

Fatigue and sleep deprivation – the impact of different working patterns on doctors

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Executive summary

What factors increase the risk of fatigue?

Doctors (and other clinical staff) are at an increased risk of fatigue because they routinely, and are increasingly, working long hours, and exposed to excessive and high intensity workloads. With increasing numbers of patient consultations, there is a higher risk of making poorer quality clinical decisions (ie decision fatigue). Unplanned and unpredictable interruptions – associated with providing patient care advice while on call – significantly impacts on fatigue risk, especially repeat disturbances during a single sleep period, or when working on call over consecutive days.

The disruptive effects of shift working on the natural sleep cycle are a substantial risk factor for fatigue (particularly working night or early morning shifts, having short recovery times between shifts, rapidly rotating schedules, and working full shifts in succession). Other factors may also impact on fatigue levels, including: having to take annual leave at fixed times in the rota; being bullied or harassed at work; stress associated with clinical negligence claims; pressures associated with time for training, education and non-clinical work; changing and unpredictable work patterns; additional responsibilities (eg running a GP practice); and specific work requirements such as telephone triage and telephone consultations.

What are the impacts?

Fatigue and sleep deprivation (associated with long working hours and shift work) impacts on personal safety risks, such as an increased likelihood of occupational accidents, road traffic crashes and needlestick injuries. Working long hours also increases patient safety risk through clinical errors. In the long term, working long hours and shift and night work significantly increases the risk of cardiovascular disease, primary sleep disorders, becoming overweight or obese, and developing type 2 diabetes. Working long hours may also increase the risk of depression and anxiety. Night shift work appears to increase the risk of breast, prostate and colorectal cancer, as well as dementia.

What are the implications for policy and practice?

While the risks and impacts of long working hours and shift work are well recognised and managed in other safety-critical industries (such as for flight crew and in driving goods/passenger vehicles), working hours for doctors (and other clinical staff) are significantly less regulated. The provisions of the European Working Time Directive have not been robustly and consistently enforced in the NHS, with evidence that doctors commonly work during days off or after night shifts, as well as not taking breaks or using them for administrative tasks. While there are more robust provisions for some groups (eg the 2016 terms and conditions of service for junior doctors in England), these do not apply across all staff, and other factors compound the problem (eg declining provision of rooms for rest and recovery, and poor access to accredited occupational medicine specialists).

A more comprehensive approach is urgently required to manage the risk of fatigue in the medical profession. This needs leadership by government and national bodies, complemented by a range of actions by employers and staff. The initial focus should be on raising awareness of the risks, providing support in anticipating and managing these risks (including comprehensive access to accredited occupational medicine specialists), changing working patterns where it is possible to do so, and ensuring compliance with health and safety requirements. In the long term, fatigue management should be central to planning and training the future workforce, and in developing models of service provision, to address factors such as excessive workload and long working hours. This must take a profession-wide approach, recognising the inter-linkages across the medical workforce and within multidisciplinary teams, to ensure all groups are working in complementary and safe patterns.

A framework for a comprehensive approach to managing fatigue in the medical profession

Government/Health Departments and national bodies

- Develop an awareness campaign to highlight the risks of fatigue in the medical profession, the factors that can affect this, and the work being done to improve how it is managed.
- Ensure all employers in the NHS have implemented appropriate systems to limit working patterns that increase the risk of fatigue, and provide support to staff in managing fatigue (including through comprehensive access to accredited occupational medicine specialists).
- Undertake a review to:
 - provide robust data on working patterns to better understand the extent to which doctors and other clinical staff are at risk of fatigue (including ensuring that exception reporting data arising from the 2016 junior doctor terms and conditions of service in England are centrally collected and analysed)
 - identify the workforce and workload pressures that adversely impact on the risk of fatigue (eg working hours, shift patterns and rota changes, frequency of interruptions to provide advice on patient care while on call)
 - set out short, medium and long-term measures to manage and reduce the impact of fatigue.
- Establish a system to monitor and identify trends in how fatigue is affecting doctors and other clinical staff, including reviewing changing working patterns and workload and workforce pressures.

Employers

Compliance with contracts

- Take all necessary steps to ensure that contractual requirements relating to working hours, safeguards and rest requirements are adhered to.
- Implement a transparent system for doctors who do not have access to exception reporting that encourages staff to raise concerns openly about the impact of working patterns that are causing fatigue and adversely impacting on performance, safety and wellbeing.

Job planning and work scheduling

- Ensure job plans and work schedules are designed (with input from an accredited occupational medicine specialist) so they are not likely to cause fatigue by:
 - minimising shift patterns and rota changes known to lead to insufficient sleep and circadian disruption (eg abrupt or frequent transitions between day and night shifts, a full shift system with blocks of seven nights, long sequences of on call duty, working through the day and then a night on call)
 - using forward-rotating (day-evening-night) rota designs
 - providing built-in rest breaks while on duty
 - allowing for adequate recovery time between shifts (minimum of 11 hours), acknowledging the effects of fatigue are typically more pronounced after night shifts than after day shifts
 - monitoring the extent to which doctors are repeatedly interrupted (to provide advice on patient care) while on call
 - avoiding long weekly working hours (of more than 60 hours) and long shifts (of more than 10 hours)
 - minimising the requirement to take annual leave at fixed times in the rota
- Ensure job plans and work schedules are reviewed regularly (with input from an accredited occupational medicine specialist) to take account of any factors that influence an individual's ability to become fatigued (such as a disability or recent ill health, age, pregnancy or breastfeeding, caring responsibilities outside of work, training demands).

- Agree and develop contingency plans to manage instances where a doctor or other member of the clinical team considers themselves unfit to work or continue to work because of fatigue.

Induction and provision of occupational medicine advice

- Make it a mandatory requirement that specific teaching – on which working patterns increase the risk of fatigue and strategies to minimise its impact – is provided during induction programmes, along with information on how to access accredited occupational medicine specialist services.
- Ensure all NHS staff have comprehensive access to accredited occupational medicine specialists.
- Offer regular screening for clinical sleep disorders, and offer treatment as required.

Supporting staff

- Provide appropriate facilities overnight to rest and nap during shifts.
- Encourage team-based approaches to providing cover and allow staff to take breaks without interruptions.
- Offer beds, free of charge, for sleep post duty periods for staff who feel too tired to drive home.

Doctors

- Take steps to understand what factors optimise the ability to manage and anticipate fatigue (eg ways to improve sleep routines and habits, and how to prepare for shift work) and implement these.
- Seek help and support from a doctor or accredited occupational medicine specialist for any concerns about fatigue and sleep problems.
- Meet the standards set out in [Good Medical Practice](#) related to responding to risks to patient safety because of the impact of fatigue. This includes notifying employers when unfit to work or continue to work because of fatigue. GP Partners should ensure there are contingency plans to manage instances when they feel unfit to work or continue to work because of fatigue.

1 Introduction

Being a doctor typically involves high-intensity, time-pressured working patterns. These can lead to sleep deprivation and an increased risk of fatigue. The adverse effects of sleep-related fatigue are significant, impacting on a doctors' health, wellbeing and performance, and thus their safety and that of their patients.^{1,2}

While a range of factors can cause fatigue (including some medical conditions such as anaemia and diabetes, infections, anxiety and depression, medications and lifestyle behaviours), a lack of good quality sleep is particularly relevant for doctors. Through chronic staff shortages, funding constraints, pressure on consultation time, rota gaps, high bed occupancy and unprecedented levels of patient demand in the NHS, they are working in an environment where sleep deprivation and fatigue are the norm, and often beyond levels tolerated in other safety critical work (eg the airline industry). This is compounded by specific factors such as inadequate rest facilities, and the changing nature of working in the NHS (eg new models of care and service needs). While the primary focus of the BMA is on fatigue among doctors, many of these concerns are applicable to other clinical staff – including those working in ambulance service teams, nurses, midwives and the wider healthcare team.

