings/ nights); • Avoid early starts • Ensure proper rest time between the end of one week's shifts and the start of the following weeks. Further guidance can be found in the health and safety section of the ASLEF web site. **Shift working checklist: for health and safety representatives:** • Find out if members have any problems working shifts. (Remember this can be a sensitive issue, has equal opportunities implications and that shift work is an issue for men and women). • Draw this article to your members' attention, especially the 'What should I do?' section • Find out if the people who set rosters and diagrams have had fatigue risk management training and if they take health issues into account when drawing rotas up • Raise any issues locally and with the Company Joint Safety Committee and Company Council.

	• Develop a Company Council shift-work policy and organise fatigue risk management training. • Inform your District Organiser and ASLEF's Executive Committee of any issues taken up and of any progress (or lack of it).

Electricity Industry Occupational Health Advisory Group (2008). Night work: Guidance note 3.3.	• Medical assessments and advice regarding fitness to work – health assessments
	  o Employer must offer a free health assessment to any worker who is to become a night workers
	  o Offer the opportunity to have further assessments at regular intervals

GMB, London Region Health and Safety Department. Reps guide to shift work.	A best practice approach based on the HSG65 guidelines is suggested for managing shift working arrangements:
	• Consider the risks of shift work and the benefits of effective management
	  o What are the undesirable effects of shift work?
	  o Consider the costs and benefits of effective management of shift working arrangements.
	• Establish systems to manage the risks of shift work.
	  o Seek management's commitment to control the risks of shift work;
	  o Identify individuals responsible for shift-working arrangements; and
	  o Consult safety representatives "in good time" and their members.
	• Assess the risks associated with shift work in your workplace
	  o Consider the risks that workers may be exposed to;
	  o Establish who might be harmed by shift work; and
	  o Consult safety representatives "in good time" and their members.
	• Take action to reduce those risks
	  o Assess how severe the risks identified are and identify where improvements need to be made:
	  o Improve the shift work schedule;
	  o Improve the working environment; and
	  o Apply appropriate control procedures.
	• Check and review your shift working arrangements regularly
	  o Implement a system for early reporting of problems associated with shift work;
	  o Monitor alterations to shift work schedules and/or conditions;
	  o Periodically review the effectiveness of the shift working arrangements.
	
	While all workers are potentially at risk from shift work, employers should consider certain groups who are more vulnerable than others:
	• Young workers
	• Older workers
	• New and expectant mothers
	• Workers with pre-existing health conditions, which may be made worse by shift work, such as those with gastro-intestinal problems, coronary heart disease and sleeping problems

	• Workers taking time-dependency medication such as insulin • Temporary or older workers, such as sub-contractors and maintenance workers, who may not be familiar with or be able to adhere to current shift work schedules, or who have been on a different schedule with a previous employer; • Workers, who following a standard day's work, have remained on call through the subsequent night or weekend
Health and Safety Authority (2012). Guidance for employers and employees on night and shift work	**Risk factors associated with shift work and practical advice on how to control them:** **Workload:** • Workload, Mental and physical demands, advice: o Plan an appropriate workload that accords with the length and timing of the shift. o If practical, schedule demanding work for periods when workers are most alert and least likely to be fatigued. o Where possible, demanding, dangerous and safety critical work should be avoided at night time, in the early hours of the morning or at the end of long shifts. o Where work is particularly demanding, consider shortening the length of the shift. **Work activity:** • Work activity, advice: o Where possible, schedule a variety of tasks into the shift and if practicable, allow workers some choice regarding their order of completion. **Shift pattern:** • Regular shifts, advice: o Permanent night shifts should be avoided where possible. o Ensure permanent night and early morning workers are aware of the risks through provision of information. o If practicable, offer workers the choice between permanent and rotating shifts. o Ensure there is adequate supervision. o Ensure adequate time at shift handover so that new shift team is fully aware of any issues in previous shift. • Rotating shifts – advice: o Plan the direction and speed of rotating shifts to assist a worker adapting to rotating shifts. • Forward versus backward rotation, advice: o Adopt forward rotating schedules where possible. o Ensure there is adequate rest time between shifts to comply with the 1997 Act: i.e. a minimum period of 11 hours. • Fast rotation versus slow rotation, advice: o Rotate shifts every two to three days where possible. o Avoid weekly/fortnightly rotating shift schedules where possible. o If fast rotation is not an option, then slow rotation over at least a three week period is the next best option. **Shift timing:** • Night shifts, advice: o Permanent night shifts should be avoided where possible. o Try to find alternatives to night work for those workers who cannot adapt to it. o The Night Work and Shift Work Regulations make allowance for transfer to day work where a night worker becomes ill as a result of night work. o Avoid demanding, monotonous and safety critical work during the night and early morning hours where possible. o Provide workers with information about the risks of night work.

