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Night Work for Hospital Nurses and Sickness Absence: a retrospective study using electronic rostering systems

Chiara Dall'Ora^{a,b*}, Jane Ball^{a,c}, Oliver C Redfern^d, Peter Griffiths^{a,b,e}

^aSchool of Health Sciences, University of Southampton, Southampton, United Kingdom;

^bApplied Research Collaboration Wessex, University of Southampton, Southampton, United Kingdom; ^cDepartment of Learning, Informatics, Management and Ethics,

Karolinska Institutet, Stockholm, Sweden; ^dNuffield Department of Clinical

Neurosciences, University of Oxford, Oxford, United Kingdom; ^e Center for Health Outcomes and Policy Research, University of Pennsylvania, Philadelphia, United States of America

*corresponding author: School of Health Sciences, University of Southampton, Highfield Campus, Southampton, SO17 1BJ. C.Dallora@soton.ac.uk, @ora_dall

Abstract

There is conflicting evidence on the effect of night work on sickness absence. Most previous studies used self-reporting to identify shift patterns and measure levels of sickness absence. In contrast, this study used objective data from electronic rosters to explore the association of nurses' patterns of night work and sickness absence. This was a retrospective longitudinal study of nurse roster data from 32 general medical and surgical wards in a large acute hospital in England. We used data from three years and included both registered nurses and unregistered nursing assistants. We used generalized linear mixed models to explore the association between night work and the subsequent occurrence of sickness absence. Of 601,282 shifts worked by 1944 nursing staff, 38,051 shifts were lost due to sickness absence. After controlling for potential confounders including proportion of long (≥ 12 h) shifts worked, proportion of overtime shifts, proportion of shifts worked in the past 7 days, and staff grade, we found that staff working more than 75% of their shifts in the past 7 days as night shifts were more likely to experience sickness absence (aOR= 1.12; 95% CI: 1.03-1.21), compared to staff working on day only schedules. Sub-group analysis found that an association between a high proportion of night shifts worked and long-term sickness (aOR= 1.31; 95% CI: 1.15-1.50), but not short-term sickness. Working high proportions of night shifts, likely representing permanent night work schedules, is associated with a higher risk of long-term sickness absence for nurses working in inpatient adult wards in acute hospitals. The higher sickness absence rates associated with permanent night shifts could result in additional costs or loss of productivity for hospitals. This study challenges the assumption that permanent night schedules maximize circadian adjustment and, therefore, reduce health problems.

Keywords:

shift work; night work; sickness absence; permanent night work; nursing

Introduction

Several health care services, including inpatient wards in hospitals, are staffed around the clock. In healthcare, covering night shifts has been achieved through two different working patterns: staff being on rotating shifts, where they take turns in doing night shifts; and staff working night shifts permanently.

Sickness absence is defined as any leave from work that is attributed to sickness by the employee and accepted as such by the employer (Whitaker 2001). It has long been recognised as an indicator of employees' health in terms of physical and social functioning (Kivimaki et al. 2003).

Shift work, particularly at night, is associated with an increased risk of negative health outcomes for staff (Dall'Ora et al. 2016; Moreno et al. 2019). These adverse health outcomes include musculoskeletal disorders (Stimpfel et al. 2015; Karkkainen et al. 2017; Passali et al. 2018), including pain (Dagfinn et al. 2017); and mental health conditions, including stress and depression (Lin et al. 2015; Lee et al. 2017; Torquati et al. 2019). Recent data from England's National Health Service found that around 20% of absence days are due to minor colds or gastrointestinal problems lasting for a maximum of three days (NHS Digital 2020). In the past seven years, absence due to mental health conditions has risen steadily among nurses (Copeland 2019), with 23% of nurses' sickness absence days due to stress and mental health-related conditions (NHS Digital 2019), while musculoskeletal disorders account for 27% of sickness absence events (Demou et al. 2018). This suggests that musculoskeletal and mental health disorders are likely pathways in the association between night work and sickness absence for nurses. Absences related to mental health-related conditions and musculoskeletal problems tend to last for more than a week, sometimes up to several months (Nystuen et al. 2001; Kausto et al. 2017),

and the resulting economic and productivity damage for employers and employees is likely to be high (Henderson et al. 2005; Gabbay et al. 2011; NHS Employers 2014).