This briefing highlights^a the reasons why doctors are at risk of fatigue and sleep deprivation, and considers the acute and long-term impacts this can have. It aims to raise awareness of the key risks, and provide a platform for identifying and developing individual and organisational approaches to managing these risks. It is accompanied by some practical guidance on how to anticipate and mitigate the risks of fatigue and sleep deprivation.

Terminology and limitations

For the purposes of this briefing, **fatigue** is taken to mean a subjective feeling of tiredness, weariness or lack of energy, usually associated with lower performance (physical or mental). It is distinct from, and can cause, drowsiness/sleepiness, which relates to feeling the need or propensity to sleep, and difficulty in maintaining a wakeful state. Fatigue can be categorised as being transient (resulting from extended time awake/severe sleep restriction), cumulative (consecutive days of extended time awake/mild sleep restriction) or because of circadian disruption (being awake and working overnight).

Sleep deprivation is an acute or chronic lack of sufficient sleep resulting from disruption to the natural sleep-wake cycle. It can be caused by specific work environments (eg shift working), by environmental stimuli (eg external noises), or by sleep disorders. Recurrent sleep deprivation over time can lead to the accumulation of sleep debt (ie when an individual does not experience sufficient restorative daily sleep).

a While the evidence base identifies broad working patterns that increase the risk of fatigue and other associated impacts, there are limitations in the ability to assess specific work patterns and how this applies to different workplace settings. This reflects the difficulty in demonstrating what has caused fatigue due to confounding factors, and that much of the data come from other countries across a range of medical and non-medical industries, and often applies to set conditions (eg specific work hours and patterns). Where possible, the evidence used is from systematic reviews and meta-analyses, with details provide about the type of research cited where this is not the case.

2 What factors put doctors at risk of fatigue and sleep deprivation?

Key messages

- Doctors (and other clinical staff) are regularly exposed to patterns of work, or specific factors, that can lead to poor quality sleep, and which increase the risk of fatigue.
- They are routinely and increasingly working long hours, with the longer the hours worked, the greater the risk of fatigue. There is some consensus from studies looking at different types of shift worker that longer shifts (12 hours or more) are associated with 25-30% higher risk of accidents or injuries than an 8-hour shift.
- The excessive workloads experienced by doctors can cause fatigue through the requirement for sustained attention over long periods of time, particularly when performing complex and mentally-demanding tasks. High workload intensity (such as a high number of patient consultations) is also an important factor, and may lead to adverse impacts (eg prescribing errors) because of decision fatigue (deteriorating quality of decisions made by an individual after a long period of decision making). Being fatigued is also a risk factor for burnout, which is commonly reported by doctors.
- Unplanned and unpredictable interruptions, such as being required to give advice on patient care while being on call, can lead to sleep disruption and fatigue because of the impact on rest and recovery time. This is likely to be particularly disruptive when there are repeat disturbances during a single sleep period, or when on call stretches over consecutive days.
- Shift working can cause doctors to feel fatigued and function less effectively because of disruption to the natural sleep cycle. The effects are more pronounced with working night shifts, early morning work, having short recovery times (<11 hours) between shifts, rapidly rotating schedules, and working full shifts in succession (eg blocks of seven nights). Individuals least suited to tolerating shift work are those who are morning types (more alert in the morning), of an older age (over the age of 40 to 50), struggle to sleep at different times of the day or take naps, and who are sensitive to sleep loss.
- A range of broader factors can affect doctors' experiences of fatigue and sleep deprivation. These include but are not limited to: the requirement to take annual leave only at times that are fixed in the rota; being bullied or harassed at work; stress associated with clinical negligence claims; pressures associated with time for training and education; demands from non-clinical work for those with portfolio careers; changing and unpredictable work patterns; additional responsibilities (eg running a GP practice); and specific factors such as increasing time spent doing telephone triage and telephone consultations.

2.1 Working long hours

Doctors' standard working hours are generally long, and they are routinely required to work beyond these – for example, the BMA's UK-wide quarterly survey results published in June 2017 (Q2) found that the majority of GPs (74%), consultants (65%) and trainees (70%) often or very often worked outside of regular hours in the last month,³ while 74% of respondents to a 2015 BMA UK-wide SAS (staff, associate specialists and specialty) doctors' survey reported working more hours than in their job plan in the past year.⁴ While there are no comprehensive data on working hours, there is some evidence these are increasing. For example, an analysis of Northern Ireland general practices found that the overall consultation rate rose from 3.39 consultations per person in 2003/04 (registered population of 204,053) to 6.06 in 2013/14 (registered population of 249,893), with a 79% increase in the consultation rate per person over the 11-year period.⁵ A substantial increase in England has also been reported.⁶

The impact of working long hours is compounded by other time demands, whether it be travelling to and from work, picking up admin/non-clinical work at home, or family and other commitments (eg caring responsibilities outside of work).

The longer the hours worked, the greater the risk of fatigue⁷ – this has been found in relation to working long shifts,^{8,9,10} as well as working longer than standard hours,^{11,12,13} although there has been significantly less research on the latter. While it is difficult to accurately determine how the level of risk changes over the period of time worked, there is some consensus from studies looking at different types of shift worker that longer shifts (12 hours or more) are associated with a 25-30% higher risk of accidents and injuries than an eight-hour shift.^{8,14,15} An individual who experiences moderate sleep deprivation (equivalent to being awake for 17-19 hours) can have the same reaction time as being at a blood alcohol level of 50mg/100ml (the legal limit for safe driving in many countries such as Scotland).¹⁶

2.2 Intensity and complexity of work

It is widely acknowledged that doctors across the healthcare system experience excessive and unmanageable workloads because of increasing demand for services. This has been reported by trainees,¹⁷ GPs,^{18,19,20,21,22,23,24,25} SAS doctors^{4,26} and consultants.^{27,28}

Excessive workload can cause fatigue through the requirement for sustained attention over long periods of time, whether acutely or cumulatively.²⁹ It is also generally recognised that complexity of tasks is an important factor, with those that are mentally-demanding and lengthy (such as consecutive patient consultations, surgery and anaesthesia) or repetitive (such as administrative work) increasing the risk of fatigue.³⁰

Increasing numbers of patient consultations, and high workload intensity (ie seeing greater numbers of patients with complex and multiple conditions), have led to concerns about 'decision fatigue'. This relates to when a doctors' quality of decision making deteriorates after a long period of making consecutive decisions. While there is limited research in this area, it has been identified as a contributory factor in judicial decisions,³¹ and there is some evidence of an impact on doctors. For example, a 2014 observational study of primary care physicians in the US concluded that the cumulative cognitive demand of making patient care decisions increased the likelihood of inappropriate antibiotic prescribing.³²

In recent years, the case mix for many consultants and SAS doctors has shifted towards predominantly managing complex cases during direct clinical care work. This not only impacts on fatigue levels, but leaves limited time for other activities such as SPA (supporting professional activities) time, as well as time to rest and reflect while on duty.

Fatigue and sleep deprivation is also a risk factor for burnout.³³ The latter is commonly reported by doctors^{24,34,35,36,37} and occurs when their workload is greater than their ability to deal with it (as defined by the Maslach Burnout Inventory³⁸). There may be specific factors that contribute to burnout, such as having to undertake routine administrative tasks repeatedly (eg fatigue associated with responding to electronic health record alerts).³⁹

2.3 Sleep disturbance while on call

Many doctors are required to work on call^b patterns. For example, the BMA's 2017 consultant workload survey for England found that approximately 90% of respondents worked non-resident on call during weeknights or weekends, during which time it was

b A doctor must be available to respond during out of hours periods, but should be able to rest for a substantial part of the duty period. These can be 'resident' (where the doctor is required to remain on site) or 'non resident' (where they can be at home and potentially need to travel into work to respond). Working Time Regulations requiring the counting of hours compulsorily on site (including when resting) towards working time limits mean that residential on calls are no longer widely used. This reflects the rulings of the European Court of Justice – in relation to the 2000 case by SiMAP (Sindicato de Médicos de Asistencia Pública) and 2003 case by Norbert Jaeger – in how the European Working Time Directive should be interpreted in defining working time and compensatory rest. On call patterns should not be confused with the broader alternative use of the term 'on call' which refers to carrying a bleep while working.

normal to be contacted about the care of a patient.²⁷ A 2017 survey by the RCOA (Royal College of Anaesthetists) found that three-quarters of UK SAS anaesthetists had on call commitments.⁴⁰ On call working is also a significant feature for trainees.