	○ In accordance with the provisions of the Night Work and Shift Work Regulations, ensure a health assessment is made available at regular intervals to night workers. ○ Where possible, provide the same or similar facilities and opportunities for night workers and day workers. • Early morning starts, advice: ○ Avoid early morning starts before 7a.m. where possible. ○ Consider providing transport to work. ○ Provide information to workers on the risks of shift work. • Afternoon starts, advice: ○ Adopt afternoon starts in preference to night or early morning starts. • Daytime shifts, advice: ○ Adopt day shifts in preference to night, early morning and afternoon starts where possible. **Shift duration:** • 8 hour shifts, advice: ○ There are few differences in the effects of 8 and 12 hour shifts on workers and there are no clear advantages to either system. ○ Eight hour shifts are preferable when the work is monotonous, demanding (physically or mentally) or safety critical. • 12 hour shifts, advice: ○ Avoid 12 hour shifts when the work is monotonous, demanding (physically or mentally) or safety critical. ○ Provide frequent and regular breaks to reduce the risk of fatigue. ○ Limit 12 hour night shifts to 2 to 3 consecutive nights where possible. ○ Be aware of the needs of vulnerable workers and transfer them to shorter shifts if necessary. ○ Avoid shift overrun and overtime. ○ Monitor shift swopping by workers. ○ Discourage workers from doing second jobs on their free days. ○ Make adequate arrangements to cover absentees. ○ Consider additional day shifts to allow for absentees, training and development. • Shifts longer than 12 hours, advice: ○ Avoid shifts longer than 12 hours. ○ It is likely workers will not get the required minimum rest period of 11 hours under the 1997 Act. • Variable shift lengths, advice: ○ Variable length shifts may be considered, as long as it is remembered that they require more planning. • Split shifts, advice: ○ Avoid split shifts as they do not allow for adequate rest breaks between shifts. **Rest breaks within shifts:** • Rest breaks within shifts, advice: ○ Under the 1997 Act workers are entitled to a 15 minute break after 4.5 hours and 30 minutes after 6 hours. ○ Depending on the workload and length of shift, short regular breaks reduce the risk of fatigue. ○ Allow workers some choice over when they take a break. ○ Where work is machine/system controlled and not self- paced, introduce frequent breaks into shift schedule. ○ Naps need close supervision and should not be allowed where safety critical decisions are made. ○ If adopted, a break of 40 minutes is needed to allow workers a 20 minute nap and time to refresh themselves and regain alertness before resuming work. ○ Make facilities available which encourage workers to take their longer breaks away from their work station.

	Rest breaks between shifts:
	• Rest breaks between consecutive shifts, advice:
	  o Ensure the minimum time between shifts is 11 hours in order to comply with the 1997 Act and allow workers time to commute, eat, sleep and enjoy family and social life.
	• Rest days, advice:
	  o Normally, a limit of five to seven consecutive working days should be set for standard (seven to eight hour) shifts. Where shifts are longer, for night shifts and early morning shifts a limit of two to three consecutive shifts followed by two to three rest days may be preferable.
	  o Under the 1997 Act, workers are entitled to a 24 consecutive hours rest period per week, although rest days may be averaged over a fortnight.
	  o When switching from day to night shifts or vice versa, make provision for a minimum of two nights of full sleep to enable workers adjust to a new schedule.
	  o The 1997 Act states the rest period shall be a Sunday unless otherwise provided in the employee's contract of employment.
	Provision of a health assessment and of workplace health promotion can prevent illness.
	Physical environment:
	• Facilities, advice:
	  o Where reasonably practicable provide similar facilities.
	  o The requirements of the General Application Regulations (GAR) 2007, Regulations 18 to 25 (welfare and sanitary) and 163 to 166 (first aid) apply.
	• Lighting, advice:
	  o Minimum compliance with Regulation 8 GAR 2007
	  o This is a technical area requiring specialist advice.
	• Temperature, advice:
	  o Minimum compliance with Regulation 7 GAR 2007.
	  o Allow workers control of the temperature if possible. Often outside night temperatures are cooler than daytime and additional warmth may be needed.
	• Ventilation, advice:
	  o Minimum compliance with Regulation 6 GAR 2007.
	• Humidity, advice:
	  o Air should be neither too dry nor too moist.
	Management issues:
	• Supervision, advice:
	  o Minimum compliance with S8 and S10 of The Safety, Health and Welfare at Work Act 2005.
	  o Shift supervisors should be trained to recognise risk factors leading to fatigue and be able to identify fatigued workers.
	  o Consider increased supervision during periods of low alertness, night and early morning, following lunch and towards the end of long shifts.
	• Overtime, advice:
	  o Avoid overtime where possible by having relief available to cover absences, emergencies etc.
	  o If unavoidable, monitor individual hours worked to avoid excessive work hours especially where shift swapping is allowed.
	• Shift swapping, advice:
	  o Monitor shift swapping to avoid excessive working hours.
	• Standby and on-call duties, advice:
	  o Ensure adequate rest periods are provided for workers on standby and on call.
	• Training and information, advice:
	  o Minimum compliance with S8 and S10 of 2005 Act is required.