Despite night work being associated with a number of adverse health outcomes (Moreno et al. 2019), current evidence on the effect of shift work on rates of sickness absence is mixed. A systematic review of 24 studies found that there was inconclusive evidence for associations between shift work characteristics and sickness absence, including night work, regardless of whether permanent or rotating night shifts were worked (Merkus et al. 2012). Four recent studies have yielded mixed results. In three large surveys, working as part of a rotating schedule was associated with increased sickness absence, compared to working only day shift (Catano and Bissonnette 2014; Natti et al. 2014), or to permanent night shifts (albeit only for women) (Niedhammer et al. 2013). In contrast, one cohort study using human resources data concluded that working on a rotating schedule was associated with reduced sickness absence, compared to working on day shifts only (van Drongelen et al. 2017). A cross-sectional study using payroll data of police officers concluded that working on permanent night schedules was associated with higher sickness absence compared to working day only schedules (Fekedulegn et al. 2013). More recently, a survey of male production workers found no relationship between working night shifts and the risk of absence due to recurrent mental health problems (Norder et al. 2015).

When focussing on healthcare staff, only three recent studies were found, all using payroll data. In a prospective registry study of 1538 nurses in Northern Europe, Vedaa and colleagues reported no effect of night work in the previous month on sickness days and sickness episodes (Vedaa et al. 2017). In contrast, a longitudinal study of 12,156 healthcare workers in Finland concluded that working four or more consecutive night shifts in the 28 days preceding sickness absence was associated with an increased

likelihood of sickness absence among shift workers (Ropponen et al. 2019). In a further study including nurses from Norway, Denmark, and Finland, age did not directly affect the association between night work and short sickness absence (≤ 3 days) (Ropponen et al. 2020). In summary, previous studies used different methods and yielded contrasting results on the effect of night work on sickness absence, and in relation to whether nights are undertaken as part of ‘rotation’ or a permanent pattern.

With a few exceptions using objective data from administrative systems (Vedaa et al. 2017; Ropponen et al. 2019, 2020), the relationship between shift work and sickness absence in healthcare has been investigated mainly through surveys, which means the identified associations might be subject to bias, including recall bias. Furthermore, several previous studies have focused on cohorts of all sectors employees, thereby failing to uncover potential differences that are occupation specific (Ferguson and Dawson 2012). However, the association between shift work and sickness absence might be schedule and population specific (Merkus et al. 2012). Studies using administrative data on shift work and sickness absence, i.e., data which are often routinely collected by workplaces, have the potential to minimise recall bias and other biases attributable to self-reported indicators of health (Harma et al. 2015).

The aim of this study was to measure the association between exposure to night work and sickness absence in a sample of hospital registered nurses and nursing assistants using administrative scheduling data. To our knowledge, this is the first study in healthcare in England to retrieve, extract, and analyse this type of scheduling data from electronic rostering systems.

Materials and Methods

This was a retrospective longitudinal study. The study drew on shift data collected

routinely between April 2012 and March 2015, from 32 adult medical and surgical units of a large general National Health Service (NHS) hospital in southern England. The approximate number of overnight beds was 1000. These data were obtained as part of a parent study (ISRCTN registration: 17930973; <http://www.isrctn.com/ISRCTN17930973>). Further detail and context can be found elsewhere (Griffiths et al. 2018). The University of Southampton Ethics Committee granted ethical approval to undertake this research (Reference Number 18311). This study was conducted in line with the international ethical considerations recommended for biological rhythm research (Portaluppi et al. 2010).

Data Sources

We extracted nurse shift data from the hospital's electronic rostering systems. These systems were linked to payroll and agency billing processes, and consequently were subjected to extensive checks by the hospital to ensure they were correct to manage staff payments. Each record contained information on whether the shift had been worked; date; shift length (including start and end time); ward where the shift was worked; and grade of the nurse. A separate system was used to record and manage bank shifts worked in the hospital. Bank shifts are temporary assignments worked by nursing staff employed directly by the hospital. We treated these as voluntary paid overtime shifts, referred to as "overtime shifts" for brevity from now onwards.

The 32 study wards were either adult medical and surgical units. Although the included wards comprised over 75% of all inpatient beds in the hospital, intensive care units, paediatric and maternity settings were not considered by the parent study; therefore, we could not include them in our analysis. We removed any shifts coded as absence for other reasons (e.g. maternity leave, vacation) and any shifts worked by non-

clinical/managerial staff (e.g. clerks). Some shifts were worked by staff with an unknown grade ($n = 1608$, 0.25% of the total). We removed these as senior nursing managers and the human resources department advised us that these staff were unlikely to be clinically active nursing staff. Registered nurses are qualified nurses registered with the Nursing and Midwifery Council, who have a university diploma or degree level qualification or equivalent. Nursing assistants provide personal care to patients and undertake some nursing tasks under supervision, but do not have any formal training requirements or registration.