Unplanned interruptions – such as being called to give advice on patient care – can adversely impact on the natural sleep-wake cycle, causing poor quality sleep and impinging on an individual's recovery time.⁴¹ There is some low-quality evidence that the thought of being on call, and the unpredictability of it, can impact on fatigue levels and the time needed to recover.^{42,43}

While there is limited research into this pattern of work, it is reasonable to assume that repeatedly being interrupted during a period of being on call overnight will cumulatively increase the short-term impact on sleep quality, fatigue levels, and consequently on a doctors' mood, cognitive ability, memory and performance. It may also be more detrimental than having a shorter period of sleep overall – for example, a 2015 small-scale experimental study found that the effects of interrupted sleep on mood was more detrimental than partial sleep loss from delaying going to bed.⁴⁴

There are also specific factors that can exacerbate the problems doctors face working on call – for example, the BMA UK consultants committee have anecdotally reported that demands to provide advice about patient care while on call are greater when working with trainees or locums they do not know, or who lack experience in performing certain clinical tasks. While being on call can be low-intensity working, it can stretch over many consecutive days (depending on the amount or frequency of the work, and the applicable employment contract), exacerbating the risks of a significant sleep deficit and limiting the opportunity for adequate recovery and rest time.

2.4 Shift working

Shifts (sometimes called full shifts)^c are common in the health service, particularly during training and increasingly for senior doctors in some medical specialties (eg paediatrics, emergency medicine, intensive care, obstetrics), as well as for other doctors such as medical officers serving in the armed forces. Many GPs also provide OOH (out of hours) care, including shift working overnight, as well as OOH evening shifts immediately following a period of work during the day.

While all doctors have their own contractual arrangements specific to their branch of practice – with varied working patterns, hours limits and rest requirements – shifts are usually eight to 12 hours' duration. They may be up to 14 hours in some circumstances, but generally not more than 13 hours to allow the legal minimum of 11 hours of rest before a repeat shift. The 2016 terms and conditions of service for doctors in training – which is now widely in use in England – has comprehensive hours limits which match and frequently go beyond the requirements of the Working Time Regulations,^d and in Scotland, limits on consecutive day and night shifts similarly exist. The Working Time Regulations requirements also apply to doctors employed under other contractual arrangements.

Working a shift pattern generally impacts adversely on the natural sleep cycle,⁴⁵ causing doctors to feel fatigued and function less effectively. It is widely acknowledged that the effects of fatigue are more pronounced working night shifts compared to day shifts,^{7,46,47} and that night work⁴⁸ and early morning work⁴⁹ are particularly associated with reduced sleep.

- c Typically used where work is intensive and continuous over a 24-hour period. Doctors are expected to work throughout the duty period or be immediately available for work.
- d The Working Time Regulations implement the European Working Time Directive in law in Great Britain. They impose obligations on employers, such as the maximum average weekly working time (subject to provision for individual workers to agree voluntarily that the maximum should not apply to them) and the provision for rest breaks where applicable. They also confer rights on workers, such as entitlement to a rest period in every 24 hours during which a worker works for his employer and longer rest periods each week or fortnight, to a rest break during a working day, and to a period of paid annual leave.

Having short recovery times (<11 hours) between shifts, or rapidly rotating schedules, also adversely impacts on sleep duration.⁵⁰ Evidence from across shift-working industries shows that working full shifts in succession (eg blocks of seven nights) increases the risk of fatigue and errors, with the risk increasing the more shifts worked consecutively.^{8,51}

There are differences between individuals in their resilience to shift work. A 2011 systematic review identified several factors related to higher shift work tolerance,^e including: young age, being more alert in the evening,^f being energetic and less languid,^g a less neurotic and anxious personality, and being more extroverted.⁵² Genetic differences also have an impact, with variations in genes that regulate the body and its circadian rhythms affecting an individual's sleep quality, sleep timing and vulnerability to sleep loss.^{53,54,55,56,57} Overall, evidence suggests that individuals least suited to tolerating shift work are those who are morning types (more alert in the morning), of an older age (over the age of 40 to 50), struggle to sleep at different times of the day or take naps, and who are sensitive to sleep loss.

2.5 Other work factors

There are some wider work factors that affect doctors' workload and working lives, and can impact on sleep deprivation and fatigue levels.

This includes a requirement to take annual leave only at times that are fixed in the rota, rather than when they choose to. The timing of this may not take account of when it is best for an individual doctor to have a period off for rest and recovery. SAS doctors report high levels of bullying and harassment,⁴ which can adversely impact on rest and recovery time through increased stress and anxiety. The increasing trend of clinical negligence claims – for example, in 2017, a full-time GP is expected to be twice as likely to receive a claim compared to 2008⁵⁸ – will also be a significant source of stress and anxiety that impacts on rest and recovery time.

Time for training and education may also add to stress and fatigue levels, either because of the squeeze on this time from workload pressures, or the intensity of learning that can cause stress and fatigue. Doctors with portfolio careers may experience excessive demands in their non-medical roles that impact on their fatigue levels, and their resilience to fatigue from working in their clinical roles.

Doctors' work patterns can change daily and from week to week, preventing adaptation to a routine. For example, there can be significant variation and unpredictability for those working on call in forensic and secure settings.

The role GP partners have in running a practice can provide an added burden on their workload, such as being responsible for responding to practice emergencies, or managing potentially open-ended demand and the consequent wide fluctuations in immediate workload and intensity.

An increasing number of GP consultations are being conducted by telephone,⁶ including telephone triage during OOH care and full telephone consultations. This form of patient interaction can be very intense as doctors do not have any non-verbal cues to assist in diagnosis, may not know the patient, and will generally be dealing with an acute medical concern. In the OOH setting, some providers operate a triage 'call centre' system where there can be a feeling of 'limitless work' in responding to calls during a shift.

e The ability to adapt to shift work without adverse consequences.

f Where an individual's circadian rhythm produces peak alertness in the evening.

g Individuals who are more languid typically have a greater disinclination for physical exertion or effort, which impacts on how well they overcome drowsiness and their sensitivity to sleep loss.

Fatigue and ageing

An individual's age will affect how well they manage fatigue and cope with different working patterns. Older people (particularly older men^h) typically have less good quality sleep because of sleep fragmentation (brief arousals during a sleep period) and waking frequently and early.⁵⁹ They may also be less likely to adapt to shift work (particularly night shift work) without adverse consequences.^{52,60,61,62} As there is considerable individual variation in susceptibility, there is no definite age by which this becomes an important factor; however, it has been suggested that adverse impacts may become relevant between the ages of 40 and 50.⁶³

h This reflects sex differences in how individuals progress through the stages of sleep cycle. Older people generally have poorer sleep quality in terms of time spent in deep (slow-wave) sleep decreasing, and lighter stages of sleep being more prominent. This is typically more pronounced for older men.

3 What are the impacts of fatigue, sleep deprivation, shift work and long working hours?

Key messages

- Fatigue and sleep deprivation increases personal safety risks, with working long hours (>12 hours) and night shifts significantly increasing the risk of occupational accidents, road traffic crashes and needlestick injuries.
- Working long hours may increase patient safety risk through clinical errors. The impact of fatigue on a doctors' mood, stress levels, etc. may also affect their interactions with patients in a detrimental way.
- Over the long term, working long hours and shift and night work significantly increases the risk of cardiovascular disease, primary sleep disorders, becoming overweight or obese, and developing type 2 diabetes. Working long hours may also increase the risk of depression and anxiety. Female night-shift workers appear to be at increased risk of breast cancer, and night shift work is linked to an elevated risk for prostate and colorectal cancer, as well as dementia.