	○ Provide information to workers and their supervisors on the risks of shift work and any relevant risk factors identified. ○ Encourage workers to report any shift related problems. ○ Encourage workers to adopt healthy behaviours and coping strategies outside of work. ○ Provide training during their shift if possible. ○ If workers have to attend training during their rest period, compensatory time off must be given. ○ Consider additional shift teams to facilitate attendance at training and development. • Communication, advice: ○ Encourage team working if possible. ○ Ensure lone workers are contacted at regular intervals during the shift. ○ Provide remote workers with phones and/or means of communication. ○ Ensure adequate time is allowed to share information between shifts. ○ Having a short overlap at the end of one shift and the start of the next will assist. ○ Ideally information handover should be person to person. **Health assessment, promotion and security:** • Health assessment, advice: ○ Comply with minimum requirements of Regulations 146 (health assessment for young persons), 151 (transfer to day work for pregnant workers) and 157 (health assessment for night workers) of GAR 2007 (see Section 6 of this guidance). ○ Provide health assessment for night workers before starting work and at regular intervals. ○ Transfer workers to day work where night shift causes or is likely to cause ill health effects. ○ Encourage workers to inform their G.P. about their working arrangements. • Health promotion, advice: ○ Where possible promote healthy behaviours such as healthy eating and exercise (see Section 5 of this guidance). • Security, advice: ○ Ensure car parks are well lit and secure (security cameras may assist). ○ Design shift start and end times around availability of public transport if possible. ○ If not, consider providing transport to and from work. ○ Ensure lone workers have access to telephones and are contacted regularly during shifts. **Practical advice for employees:** • Driving to and from work ○ Get a lift, or use public transport or a taxi if possible ○ Share lifts ○ Drive carefully and do not speed ○ Do not drive if overtired ○ Stop for a quick rest if you feel sleepy while driving • Sleep pattern ○ Find out if you sleep better by going to bed soon after returning home from work or waiting up and going to sleep before the next shift ○ Have a short sleep before your first night shift ○ Have a short sleep after coming off night shifts and go to bed early that night • Sleep environment ○ Use your bedroom for sleep and not as an entertainment room (e.g. no television) ○ Avoid falling asleep in the living room ○ Choose a quiet room as your bedroom, where there is least disturbance from outside and internal noise and sounds

	○ Blackout the bedroom as much as possible to keep out daylight, this will help you sleep and encourage melatonin production, vital for the suppression of tumours ○ Consider using heavy curtains or blinds, which can help in blacking out the room ○ Put your mobile on silent and landline ringing volume on low ○ Ask your family to keep the noise levels down from voice, radio, television and not to disturb you ○ If necessary let your neighbours know your schedule and request them to avoid use of noisy machines such as grass mowers and power tools when you should be sleeping ○ If they have a dog that barks a lot, ask them to bring it inside if possible ○ Use ear muffs and eye shields if necessary ○ Maintain a cool temperature: not too warm in the bedroom • Promoting sleep ○ Do some gentle exercise such as a short walk (but don't over exercise as it stimulates the body and raises temperature) ○ Get relaxed by reading or listening to music or watching a television programme ○ Have a shower or bath ○ Avoid drinking caffeine or other stimulants a few hours before going to sleep ○ Drink very little alcohol as it reduces the quality of sleep (see Section 5.7 stimulants and sedatives) ○ If you are hungry eat a light meal; don't go to bed hungry or overfed • Diet ○ Eat regular light meals as heavy meals can cause drowsiness ○ Avoid fatty foods as they are more difficult to digest ○ Choose foods that are easily digestible such as pasta, rice, bread, fruit and vegetables ○ Avoid sugary foods, which do provide a short energy boost, but then cause a dip in energy levels ○ Eat plenty of fruit and vegetables, which are a good option as their sugar is converted slowly into energy and they also provide vital vitamins, minerals and fibre ○ Drink plenty of water to avoid dehydration which affects both physical and mental performance; add a sweetener if you don't like water ○ However, don't drink too much before sleeping as it will result in you waking up early to relieve your bladder • Stimulants and sedatives ○ Caffeine is a mild stimulant found in coffee, tea, cola, energy drinks and in tablet form. It can improve reaction time and feelings of alertness for short periods. Occasional use of caffeine is fine, but it should not be used to keep you awake. You also need to be aware of what might happen when its effects wear off ○ Alcohol can promote the onset of sleep. However, it is associated with waking up early, disrupted sleep and poorer sleep quality. Excessive use can result in dependency and addiction and lead to long-term damage to your physical and mental health, work performance and family and social relations ○ Regular use of sleeping pills can lead to dependency and addiction • Physical exercise ○ General physical exercise advice, at least 30 minutes daily exercise. • Social support ○ Let your family and friends know about how shift work affects you. If they understand the problems, they can be more supportive ○ Let them know your shift schedule well in advance. This means that social and family activities can be planned around your shift schedule ○ Get involved as much as possible with family activities such as meals, household chores, sport and going out together ○ Plan your domestic chores and duties so that they do not disrupt your rest and sleep schedule ○ Try to carry out some social activities with work colleagues who share similar shift schedules to you as they may be available when family and friends are not