Shifts were further classified as “day” or “night” based on the finish time of the shift. If a shift ended before 08:00h, it was classified as a night shift. For each worked shift, we calculated variables to characterise the working pattern in the past seven days as follows:

- Proportion of night shifts
- Proportion of long shifts (≥ 12 h)
- Proportion of worked shifts
- Proportion of overtime shifts

For analysis purposes, we categorized proportion of night shifts as $<25\%$; between 25% and 50%, between more than 50% and 75%; and $\geq 75\%$. We chose these categories based on sensitivity analyses we performed, and using this categorization provided a parsimonious approach and showed a similar pattern of results to the more granular analysis. In the $\geq 75\%$ category, 62,859 shifts (94%) were 100% night shifts, meaning that this category represents almost entirely shifts worked by staff who worked night shifts only in the past 7 days. A sickness episode was defined from the first day an employee was absent from work due to sickness absence and to when the employee returned to work for at least one full day.

Long-term sickness absence episodes were defined as lasting seven or more consecutive days. This reflects the UK Government legislation, according to which employees need to provide proof to their employer if they are unwell for more than seven days (UK Government 2019). This threshold has also been adopted by previous UK studies. (Kivimaki et al. 2003; Ferrie et al. 2005). Sickness episodes not preceded by any shifts in the past seven days were excluded to ensure that sickness was likely shift work related.

Data Analysis

We used generalized linear mixed-effects models to measure associations between nurses' night work and sickness absence, with shifts nested in nursing staff members. We modelled the association between sickness absence and the proportion of night shifts worked over the seven days prior to sickness episodes, and also undertook a subgroup analysis of the relationship of long-term and short-term sickness episodes. We controlled for the proportion of long (≥ 12 h) shifts worked, proportion of overtime shifts worked, proportion of days worked, and nursing staff grade (registered nurse vs. nursing assistant).

For all models, we computed the Variance Inflation Factor (VIF) to detect the presence of multi-collinearity between the model covariates. All VIF scores were < 3 , indicating low multicollinearity (O'Brien 2007). All analyses were performed with R (R Development Core Team 2019), and mixed-effects models were fitted using the package lme4 (Bates et al. 2014).

Results

After exclusions, there were 601,282 worked nursing shifts available for analysis. These shifts were undertaken by 1944 nursing staff, of which 1244 were registered nurses, and

700 were nursing assistants. 566,206 were rostered shifts, and 35,076 were overtime shifts; of these worked shifts, 163,390 (27.1%) were night shifts. Sixty-seven percent of night shifts lasted ≥ 12 h, and 33% lasted between 8 and 12 h. Over the three years of the study, 38,051 shifts (5.9%) were lost due to sickness absence, grouped in 8090 distinct sickness episodes. The most common absence length was 2 days ($n = 1221$, 15.1%) and the majority of the episodes were short-term (< 7 days) ($n = 5555$, 69.7%). Figure 1 shows a histogram with the detailed length of sickness absence.

Figure 1 here

Table 1 shows the sickness absence according to the proportion of night work in the past seven days.

Table 1 here

Working more than three quarters of shifts in the past seven days as night shifts showed the highest proportion of sickness episodes ($n=1051$, 1.6%).

Our generalized linear mixed models (see Table 2) showed that compared to not working any night shifts, the odds of sickness absence were decreased when nurses worked $< 25\%$ of shifts as nights in the previous 7 days, although the effect was not statistically significant in the fully adjusted model (adjusted Odds Ratio (aOR)= 0.91; 95% CI: 0.78-1.07).

When nurses worked $> 25\%$ of shifts as night shifts, the odds of sickness absence were increased in the adjusted models, although the increase was not consistent in the unadjusted models. When $> 75\%$ of shifts in the past seven days were night shifts there was a 12% increase in the odds of sickness absence in both the unadjusted (OR= 1.12; 95% CI: 1.04-1.22) and fully adjusted models (aOR = 1.12; 95% CI: 1.03-1.21).

Table 2 here

As night shifts were longer time periods (e.g., 67.3% of night shifts were ≥ 12 h), we explored whether the effect of night work on sickness absence varied as a function of shift length by adding an interaction terms between long shifts and night shifts, but the relationship was not significant (OR= 0.99, 95% CI: 0.98-1.00).