3.1 Acute impacts

Fatigue and sleep deprivation adversely impacts on cognitive and psychomotor skills, such as working memory capacity, attentional issues, and performance on tasks.

This can increase personal safety risk. A 2011 systematic review – including studies of clinical staff and non-medical industries – found that long hours and shift and night work increased the risk of occupational accidents.⁶⁴ It concluded that work periods of over eight hours carry an increased risk of accidents that cumulates, with twice the risk of an accident at around 12 hours compared to eight hours, and that shift work (including nights) led to a higher risk than consistently working a night pattern. Two specific risks that have been studied relevant to doctors are the risks associated with driving home and needlestick injuries.

- Several observational studies have shown an elevated risk for road traffic incidents after shift work (particularly night shift work).^{65,66,67,68} The highest quality of these (involving over 2,500 US interns, tracked over a year) found that those working an extended duration shift (>24 hours) were 2.3 times more likely to have a motor vehicle car crash, and 5.9 times more likely to have a near miss, compared to after a non-extended duration shift.⁶⁵
- Two observational studies have also reported a higher risk of needlestick injury after working long hours.^{69,70} The highest quality of these (involving 2,737 US interns) found self-reported needlestick injuries to be more frequent during extended work shifts (>20 hours) and during night duties, compared to a shift averaging less than 12 hours, with fatigue reported more commonly as a contributory factor after extended work.⁶⁹

Fatigue and insufficient sleep can also increase patient safety risk through clinical errors.

- While there is limited evidence, various observational studies have highlighted self-reported fatigue-related clinical errors, including causing injury or leading to patient mortality.^{71,72,73,74} The most comprehensive of these found that US interns made substantially more serious medical errors (36%), and 5.6 times as many serious diagnostic errors, working extended work shifts (>24 hours) every other shift than when working shorter shifts (<16 hours).⁷⁴

These acute impacts on a doctor may also affect their interactions with patients in a detrimental way because of the effect sleep deprivation and fatigue can have on mood, stress levels, emotional reactivity and other factors.

3.2 Long-term impacts

Working long hours and shift and night work is associated with an increased risk of a wide range of long-term health impacts.^{1,2,10,11,75,76}

- Several observational studies have found a significant negative effect of working long hours on sleep disturbance/problematic sleep,^{77,78,79} and primary sleep disorders (such as sleep apnoea, where relaxation of throat muscles/soft tissue causes breathing interruptions) have been found to be common among shift workers.^{80,81}
- There is good quality evidence that shift work affects metabolic disorders, increasing the risk of becoming overweight or obese, and of developing type 2 diabetes.^{82,83,84,85,86}
- Numerous observational studies have reported an increased risk of cardiovascular disease (coronary heart disease, myocardial infarction and ischaemic stroke) when working shifts, with the highest risk related to night shifts.⁸⁷ There is good quality evidence that working long hours is associated with an increased risk of cardiovascular disease.⁸⁸
- There is mixed evidence on the impact on mood disorders. Several observational studies have reported an increased risk of depression and anxiety with long working hours.^{77,89,90,91} A link between shift work and depression has not been reported in any systematic reviews or meta-analysis; however, poor quality and short sleep are associated with an increased risk of depression.^{92,93}
- There is good quality but limited evidence that female night-shift workers are at increased risk of breast cancer, potentially on a dose-response relationship, with long exposure to night work (>20 years) being significant.^{94,95,96,97,98,99,100} While there is mixed evidence on the association between night shift work and other forms of cancer, there is some evidence of an elevated risk for prostate¹⁰¹ and colorectal¹⁰² cancer.
- Shift work may increase the risk of dementia – for example, an observational study of Danish nurses found a strong association between evening and rotating shift work and mortality from Alzheimer’s disease and dementia.¹⁰³

How does shift work and sleep disturbance link to adverse health outcomes?

A range of factors – including specific behaviours (eg altered eating habits and sleep routines), psychological stress related to work-life balance and physiological mechanisms – influence the way shift work and sleep disturbance cause adverse health outcomes.¹ The physiological mechanisms are the subject of significant research and include: circadian disruption (or misalignment) of regulatory hormones;¹⁰⁴ mild temporary increases in stress responses;¹⁰⁵ increases in factors that affect the risk of having diabetes, heart disease or stroke (eg impaired glucose metabolism, hypertension etc.);^{106,107} altered immune functioning (ie susceptibility to infections, inflammation, etc.);^{108,109} and increased risk of chronic diseases through cellular stress (such as oxidative stress, accumulation of metabolites, etc.).^{110,111}

4 Discussion – implications for policy and practice

This briefing highlights that doctors are regularly exposed to patterns of work that can increase the risk of fatigue and sleep deprivation, and consequently the risk of adverse impacts on safety, performance and wellbeing. These impacts are well recognised and managed in other professions through robust regulatory requirements, including the airline industry^{112,113} and for drivers of road haulage and passenger transport vehicles.^{114,115} They are also reflected in the advice for road users in The Highway Code (for England, Scotland and Wales)¹¹⁶ and The Highway Code for Northern Ireland.¹¹⁷

Approaches to managing fatigue in other industries

Flight time limitations¹¹³

- European Aviation Safety Agency regulations stipulate that:
 - the total duty period limit for a crew member must be 60 hours in any seven consecutive days, 110 hours in any 14 consecutive days, and 190 hours in any 28 consecutive days;
 - the total flight time (flying hour limits) must be 100 hours in any 28 consecutive days, 900 hours in any calendar year, and 1,000 hours in any 12 consecutive calendar months;ⁱ
 - there must be 12 hours rest between flights, or the length of the preceding duty if more than 12 hours;
 - night-time flight duty must be restricted to a maximum of 11 hours in a row;
 - there must be an extended recovery rest period of 36 hours, including two local nights (a period of eight hours falling between 22:00 and 08:00 local time)
 - there must be an extended recovery rest period of 48 hours, including two local days (a local day is a 24-hour period commencing at 00:00 local time), twice every month (recovery rest).

Driving a goods or passenger-carrying vehicle¹¹⁵

- European Union rules stipulate that:
 - driving hours must not exceed nine hours a day (with an extension to 10 hours twice a week), 56 hours in a week, or 90 hours in any two consecutive weeks;
 - all driving must be recorded on a tachograph;
 - drivers must take at least 11 hours rest every day (reduced to nine hours rest three times between any two weekly rest periods), an unbroken rest period of 45 hours every week (reduced to 24 hours every other week), a break or breaks totalling at least 45 minutes after no more than four hours 30 minutes, and weekly rest after six consecutive 24-hour periods of working, starting from the end of the last weekly rest period taken.

As has recently been highlighted in a 2017 BMJ analysis paper,¹¹⁸ doctors and other clinical staff are no less able to withstand fatigue than workers in other safety-critical industries; yet, their working time is significantly less regulated than in those industries. The introduction of the European Working Time Directive imposes some regulatory protection for all workers. However, these rules have not been robustly and consistently enforced in the NHS – staff can opt out of elements of the regulations, in some cases doctors tacitly accept, or are actively encouraged to, work during days off or after night shifts, and there is anecdotal evidence that many doctors either do not take breaks at all or use them to catch up on administration tasks.¹¹⁸ While there are more robust provisions for some groups, as with the

i The 900-hour limit per calendar year was introduced to address concerns around cumulative fatigue. The additional 1,000 hour limit per any 12 consecutive calendar months was introduced because of concern that the 900-hour limit would particularly affect Charter Operators whose activities are very sensitive to holiday peak periods, with such peaks varying in time from one year to another.

new 2016 terms and conditions of service for junior doctors in England, these do not apply to all doctors and other clinical staff. This is compounded by specific changes, such as the decline in the provision of suitable rooms that provide a space for rest and recovery, the emergence of new working patterns (eg complex on-call arrangements), and poor access to accredited occupational medicine specialists.