	• Keeping alert at work
	  o Exercise lightly before starting work
	  o Keep light levels bright
	  o Maintain adequate room temperature and ventilation
	  o Take regular short breaks if allowed
	  o Walk away from your work station during breaks
	  o If possible do more stimulating work when you begin to feel drowsy
	  o Keep in contact with colleagues

Health and Safety Executive (2006). Managing shift work: health and safety guidance.	**A systematic approach to assessing and managing the risks associated with shift work:**
	• Consider the risks of shift work and the benefits of effective management
	  o What are the undesirable effects of shift work?
	  o Consider the costs and benefits of effective n management of shift-working arrangements.
	• Establish systems to manage the risks of shift work.
	  o Seek management commitment to control the risks n of shift work.
	  o Identify individuals responsible for shift-working n arrangements.
	  o Involve safety representatives and workers
	• Assess the risks associated with shift work in your workplace.
	  o Consider the risks that workers may be exposed to.
	  o Establish who might be harmed by shift work.
	  o Consult workers and their safety representatives.
	• Take action to reduce these risks.
	  o Assess how severe the risks are and identify where n improvements need to be made.
	  o Improve the shift-work schedule.
	  o Improve the workplace environment.
	  o Apply good practice guidelines.
	• Check and review your shift-work arrangements regularly.
	  o Implement a system for early reporting of problems n associated with shift work.
	  o Monitor alterations to shift-work schedules and/or n work conditions.
	  o Periodically review the effectiveness of your shift- n working arrangements
	
	While all workers are potentially at risk from shift work, you should consider certain groups who are more vulnerable than others. These include:
	• Young workers;
	• Older workers;
	• New and expectant mothers;
	• Workers with pre-existing health conditions, which may be made worse by shift n work, such as those with gastro-intestinal problems, coronary heart disease and sleeping problems;
	• Workers taking time-dependent medication such as insulin;
	• Temporary and other workers, such as sub-contractors and maintenance n workers, who may not be familiar with or be able to adhere to current shift work schedules, or who have been on a different schedule with a previous employer;
	• Workers, who following a standard day's work, have remained on call through the subsequent night or weekend
	
	Consult workers and safety reps, including:

	○ Encourage workers to share their experiences of shift work; ○ Discuss which shifts are hardest and why; ○ Use assessment tools and techniques to highlight potential problems and n compare different shift schedules (see appendix 3); ○ Provide examples of different shift-work schedules; ○ Invite spontaneous contribution of ideas. **Improve the shift work schedule:** **Workload:** • Workload, Mental and physical demands, advice: ○ When planning work, plan an appropriate workload, according to the length and the timing of the shift. If practical, schedule demanding work for periods when workers are most alert and least likely to be fatigued. Where possible, demanding, dangerous and/or safety-critical work should be avoided during the night and early hours of the morning and towards the end of long shifts. When work is particularly demanding, consider shortening the length of the shift. **Work activity:** • Work activity, advice: ○ Where possible, schedule a variety of tasks into the shift plan and if practicable, allow workers some choice regarding their order of completion. **Shift pattern:** • Permanent shifts, advice: ○ Permanent night shifts should be avoided where possible, although some workers and supervisors may find them desirable. Ensure staff, especially those who work permanent night shifts or early morning shifts are aware of the risks, through provision of training and information. ○ If reasonably practicable, offer workers the choice between permanent and rotating shifts. ○ Ensure there is enough supervision of shifts to facilitate communication between workers and promote appropriate behaviour and rational decision making. ○ Improve communication at shift handover to ensure that new shift teams are fully aware of issues that have arisen during the previous shift. • Rotating shifts – comment: ○ Rotating shift schedules reduce the number of nights an individual has to work, as night work is shared between all workers. However, the constantly changing shift pattern means that workers may have difficulty adapting to the schedule. The direction and speed of rotation can influence how an individual adapts to rotating shifts. • Forward versus backward rotation, advice: ○ Adopting forward-rotating schedules rather than backward-rotating, may help reduce sleep loss and fatigue. ○ Ensure there is adequate rest time between shifts. Under the WTR, the minimum time allowed between shifts is 11 hours. • Fast rotation versus slow rotation, advice: ○ Rotating shifts every 2-3 days is recommended, as the internal body clock does not adapt and sleep loss can be quickly recovered, reducing the risk of fatigue and ill health. ○ Weekly/fortnightly rotating shift schedules are not recommended. Avoid these where possible. ○ If fast rotation is not possible, then slowly rotating shifts over at least a 3-week period is the next best option. **Shift timing:** • Night shifts, advice: ○ Only a limited number of workers can successfully adapt to night work. Try to find alternatives to night work for those workers who cannot adapt. Where possible, permanent night shifts should be avoided. ○ Consider the type of work being done and the workload. Where possible, avoid demanding, monotonous, dangerous and/or safety-critical work during the night and early hours of the morning.