In the absence of a more robust response at a national level, several medical organisations have published guidance and advice to support doctors and other clinical staff in this area (eg the Association of Anaesthetists of Great Britain and Northern Ireland,¹¹⁹ the Royal College of Physicians,^{120,121} the Royal College of General Practitioners¹²² and the Royal College of Nursing¹²³). Individual healthcare organisations have also developed their own approaches, such as Guy's and St Thomas NHS Foundation Trust,¹²⁴ which has developed its 'HALT: Take A Break' campaign, and promotes education about improving sleep and managing shift work in local induction programmes.

2016 junior doctors contract

The 2016 terms and conditions of service for junior doctors in England has an unprecedented package of safety limits and rest requirements. This was pushed for by BMA negotiators following engagement with the wider membership who clearly indicated safety as their top priority.

- The requirements of the Working Time Regulations – including a maximum 48-hour average week and minimum 11 hours' rest between shifts – are written into the contract.
- The previous limit of 91 hours of work per week is reduced to 72, and the previous limit of 12 consecutive shifts is reduced to eight, with no more than four consecutive night shifts and a minimum 46 hours rest following nights.
- There is also a system for trainees to report to their supervisor when they are required to work late, allowing time off in lieu for extra hours. Collated reports of these exceptions must be submitted to the Trust Executive Board, creating a national picture of the unplanned overtime juniors are required to work.
- A new independent 'guardian of safe working hours' role in each employing organisation monitors on safety and reports to the board and Local Negotiating Committee, who oversee automatic fines to employers who make trainees work beyond the upper safety limits.
- Protections against fatigue are built in, with new clauses allowing trainees to self-declare as too tired to work safely following a busy on call with no financial detriment, and requirements for employers to provide either a place to sleep or alternative travel arrangements if trainees feel too tired to drive home safely.¹²⁵

The new contract is still bedding in after its first year of implementation, and it is too soon to assess the impact of these changes on working practices and workplace culture. Junior doctors remain an outlier in terms of the level of safeguards featured in their contract, although this only applies in England and not the devolved nations, where trainees, along with their other medical colleagues, rely on the legal protection of the Working Time Regulations. Following the UK's decision to leave the European Union, and with a range of voices from outside and inside the medical profession calling for the Working Time Regulations to be weakened or even completely repealed, it will be important to ensure legal protections remain in place to manage the risks of fatigue and sleep deprivation among doctors.

A more comprehensive approach is urgently required that recognises the factors that are known to increase the risk of fatigue and sleep deprivation among doctors and other clinical staff. As set out in the following framework, this will need leadership by government and national bodies, as well as actions by employers and staff.

In the short term, with input from accredited occupational medicine specialists, there should be a focus on:

- ways to raise awareness of the risks
- providing support in anticipating and managing these risks (directly to doctors and other clinical staff through comprehensive access to accredited occupational medicine specialists, but also to employers attempting to make changes locally)
- changing working patterns where it is possible to do so
- ensuring compliance with health and safety requirements, including those relating to specific groups at work, such as new and expectant mothers (see Appendix 1).

These measures will be particularly important during times of increased pressure on services (such as during the winter period).

There will also need to be a long-term focus on reducing the risk of fatigue and sleep deprivation in planning and training the future workforce, and in developing models of service provision. This reflects how many of the factors that increase the risk (ie excessive workload, longer working hours, variable shift patterns, etc.) can only be addressed through whole-system changes.

Changing working patterns and implementing measures to reduce the risk of fatigue and sleep deprivation must also recognise the inter-linkages across the medical workforce and within multidisciplinary teams. For example, the introduction of new safeguarding requirements for one group of staff may have unintended impacts on the working patterns and demands on others. Implementing these measures needs to be considered at a profession-wide level, ensuring all groups are working in complementary and safe patterns.

A framework for a comprehensive approach to managing fatigue in the medical profession

Government/Health Departments and national bodies

- Develop an awareness campaign to highlight the risks of fatigue in the medical profession, the factors that can affect this, and the work being done to improve how it is managed.
- Ensure all employers in the NHS have implemented appropriate systems to limit working patterns that increase the risk of fatigue, and provide support to staff in managing fatigue (including through comprehensive access to accredited occupational medicine specialists).
- Undertake a review to:
 - provide robust data on working patterns to better understand the extent to which doctors and other clinical staff are at risk of fatigue (including ensuring that exception reporting data arising from the 2016 junior doctor terms and conditions of service in England are centrally collected and analysed)
 - identify the workforce and workload pressures that adversely impact on the risk of fatigue (eg working hours, shift patterns and rota changes, frequency of interruptions to provide advice on patient care while on call)
 - set out short, medium and long-term measures to manage and reduce the impact of fatigue.
- Establish a system to monitor and identify trends in how fatigue is affecting doctors and other clinical staff, including reviewing changing working patterns and workload and workforce pressures.

Employers

Compliance with contracts

- Take all necessary steps to ensure that contractual requirements relating to working hours, safeguards and rest requirements are adhered to.

- Implement a transparent system for doctors who do not have access to exception reporting that encourages staff to raise concerns openly about the impact of working patterns that are causing fatigue and adversely impacting on performance, safety and wellbeing.

Job planning and work scheduling

- Ensure job plans and work schedules are designed (with input from an accredited occupational medicine specialist) so they are not likely to cause fatigue by:
 - minimising shift patterns and rota changes known to lead to insufficient sleep and circadian disruption (eg abrupt or frequent transitions between day and night shifts, a full shift system with blocks of seven nights, long sequences of on call duty, working through the day and then a night on call)
 - using forward-rotating (day-evening-night) rota designs
 - providing built-in rest breaks while on duty
 - allowing for adequate recovery time between shifts (minimum of 11 hours), acknowledging the effects of fatigue are typically more pronounced after night shifts than after day shifts
 - monitoring the extent to which doctors are repeatedly interrupted (to provide advice on patient care) while on call
 - avoiding long weekly working hours (of more than 60 hours) and long shifts (of more than 10 hours)
 - minimising the requirement to take annual leave at fixed times in the rota
- Ensure job plans and work schedules are reviewed regularly (with input from an accredited occupational medicine specialist) to take account of any factors that influence an individual's ability to become fatigued (such as a disability or recent ill health, age, pregnancy or breastfeeding, caring responsibilities outside of work, training demands).
- Agree and develop contingency plans to manage instances where a doctor or other member of the clinical team considers themselves unfit to work or continue to work because of fatigue.

Induction and provision of occupational medicine advice

- Make it a mandatory requirement that specific teaching – on which working patterns increase the risk of fatigue and strategies to minimise its impact – is provided during induction programmes, along with information on how to access accredited occupational medicine specialist services.
- Ensure all NHS staff have comprehensive access to accredited occupational medicine specialists.
- Offer regular screening for clinical sleep disorders, and offer treatment as required.

Supporting staff

- Provide appropriate facilities overnight to rest and nap during shifts.
- Encourage team-based approaches to providing cover and allow staff to take breaks without interruptions.
- Offer beds, free of charge, for sleep post duty periods for staff who feel too tired to drive home.

Doctors

- Take steps to understand what factors optimise the ability to manage and anticipate fatigue (eg ways to improve sleep routines and habits, and how to prepare for shift work) and implement these.
- Seek help and support from a doctor or accredited occupational medicine specialist for any concerns about fatigue and sleep problems.
- Meet the standards set out in [Good Medical Practice](#) related to responding to risks to patient safety because of the impact of fatigue. This includes notifying employers when unfit to work or continue to work because of fatigue. GP Partners should ensure there are contingency plans to manage instances when they feel unfit to work or continue to work because of fatigue.

Appendix 1 – key health and safety law

The Health and Safety at Work etc Act 1974 is the main legislation covering health and safety in the UK, placing a duty on all employers to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all their employees. Several regulations govern how health and safety risks should be managed.

Management of Health and Safety at Work Regulations 1999

- Places a legal duty on employers to assess and implement appropriate measures to remove, reduce or control health and safety risks for their employees whilst at work (Regulation 3).
- These Regulations implement the health and safety requirements of the Pregnant Workers Directive (92/85/EEC) into law in Great Britain. Regulation 16 requires employers to undertake a risk assessment to include any specific risks to females of childbearing age who could become pregnant, and any risks to women who are breastfeeding, to new and expectant mothers or to her baby. If these risks cannot be removed, employers must either: 1) temporarily adjust working conditions and/or hours of work; or if that is not possible, 2) offer suitable alternative work (at the same rate of pay) if available; or if that is not feasible, 3) suspend from work on paid leave for as long as necessary.
- Where a new or expectant mother works nights and provides a medical certificate from a GP or midwife which says that working night shifts will affect her health, then her employer must suspend her from work, on full pay, for as long as necessary. According to the Employment Rights Act 1996, where appropriate, suitable alternative work should be offered, on the same terms and conditions, before any suspension from work is considered.
- A breach of The Management of Health and Safety at Work Regulations 1999 may be unlawful discrimination under the Equality Act.

Workplace (Health, Safety and Welfare) Regulations 1992

- Require employers to provide suitable rest facilities for workers who are pregnant or breastfeeding. The facilities should be suitably located (eg near to toilets) and where necessary should provide appropriate facilities for the new or expectant mother to lie down.

References

- 1 Keckland G & Axelsson J (2016) Health consequences of shift work and insufficient sleep. *BMJ* 355: i5210.
- 2 Bannai A & Tamakoshi A (2014) The association between long working hours and health: a systematic review of epidemiological evidence. *Scandinavian Journal of Work, Environment & Health* 40(1): 5-18.
- 3 British Medical Association (2017) *BMA workload and wellbeing quarterly survey. Quarter 2: June 2017*. London: British Medical Association.
- 4 British Medical Association (2016) *SAS doctor survey*. London: British Medical Association.
- 5 Department of Health, Social Services and Public Safety (2015) *Estimating the volume & growth in consultation rates in general practice in Northern Ireland, 2003/04 to 2013/14: analysis of survey returns from general practices*. Belfast: Department of Health, Social Services and Public Safety.
- 6 Hobbs FDR, Bankhead C, Mukhtar T et al (2016) Clinical workload in UK primary care: a retrospective analysis of 100 million consultations in England, 2007-14. *The Lancet* 387(10035): 2323-30.
- 7 Morrow G, Burford B, Carter M et al (2012) *The impact of the working time regulations on medical education and training: literature review. A report for the General Medical Council*. Durham: Centre for Medical Education Research, Durham University.
- 8 Folkard S & Tucker P (2003) Shift work, safety and productivity. *Occupational Medicine* 53(2): 95-101.
- 9 Nachreiner F, Akkermann S & Haenecke K (2000) Fatal accident risk as a function of hours into work. In: Hornberger S, Knauth P, Costa G et al (eds) *Shiftwork in the 21st Century*. Frankfurt: Peter Lang.
- 10 Kodz J, Davis S, Lain D et al (2003) *Working long hours: a review of the evidence. Volume 1 — main report*. London: Department of Trade and Industry.
- 11 White J & Beswick J (2003) *Working long hours*. Sheffield: Health & Safety Laboratory.
- 12 Van der Hulst M, Van Veldhoven M & Beckers D (2006) Overtime and need for recovery in relation to job demands and job control. *Journal of Occupational Health* 48(1): 11-9.
- 13 Caruso CC (2006) Possible broad impacts of long work hours. *Industrial Health* 44(4): 531-6.
- 14 Folkard S & Lombardi DA (2004) Toward a 'risk index' to assess work schedules. *Chronobiology International* 21(6): 1063-72.
- 15 Folkard S, Robertson KA & Spencer MB (2007) A fatigue/risk index to assess work schedules. *Somnologie Schlafforschung und Schlafmedizin* 11(3), 177-85.
- 16 Williamsom AM & Feyer AM (2000) Moderate sleep deprivation produces impairments in cognitive and motor performance equivalent to legally prescribed levels of alcohol intoxication. *Occupational and Environmental Medicine* 57(10): 649-55.
- 17 General Medical Council (2017) *2017 national training surveys summary report: initial results on doctors' training and progression*. London: General Medical Council.
- 18 British Medical Association (2016) *Survey of GPs in England. Full report. October-November 2016*. London: British Medical Association.
- 19 British Medical Association (2016) *Responsive, safe and sustainable: our urgent prescription for general practice*. London: British Medical Association.
- 20 British Medical Association (2016) *Urgent prescription: a survey of general practice in 2016*. Cardiff: BMA Cymru Wales.
- 21 British Medical Association (2016) *General practice in crisis – a report on primary care in Northern Ireland*. Belfast: BMA Northern Ireland.
- 22 British Medical Association press release (9.12.16) *Survey highlights pressure on GPs in Scotland*.
- 23 Baird B, Charles A, Honeyman M et al (2016) *Understanding pressures in general practice*. London: King's Fund.
- 24 Royal College of General Practitioners (2015) *Patient safety implications of general practice workload*. London: Royal College of General Practitioners.
- 25 British Medical Association (2017) *Sessional GP survey 2017*. London: British Medical Association.
- 26 British Medical Association (2017) *SAS charter survey 2017* (unpublished).
- 27 British Medical Association (2017) *Consultant workload survey*. London: British Medical Association.
- 28 British Medical Association (2017) *BMA NI consultants survey* (unpublished).
- 29 www.hse.gov.uk/humanfactors/topics/fatigue.htm (last accessed 4 December 2017).
- 30 Hockey R (2013) *The psychology of fatigue. Work, effort and control*. New York: Cambridge University Press.
- 31 Danziger S, Levav J & Avnaim-Pesso L (2011) Extraneous factors in judicial decisions. *Proceedings of the National Academy of Sciences of the United States of America* 108(17): 6889-92.

- 32 Linder AJ, Doctor JN, Fridberg MW et al (2014) Time of day and the decision to prescribe antibiotics. *JAMA Internal Medicine* **174**(12): 2029-31.
- 33 Vela-Bueno A, Moreno-Jiménez B, Rodríguez-Muñoz A et al (2008) Insomnia and sleep quality among primary care physicians with low and high burnout levels. *Journal of Psychosomatic Research* **64**(4): 435-42.
- 34 Orton P, Orton C & Gray DP (2012) Depersonalised doctors: a cross-sectional study of 564 doctors, 760 consultations and 1876 patient reports in UK general practice. *BMJ Open* **2**: e000274.
- 35 Imo UO (2017) Burnout and psychiatric morbidity among doctors in the UK: a systematic literature review of prevalence and associated factors. *BJPsych Bulletin* **41**(4): 197-204.
- 36 British Medical Association (2015) *BMA quarterly survey. Quarter 2: April 2015*. London: British Medical Association.
- 37 Lemaire JB & Wallace JE (2017) Burnout among doctors. *BMJ* **358**: j3360.
- 38 Maslach C, Jackson S, Leiter M (1996) *MBI: the maslach burnout inventory manual*. Palo Alto, California: Consulting Psychologists Press.
- 39 Gregory ME, Russo E & Singh H (2017) Electronic health record alert-related workload as a predictor of burnout in primary care providers. *Applied Clinical Informatics* **8**(3): 686-97.
- 40 Royal College of Anaesthetists (2017) *SAS anaesthetists – securing our workforce*. London: Royal College of Anaesthetists.
- 41 Nicol AM & Botterill JS (2004) On-call work and health: a review. *Environmental Health* **3**: 15.
- 42 Ziebertz CM, van Hooff MLM, Beckers DGJ et al (2015) The relationship of on-call work with fatigue, work-home interference, and perceived performance difficulties. *BioMed Research International* **2015**: 643413.
- 43 van de Ven HA, Bültmann U, de Looze MP et al (2015) Need for recovery among male technical distal on-call workers. *Ergonomics* **58**(12): 1927-38.
- 44 Finan PH, Quartana PJ & Smith MT (2015) The effects of sleep continuity disruption on positive mood and sleep architecture in healthy adults. *Sleep* **38**(11): 1735-42.
- 45 Monk T & Folkard S (1992) *Making shift work tolerable*. London: Taylor and Francis.
- 46 Sallinen M & Kecklund G (2010) Shift work, sleep, and sleepiness – differences between shift schedules and systems. *Scandinavian Journal of Work, Environment & Health* **36**(2): 121-33.
- 47 Wright KP Jr, Bogan RK & Wyatt JK (2013) Shift work and the assessment and management of shift work disorder (SWD). *Sleep Medicine Reviews* **17**(1): 41-54.
- 48 Pilcher JJ, Lambert BJ & Huffcutt AI (2000) Differential effects of permanent and rotating shifts on self-report sleep length: a meta-analytic review. *Sleep* **23**(2): 155-63.
- 49 Åkerstedt T (2003) Shift work and disturbed sleep/wakefulness. *Occupational Medicine* **53**(2): 89-94.
- 50 Vedaa Ø, Harris A, Bjorvatn B et al (2016) Systematic review of the relationship between quick returns in rotating shift work and health-related outcomes. *Ergonomics* **59**(1): 1-14.
- 51 Folkard S, Lombardi DA & Tucker PT (2005) Shift work: safety, sleepiness and sleep. *Industrial Health* **43**(1): 20-3.
- 52 Saksvik IB, Bjorvatn B, Hetland H et al (2011) Individual differences in tolerance to shift work – a systematic review. *Sleep Medicine Reviews* **15**(4): 221-35.
- 53 Van Dongen HP, Caldwell JA Jr & Caldwell JL (2011) Individual differences in cognitive vulnerability to fatigue in the laboratory and in the workplace. *Progress in Brain Research* **190**: 145-53.
- 54 Rétey JV, Adam M, Gottselig JM et al (2006) Adenosinergic mechanisms contribute to individual differences in sleep deprivation-induced changes in neurobehavioral function and brain rhythmic activity. *Journal of Neuroscience* **26**(41): 10472-9.
- 55 Viola AU, Archer SN, James LM et al (2007) PER3 polymorphism predicts sleep structure and waking performance. *Current Biology* **17**(7): 613-8.
- 56 Landolt HP (2008) Genotype-dependent differences in sleep, vigilance, and response to stimulants. *Current Pharmaceutical Design* **14**(32): 3396-407.
- 57 Arendt J (2010) Shift work: coping with the biological clock. *Occupational Medicine* **60**(1): 10-20.
- 58 Medical Protection Society (2017) *The rising cost of clinical negligence who pays the price? Clinical negligence costs. Striking a balance*. London: Medical Protection Society.