	○ Provide training and information about the risks of shift work for workers and their families. Make staff aware of sources of information and support, such as child care and counselling services. Under the WTR, night workers have a right to receive free health assessments. ○ Where reasonably practicable, provide similar facilities and opportunities for night workers as those available for your daytime workers. • Early morning starts, advice: ○ Where early morning starts are not essential for business needs, avoid shift starts before 07.00 am. Consider if providing transport to and from the workplace would be beneficial. ○ Provide training and information about the risks of shift work for workers and their families. Make staff aware of sources of information and support, such as child care and counselling services. • Afternoon starts, advice: ○ Afternoon shifts are suitable for most workers and where practicable, you should adopt them in preference to night or early morning shifts. ○ Provide training and information about the risks of shift work for workers and their families. Make staff aware of sources of information and support such as child care and counselling services. • Daytime shifts, advice: ○ Where practicable, adopt day shifts rather than night or early morning shifts. **Shift duration:** • 8 hour shifts, advice: ○ There are few differences in the effects of 8-hour and 12-hour shifts on workers and there are no clear advantages to either system. However, the nature of the work needs to be considered. 8-hour shifts are preferable when work is monotonous, demands concentration or vigilance, is isolated, is safety critical and/or there is exposure to work-related physical or chemical hazards. • 12 hour shifts, advice: ○ Avoid shifts that are longer than 8 hours, where work is demanding, safety critical or monotonous and/or there is exposure to work-related physical or chemical hazards. Encourage and promote the benefit of frequent and regular breaks to reduce the risk of fatigue. Allow adequate recovery time between shifts and bear in mind that commuting times and availability of public transport may contribute to the fatigue related to long shifts. Limit 12-hour night shifts to 2-3 consecutive nights. ○ Consider the needs of vulnerable workers: arrange for these workers to do shorter shifts if necessary. ○ Shifts should not be planned to be longer than 12 hours. Avoid overrun and discourage overtime. Monitor and control shift swapping. Make adequate arrangements to cover absentees. Discourage workers from taking second jobs. If this is a particular problem you could set this as a condition of employment in contracts of work. ○ Make adequate arrangements to cover absentees. Some companies include an extra shift in their rosters (usually days) to allow flexibility and time for training, development etc. Monitor and control shift swapping. • Shifts longer than 12 hours, advice: ○ Avoid shifts that are longer than 12 hours in length. Avoid overrun and discourage overtime. Monitor and control shift swapping. Make adequate arrangements to cover absentees. Discourage workers from taking second jobs. • Variable shift lengths, advice: ○ Consider if shifts of variable duration and/or flexible start and end times could offer a suitable compromise for your organisation. Bear in mind that schedule design will be more complex and require more planning and organisation. • Split shifts, advice: ○ If reasonably practicable, avoid split shifts, as they do not allow enough recovery time between shifts. If split shifts are necessary, ensure that suitable on-site catering and rest facilities are available. ○ Ensure workers are aware of the risks of shift work, through provision of training and information. **Rest breaks within shifts:** • Rest breaks within shifts, advice:

	○ Encourage and promote the benefit of frequent and regular breaks to reduce the risk of fatigue. Under the WTR, workers are entitled to a 20-minute rest break if the working day is longer than six hours. But consider the length of the shift and the workload when planning the amount and length of breaks. A short break of 5-15 minutes every 1-2 hours may help maintain performance and reduce accidents, particularly when the work is demanding or monotonous. ○ If practicable, workers should be allowed some discretion over when they take a break from work. Ideally, workers should be allowed to rest before they experience fatigue. However, workers may not always act as the best judge of when a break is needed and should be strongly discouraged from saving up their rest time in order to leave earlier. Where the pace is out of the worker's control (e.g. machine/system paced), schedule frequent rest breaks in the shift plan. ○ Napping should be well supervised and only be used as a strategy in organisations where there is a high risk of involuntary sleeping, such as driving and night-time vigilance tasks. Do not adopt it in work environments where important decisions, especially safety-critical decisions, could be clouded by sleepiness. If napping is adopted, appropriate facilities should be provided with scheduled breaks of around 40 minutes to allow workers sufficient time to have a short nap, refresh themselves and regain alertness before resuming work. ○ Make facilities available and encourage workers to take their longer breaks away from their workstation. **Rest breaks between shifts:** • Rest periods between consecutive shifts, advice: ○ Workers need sufficient time between shifts to commute, eat meals, sleep and participate in domestic and social activities. Under WTR, the minimum time allowed between shifts is 11 hours. • Rest days, advice: ○ In general, a limit of 5-7 consecutive working days should be set for standard (i.e. 7-8 hour) shifts. Where shifts are longer than this, for night shifts and for shifts with early morning starts it may be better to set a limit of 2-3 consecutive shifts, followed by 2-3 rest days to allow workers to recover. ○ Consider if regular refresher training in complex procedures and time allowed for refamiliarisation/updating would help when there are extended rest periods (including holidays) between successive shifts. ○ Under WTR, workers are entitled to a 24-hour day off per week, although days off may be averaged over a fortnight. When switching from day to night shifts or vice versa, make provision to allow workers a minimum of 2 nights of full sleep to enable them to adjust to the new schedule. ○ Where possible, regular weekend breaks should be built into the shift schedule. **How factors in the workplace environment may increase the risks associated with shift work and offer advice on how to make improvements to reduce these risks.** **Physical environment:** • Facilities, advice: ○ Where reasonably practicable, provide similar facilities and opportunities for shift workers as those available for your daytime workers. Where this is not possible, it is important to make provision for workers to make a drink and heat up food and to allow workers to take their longer/meal breaks away from their workstation. First-aid facilities, and if possible, a trained first-aider should be made available for all shifts. • Lighting, advice: ○ You should take into account the extent of natural lighting, the reflective properties of the surrounding area and the work materials, the nature of tasks being undertaken and the age of the workforce when you consider workplace lighting. A combination of direct and indirect lighting (e.g. up lighting) will help reduce glare and areas of shadow. ○ The practical application of bright light exposure to shift-work schedules is a complicated area. As yet it is relatively untried, and may require considerable resource. Seek specialist advice when considering this as a means of increasing alertness. • Temperature, advice: ○ Monitor workplace temperature on a regular basis to determine if adjustments to the heating supply need to be made for particular shifts. For example, during the night, heating may need to be increased to compensate for the drop in body temperature; however, a warm, stuffy

	atmosphere can cause drowsiness. Allow workers control of local heating arrangements. Where maintaining a comfortable temperature is impractical, take all reasonable steps to achieve a temperature which is as comfortable as possible. These may include providing localised heating/cooling devices, appropriate clothing and provision of rest facilities. **Management issues:** • Supervision, advice: o Consider if increased supervision would be beneficial during key periods of low alertness, e.g. during the night and early hours of the morning, following lunch and towards the end of long shifts. Ensure supervisors are aware of the risks of shift work, through provision of training and information. Ensure that they are sufficiently trained to recognise the symptoms of fatigue, which may indicate that a worker is failing to cope with their current shift-work schedule or that there are general problems with the shift-working arrangements. • Overtime, advice: o Where possible, avoid overtime by establishing systems to provide relief staff to cover absentees, vacancies, increased workloads and emergencies. If overtime is unavoidable, review a worker's preceding work and rest periods before agreeing to it. You should also monitor and record the hours that individuals have worked to identify where action should be taken to avoid excessive working hours. This is especially important when an individual has opted out of WTR, in workplaces where shift swapping is permitted and during exceptional circumstances such as emergency workers attending an incident. • Shift swapping, advice: o Shift swapping should be monitored and recorded by supervisors. It is important to review a worker's scheduled work and rest periods before agreeing to a swap to avoid excessive hours being worked. • Standby and on-call duties, advice: o Under WTR, periods when workers carrying out standby and on-call duties are required to be at the workplace, whether working or not, is considered working time. Make provision in the work schedule to allow adequate rest for those workers carrying out standby/on-call duties. Ensure workers are aware of the risks associated with fatigue through provision of training and information. • Training and information, advice: o Tailored training and/or information regarding the risks associated with shift work should be available for workers, their families, their supervisors, safety representatives and management. Make workers aware of the potential impact fatigue may have on safety, health and well-being. Encourage workers to report shift work-related problems they may have and consider any suggestions workers make in relation to improving the shift-working arrangements. Encourage workers to take responsibility for their welfare outside work and promote the use of appropriate coping strategies to help workers and their families to adapt to shift work (see Appendix 2). o If possible, arrange/adapt training sessions to the shift pattern rather than restricting it to daytime hours. Alternatively, ensure that workers are given compensatory time off if they have to attend training during rest periods by establishing a system to provide relief staff when required. To help this, some companies include extra shifts in their rosters (usually on days) to allow flexibility and time for training and development. • Communication, advice: o Encourage interaction and if possible arrange for employees to work together or in teams. If an employee must work alone, encourage them to make contact with other workers at regular intervals. If they are located remotely then contact can be provided by telephone or similar communications devices. In case of emergency, provide an alarm or other communication device. Ensure information on workplace issues is made available to all staff. o Agree on, and make sure timing and procedures for transmitting information to the next shift team are clear, available to all staff and followed at all times. Avoid extending shifts by good planning of the handover, e.g. by building in a small overlap between start and finish times on consecutive shifts. Ideally, shift handovers should be conducted face-to-face and be two-way, with all participants taking responsibility for ensuring accurate communication, using both verbal and written means, be based on a pre-determined analysis of the information needs of incoming staff and be given as much time as necessary to ensure clear and accurate communication. **Welfare:** • Occupational health, advice:

	○ Encourage workers to inform their doctor about their working arrangements, as this may help early diagnosis of any shift work-related ill health. Consider if alternative work is available for workers who have difficulties adapting to shift work or develop shift work-related health problems. This is particularly important for groups such as ageing workers and new and expectant mothers who might be more vulnerable to the risks of shift working. ○ Promote healthy living strategies like increasing exercise and improving diet, such as those included in Appendix 2. ○ Employers should seek specialist advice from a suitably qualified health care professional, when devising and assessing the results of health assessments. If a worker suffers from health problems that are caused or made worse by night work, you should, where possible, transfer him or her to day work. • Lone working/violence, advice: ○ Employers should take steps to make sure that the workplace and its surroundings are well lit, safe and secure. Consider if shift start and end times can be adjusted to fit in with the availability of public transport. If not, consider providing transport to and from the workplace. Promote car sharing and ensure car parks and entrances are well lit and secure. Encourage communication between workers and ensure all, especially those who work alone, have access to telephones and alarm systems. Consider if you need to install security cameras and/or provide security staff.
Joint submission from social and public health sciences unit and the Scottish collaboration for public health research and policy.	This document is a response to the economy, energy and tourism inquiry. The document suggests there is some evidence that reorganisation of working schedules can have a positive impact on employees health (Bambra et al., 2008).
Labour Research Department: FACT Service (2012). Breast cancer link to working night shifts, 74(22).	This is a short overview of research in the area, highlighting the Danish compensation system for women suffering from breast cancer who had worked night shifts for longer than 20 years, paid for through employer insurance. This article highlights that advice from HSE and government is needed for employers so that they can reduce the risk of female workers developing breast cancer, such as through safer shift patterns.
Office of Rail Regulation (2012). Managing Rail Staff Fatigue. **Guidance document**	The document focuses on the management of fatigue of workers, not solely in relation to shift work. **Examples of controls for managing and mitigating fatigue risk for shift workers include:** • Shorter shifts • Fewer successive shifts without a rest day • Steps to reduce short-notice variations in planned start times • Enhanced fatigue education and training • How to recognise fatigue • Ensuring staff remain fit for duty throughout their shifts • Have a policy and agreed arrangements for shift exchange to prevent swapping shifts without proper assessment of the potential fatigue consequences • Monitor trends in shift exchange **Limits for hours worked and working patterns for safety critical workers are generally appropriate for:** • The maximum length of any work shift or period of duty; • The minimum rest interval between any periods of duty; • The maximum number of hours to be worked in any seven day period; • The minimum frequency of rest days; • The maximum number of consecutive day shifts; • The maximum number of consecutive night shifts and early-morning shifts; and

	• The maximum period of time between breaks, including breaks for meals. **Good practice for maximum shift lengths would be as follows (RSSB T059):** • Day shift – twelve hours • Night & early shifts – ten hours • Shifts starting before 0500 - eight hours. **Good practice for the maximum number of consecutive shifts before a rest day would be as follows (RSSB report T059):** • Day (including mixed patterns) – seven • Night – three • Early – five **Working patterns designed to:** • Minimise the build-up of fatigue by restricting the number of consecutive night or early-morning shifts; • Allow fatigue to dissipate by ensuring adequate rest between shifts and between blocks of shifts; and • Minimise sleep disturbance. **Features of work patterns to consider:** • Timing of shift start • Length of shift • Weekly work-rest ratio • Shift rotation • Predictability
Health and Wellbeing for UK Rail: Workshop 2: (2013). Institute for Manufacturing.	• This report is from a one day workshop mapping the future of health and wellbeing for the UK rail industry. It doesn't specify specific recommendations for shift working. • In the short term fatigue/shift patterns, the future occupational cancer burden/ shift work and fatigue/shift patterns were highlighted as a health and wellbeing challenge and opportunity under occupational health and the effect of work on health. In the medium term there is a challenge and opportunity for assistance in managing a shift work lifestyle to enable better sleep, eating habits and exercise.
The Young Foundation (2011). Rough Nights: The growing dangers of working at night.	**Advice and tips for night workers:** **Getting enough sleep** • Having a bedtime ritual that you follow before going to sleep. This could involve having a hot bath, avoiding stressful or stimulating activity directly before bed. • Lower the temperature of the room you are sleeping in – people sleep better in cooler environments • Try not to let your mind dwell on the upcoming shift or other stressful situations. Try to concentrate on innocuous relaxing activities such as walking on a beach/going to the park etc. • If you can't sleep, get up and do something in another room to distract yourself. It doesn't help lying in bed worrying that you can't sleep. • When sleeping in the day: o Turn off mobile phones, disconnect landlines, consider putting up a notice at your door that you do not want to be disturbed o Wear ear plugs and eye shades o Use thick, light blocking curtains – these will also reduce other noises