- 59 Redline S, Kirchner HL, Quan SF et al (2004) The effects of age, sex, ethnicity, and sleep-disordered breathing on sleep architecture. *Archives of Internal Medicine* **164**(4): 406-18.
- 60 Folkard S (2008) Shift work, safety, and aging. *Chronobiology International* **25**(2): 183-98.
- 61 Blok MM & de Looze MP (2011) What is the evidence for less shift work tolerance in older workers? *Ergonomics* **54**(3): 221-32.
- 62 Griffiths A, Knight A & Nor Mohd Mahudin D (2009) *Ageing, work-related stress and health – reviewing the evidence. A report for Age Concern and Help the Aged, and TAEN – the age and employment network*. Nottingham: Institute of Work, Health & Organisations, University of Nottingham.
- 63 Costa G & Sartori S (2007) Ageing, working hours and work ability. *Ergonomics* **50**(11): 1914-30.
- 64 Wagstaff AS & Sigstad Lie JA (2011) Shift and night work and long working hours – a systematic review of safety implications. *Scandinavian Journal of Work, Environment & Health* **37**(3): 173-85.
- 65 Barger LK, Cade BE, Ayas NT (2005) Extended work shifts and the risk of motor vehicle crashes among interns. *New England Journal of Medicine* **352**(2): 125-34.
- 66 Stutts JC, Wilkins JW, Osberg JS et al (2003) Driver risk factors for sleep-related crashes. *Accident Analysis & Prevention* **35**(3): 321-31.
- 67 Kirkcaldy BD, Trimpop R & Cooper CL (1997) Working hours, job stress, work satisfaction, and accident rates among medical practitioners and allied personnel. *International Journal of Stress Management* **4**(2): 79-87.
- 68 Lee ML, Howard ME, Horrey WJ (2016) High risk of near-crash driving events following night-shift work. *Proceedings of the National Academy of Sciences* **113**(1): 176-81.
- 69 Ayas NT, Barger LK, Cade BE et al (2006) Extended work duration and the risk of self-reported percutaneous injuries in interns. *Journal of the American Medical Association* **296**(9): 1055-62.
- 70 Fisman DN, Harris AD, Rubin M et al (2007) Fatigue increases the risk of injury from sharp devices in medical trainees: results from a case-crossover study. *Infection Control & Hospital Epidemiology* **28**(1): 10-7.
- 71 Gander P, Purnell H, Garden A et al (2007) Work patterns and fatigue-related risk among junior doctors. *Occupational & Environmental Medicine* **64**(11): 733-38.
- 72 Gander PH, Merry A, Millar MM et al (2000) Hours of work and fatigue-related error: a survey of New Zealand anaesthetists. *Anaesthesia & Intensive Care* **28**(2): 178-83.
- 73 Barger LK, Ayas NT, Cade BE et al (2006) Impact of extended-duration shifts on medical errors, adverse events, and attentional failures. *PLOS Medicine* **3**(12): e487.
- 74 Landrigan CP, Rothschild JM, Cronin JW et al (2004) Effect of reducing interns' work hours on serious medical errors among interns in intensive care units. *New England Journal of Medicine* **351**(18): 1838-48.
- 75 Ansiau D, Marquié JC, Tucker P et al (2015) *Longitudinal study of the effects of shift work on health. Analyses of VISAT (ageing, health and work) data. Report submitted to the IOSH Research Committee*. Wigston, Leicestershire: Institution of Occupational Safety and Health.
- 76 Caruso CC, Hitchcock EM, Dick RB et al (2004) *Overtime and extended work shifts: recent findings on illnesses, injuries, and health behaviors*. Cincinnati, Ohio: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.
- 77 Nakashima M, Morikawa Y, Sakurai M et al (2011) Association between long working hours and sleep problems in white-collar workers. *Journal of Sleep Research* **20**(1): 110-6.
- 78 Sekine M, Chandola T, Martikainen P et al (2006) Work and family characteristics as determinants of socioeconomic and sex inequalities in sleep: the Japanese civil servants study. *Sleep* **29**(2): 206-16.
- 79 Virtanen M, Ferrie JE, Gimeno D et al (2009) Long working hours and sleep disturbances: the Whitehall II prospective cohort study. *Sleep* **32**(6): 737-45.
- 80 Rajaratnam SM, Barger LK, Lockley SW et al (2011) Sleep disorders, health, and safety in police officers. *Journal of American Medical Association* **306**(23): 2567-78.
- 81 Barger LK, Rajaratnam SM, Wang W et al (2015) Common sleep disorders increase risk of motor vehicle crashes and adverse health outcomes in firefighters. *Journal of Clinical Sleep Medicine* **11**(3): 233-40.