	○ Ask family and friends at home to make sure it is a peaceful place during the day • Avoid alcohol before going to bed and don't drink caffeine for up to four hours before going to bed • Drink less fluid before going to bed to avoid trips to the toilet • Eat a small meal before going to bed to prevent hunger, but avoid heavy meals which are hard to digest • Avoid nicotine before going to bed; it is a stimulant • Drink less fluid before going to bed to avoid trips to the toilet • Eat a small meal before going to bed to prevent hunger, but avoid heavy meals which are hard to digest • Avoid nicotine before going to bed; it is a stimulant • Regular exercise during the day helps sleep patterns **Get plenty of sleep before your first shift** • Try to have a long lie-in in the morning • Try staying up later the night before to adjust • Have a sleep in the afternoon, so that you are well rested before you start **Napping during your shift** • Try to have a short nap during the shift, as short as 20-40 minutes. They should be no longer than 45 minutes **Don't neglect your relationships** **Let your GP know you work night shifts** **Pay particular attention to your journey home** • Consider sharing lifts home • Have a nap if you are feeling sleepy • Consider using public transport **Stay vigilant when you are most vulnerable** **Keep the lights on during your shift** **Eat and drink properly** **Reduce your caffeine intake** **Be vigilant if operating heavy machinery or safety equipment**
UNISON. Gender, safety and health: a guide for UNISON safety reps.	• The Working Time Regulations require that health assessments are provided for all night shift workers: ○ UNISON believes that employers should offer advice on breast and prostate cancer awareness and breast and prostate examination as part of the health assessment. • It is recommended that women avoid or be relieved of irregular hours or rotating shifts during pregnancy.
UNITE the Union (2013). Unite guide to shift work and night work: a health and safety issue for Unite members.	All workers are potentially at risk if they do shift work – and some groups may be even more so: • Young workers and older workers • New and expectant mothers – women of childbearing age • Workers with pre-existing health conditions or disabilities e.g. heart disease, sleep apnoea • Workers taking medication e.g. the effectiveness of insulin for diabetics may be affected by changing routines

	• Temporary, agency or contract workers who may not be used to shift work and may not be aware of their legal rights. **Suggested guidelines for shift design:** • Plan an appropriate and varied workload. • Offer a choice of permanent or rotating shifts and try to avoid permanent night shifts. • Either rotate shifts every 2-3 days or every 3-4 weeks - otherwise adopt forward rotating shifts. • Avoid early morning starts and try to fit shift times in with the availability of public transport. • Limit shifts to 12 hours including overtime, or to 8 hours if they are night shifts and/or the work is demanding, monotonous, dangerous and/or safety critical. • Encourage workers to take regular breaks and allow some choice as to when they are taken. • Consider the needs of vulnerable workers, such as young or ageing workers and new and expectant mothers. • Limit consecutive work days to a maximum of 5 -7 days and restrict long shifts, night shifts and early morning shifts to 2-3 consecutive shifts. • Allow 2 nights' full sleep when switching from day to night shifts and vice versa. • Build regular free weekends into the shift schedule. **Suggested guidelines for the work environment- employers should:** • Provide similar facilities as those available during the daytime – such as a canteen – and allow shift workers time for training and development. • Ensure temperature & lighting is appropriate and preferably adjustable. • Provide training and information on the risks of shift work and ensure supervisors and management can recognise problems. • Consider increasing supervision during periods of low alertness. • Control overtime, shift swapping and on-call duties and discourage workers from taking second jobs. • Set standards and allow time for communication at shift handovers. • Encourage interaction between workers and provide a means of contact for lone workers. • Encourage workers to tell their GP that they are shift workers. • Provide free health assessments for night workers. • Ensure the workplace and surroundings are well lit, safe and secure. **Practical issues for safety reps to consider with members when negotiating agreements:** • Hours • Training • Welfare and other issues to be considered **Other important provisions of the working time regulations:** • Daily rest • Breaks • Maximum weekly working time • Annual leave • Changes to the employment contract • Agency workers • Personal injury claims