- 82 van Drongelen A, Boot CRL, Merkus SL et al (2011) The effects of shift work on body weight change – a systematic review of longitudinal studies. *Scandinavian Journal of Work, Environment & Health* **37**(4): 263-75.
- 83 Proper KI, van de Langenberg D, Rodenburg W et al (2016) The relationship between shift work and metabolic risk factors: a systematic review of longitudinal studies. *American Journal of Preventive Medicine* **50**(5): e147-57.
- 84 Gan Y, Yang C, Tong X et al (2015) Shift work and diabetes mellitus: a meta-analysis of observational studies. *Occupational and Environmental Medicine* **72**(1): 72-8.
- 85 Anothaisintawee T, Reutrakul S, Van Cauter E et al (2015) Sleep disturbances compared to traditional risk factors for diabetes development: systematic review and meta-analysis. *Sleep Medicine Reviews* **30**: 11-24.
- 86 Knutsson A & Kempe A (2014) Shift work and diabetes – a systematic review. *Chronobiology International* **31**(10): 1146-51.
- 87 Vyas MV, Garg AX, Iansavichus AV et al (2012) Shift work and vascular events: systematic review and meta-analysis. *BMJ* **345**: e4800.
- 88 Virtanen M, Heikkilä K, Jokela M et al (2012) Long working hours and coronary heart disease: a systematic review and meta-analysis. *American Journal of Epidemiology* **176**(7): 586-96.
- 89 Virtanen M, Stansfeld SA, Fuhrer R et al (2012) Overtime work as a predictor of major depressive episode: a 5-year follow-up of the Whitehall II study. *PLoS One* **7**(1): e30719.
- 90 Virtanen M, Ferrie JE, Singh-Manoux A et al (2011) Long working hours and symptoms of anxiety and depression: a 5-year follow-up of the Whitehall II study. *Psychological Medicine* **41**(12): 2485-94.
- 91 Shields M (1999) Long working hours and health. *Health Reports* **11**(2): 33-48.
- 92 Zhai L, Zhang H & Zhang D (2015) Sleep duration and depression among adults: a meta-analysis of prospective studies. *Depression and Anxiety* **32**(9): 664-70.
- 93 Baglioni C, Battagliese G, Feige B et al (2011) Insomnia as a predictor of depression: a meta-analytic evaluation of longitudinal epidemiological studies. *Journal of Affective Disorders* **135**(1-3): 10-9.
- 94 Kolstad HA (2008) Nightshift work and risk of breast cancer and other cancers – a critical review of the epidemiologic evidence. *Scandinavian Journal of Work, Environment & Health* **34**(1): 5-22.
- 95 Ijaz S, Verbeek J, Seidler A et al (2013) Night-shift work and breast cancer – a systematic review and meta-analysis. *Scandinavian Journal of Work, Environment & Health* **39**(5): 431-47.
- 96 Jia Y, Lu Y, Wu K et al (2013) Does night work increase the risk of breast cancer? A systematic review and meta-analysis of epidemiological studies. *Cancer Epidemiology* **37**(3): 197-206.
- 97 Wang F, Yeung KL, Chan WC et al (2013) A meta-analysis on dose-response relationship between night shift work and the risk of breast cancer. *Annals of Oncology* **24**(11): 2724-32.
- 98 He C, Anand ST, Ebell MH et al (2015) Circadian disrupting exposures and breast cancer risk: a meta-analysis. *International Archives of Occupational and Environmental Health* **88**(5): 533-47.
- 99 Lin X, Chen W, Wei F et al (2015) Night-shift work increases morbidity of breast cancer and all-cause mortality: a meta-analysis of 16 prospective cohort studies. *Sleep Medicine* **16**(11): 1381-7.
- 100 Kamdar BB, Tergas AI, Mateen FJ et al (2013) Night-shift work and risk of breast cancer: a systematic review and meta-analysis. *Breast Cancer Research and Treatment* **138**(1): 291-301.
- 101 Rao D, Yu H, Bai Y et al (2015) Does night-shift work increase the risk of prostate cancer? A systematic review and meta-analysis. *OncoTargets and Therapy* **8**: 2817-26.
- 102 Wang X, Ji A, Zhu Y et al (2015) A meta-analysis including dose-response relationship between night shift work and the risk of colorectal cancer. *Oncotarget* **6**(28): 25046-60.
- 103 Jørgensen JT, Karlsen S, Stayner L et al (2017) Shift work and overall and cause-specific mortality in the Danish nurse cohort. *Scandinavian Journal of Work, Environment & Health* **43**(2): 117-26.
- 104 Depner CM, Stothard ER & Wright KP Jr (2014) Metabolic consequences of sleep and circadian disorders. *Current Diabetes Reports* **14**(7): 507.

- 105 Meerlo P, Sgoifo A & Suchecki D (2008) Restricted and disrupted sleep: effects on
autonomic function, neuroendocrine stress systems and stress responsivity. *Sleep
Medicine Reviews* **12**(3): 197-210.
- 106 Proper KI, van de Langenberg D, Rodenburg W et al (2016) The relationship between
shift work and metabolic risk factors: a systematic review of longitudinal studies.
American Journal of Preventive Medicine **50**(5): e147-57.
- 107 Wang Y, Mei H, Jiang YR et al (2015) Relationship between duration of sleep and
hypertension in adults: a meta-analysis. *Journal of Clinical Sleep Medicine* **11**(9): 1047-56.
- 108 Irwin MR (2015) Why sleep is important for health: a psychoneuroimmunology
perspective. *Annual Review of Psychology* **66**: 143-72.
- 109 Prather AA, Janicki-Deverts D, Hall MH et al (2015) Behaviorally assessed sleep and
susceptibility to the common cold. *Sleep* **38**(9): 1353-9.
- 110 Villafuerte G, Miguel-Puga A, Rodriguez EM et al (2015) Sleep deprivation and oxidative
stress in animal models: a systematic review. *Oxidative Medicine and Cellular Longevity*
2015: 234952.
- 111 Cedernaes J, Osorio RS, Varga AW et al (2017) Candidate mechanisms underlying the
association between sleep-wake disruptions and Alzheimer's disease. *Sleep Medicine
Reviews* **31**: 102-11.
- 112 www.icao.int/safety/fatiguemanagement/Pages/default.aspx (last accessed: 4
December 2017).
- 113 [http://eur-lex.europa.eu/LexUriServ/LexUriServ.
do?uri=OJ:L:2014:028:0017:0029:EN:PDF](http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2014:028:0017:0029:EN:PDF) (last accessed: 4 December 2017).
- 114 https://ec.europa.eu/transport/modes/road/social_provisions/driving_time_en (last
accessed: 4 December 2017).
- 115 www.gov.uk/drivers-hours (last accessed: 4 December 2017).
- 116 Rule 91 The Highway Code. Available at: [www.gov.uk/guidance/the-highway-code/
rules-for-drivers-and-motorcyclists-89-to-102](http://www.gov.uk/guidance/the-highway-code/rules-for-drivers-and-motorcyclists-89-to-102) (last accessed: 4 December 2017).
- 117 Rule 91 The Highway Code for Northern Ireland. Available at: [www.nidirect.gov.uk/
articles/rules-drivers-and-motorcyclists-89-102](http://www.nidirect.gov.uk/articles/rules-drivers-and-motorcyclists-89-102) (last accessed: 4 December 2017).
- 118 Greig P & Snow R (2017) Fatigue and risk: are train drivers safer than doctors? *BMJ* **359**:
j5107.
- 119 The Association of Anaesthetists of Great Britain & Ireland (2014) *Fatigue and
anaesthetists*. London: The Association of Anaesthetists of Great Britain & Ireland.
- 120 Horrocks N & Pounder R (2006) *Working the night shift: preparation, survival and
recovery. A guide for junior doctors*. London: Royal College of Physicians.
- 121 NHS Plus, Royal College of Physicians & Faculty of Occupational Medicine (2009)
*Physical and shift work in pregnancy: occupational aspects of management. A national
guideline*. London: Royal College of Physicians.
- 122 Royal College of General Practitioners (2015) *Patient safety implications of general
practice workload*. London: Royal College of General Practitioners.
- 123 Royal College of Nursing (2012) *A shift in the right direction. RCN guidance on the
occupational health and safety of shift work in the nursing workforce*. London: Royal
College of Nursing.
- 124 [www.guysandstthomaseducation.com/project/sleep-looking-after-your-wellbeing/
\(last accessed: 4 December 2017\).](http://www.guysandstthomaseducation.com/project/sleep-looking-after-your-wellbeing/)
- 125 Terms and Conditions of Service for NHS Doctors and Dentists in Training (England)
2016. Available at: [www.nhsemployers.org/case-studies-and-resources/2017/04/
terms-and-conditions-of-service-for-nhs-doctors-and-dentists-in-training-england-
2016-version-3](http://www.nhsemployers.org/case-studies-and-resources/2017/04/terms-and-conditions-of-service-for-nhs-doctors-and-dentists-in-training-england-2016-version-3) (last accessed: 4 December 2017).

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