Table 3 here

The effect of the proportion of night shifts on short-term and long-term sickness absence, reported in Table 3, was different in the short-term sickness absence subgroup: the only significant effect was found for nurses working between more than 25% and less than 50% of their shifts as night shifts in the past seven days (aOR= 1.16; 95% CI: 1.03-1.30). There was little difference between working 0% and 75% of the shifts in the past seven days as nights. Working >75% of shifts as night shifts in the past seven days was associated with a higher likelihood of experiencing a long-term sickness absence episode (OR=1.31; 95% CI: 1.15-1.5), and this association strengthened compared to the overall sample (see Table 2).

Discussion

This is the first study we know of that used longitudinal objective data to quantify the relationship between the proportion of night work and the rate of sickness absence in hospital nursing staff. Analyses were performed at the shift level, and nested into staff members. The results do not show a straightforward dose-response relationship; rates of sickness absence only increased at the highest level of exposure to night working (>75%

of shifts in the past seven days being at night). The effect of working a high proportion of night shifts was observed in relation to long-term sickness absence but not short-term sickness absence.

Nursing staff working a high proportion of night shifts were likely to be those working almost exclusively at night, whereas those working a lower proportion are more likely working a shift pattern rotating between day and night shifts. Previous studies, while giving no clear picture overall, have come to contrasting conclusions about the effects of rotating as opposed to permanent night shifts (e.g., Niedhammer et al. 2013). Short-term sickness absence for NHS staff is mainly associated with colds and minor illnesses (NHS Digital 2020), and night work might not be a risk factor for such minor conditions. Within our sample, nursing staff working permanent night shifts opted to do so, and there is evidence that nurses who choose to work permanent night schedules are motivated by a better fit of their work schedule with their life commitments, including childcare and household chores, which they resume within hours of returning from night shifts (Lowson and Arber 2014). This leads to questioning whether nurses who work permanent night shifts can benefit from adequate sleep and have enough time to rest and recover. Increased sickness absence from permanent night working might be explained by increased fatigue and absence of recovery (Sagherian et al. 2017).

Compared to previous studies using registry data, we found that the distribution of high proportions of night shifts (11% in our sample) were slightly higher than in Finland (10%) and Denmark (10%) and lower than in Norway (14%) (Garde et al. 2019), meaning that there are similarities and our results might, therefore, generalise to other countries.

The ability to make circadian adjustments is often used as an argument in support of permanent night duty; however, it is estimated that only 3% of employees show a

complete adaptation to night work (Folkard 2008). Our study showed an association between a high proportion of night shifts and long-term sickness absence, which more often reflects a health impairment (Bakker et al. 2003). There is ample evidence from other sectors that night work is associated with several health impairments, including musculoskeletal disorders, chronic fatigue, and depression (Moreno et al. 2019). Nurses and nursing assistants in this sample may have found themselves unable to attend work because they were experiencing these adverse health outcomes.

While some increased risk of sickness absence may be an inevitable consequence of night work, sickness absence that is long term and associated with chronic ill health is of much greater potential significance both for the worker, in terms of health and wellbeing (Bryngelson 2009), and for the economy, in terms of lost productivity and staff turnover (Johnson et al. 2003; Bryngelson 2009; Stromberg et al. 2017).

Strengths and Limitations

The results of this study are based on a large and objective dataset with no recall bias, and comprising longitudinal data collected over three years, which is a major strength compared to earlier studies based on self-report or cross-sectional data. In addition, compared to previous studies often considering mixed occupations, it provides a homogeneous sample of nurses and nursing assistants. However, it has some limitations. Being the first study using electronic roster data in nursing in England, we chose a careful approach and resolved to collect data from one hospital, only: hence, generalization of our results should be approached with caution. In addition, although the included wards comprised over 75% of all inpatient beds in the hospital, we did not collect data from intensive care units, paediatric, and maternity settings.

Importantly, we could not control for the characteristics of staff in the study, and of their practice environments, which could play a role in determining sickness absence – these include age, gender, presence of chronic illness, and non-work commitments (i.e. caring for any dependants). We are reassured that a recent study by Ropponen and colleagues found that age did not directly affect the relationship between night work and sickness absence in a large sample of nurses (Ropponen et al. 2020). In addition, the absence of control for staff characteristics could lead to bias if such staff characteristics were systematically associated with staff electing to work night shifts only, and an increased preference for night shifts only for older nurses seems unlikely from the current evidence (Ropponen et al. 2020). Furthermore, each staff member was included as a random effect in our models (i.e., shifts were nested in individual staff members), which reassures us that individual characteristics were at least partially controlled for.

Sleep patterns, exercise, and diet could also play a role in moderating the relationship between night work and sickness absence (Nakata et al. 2004; Akerstedt et al. 2007; Heath et al. 2012; Gupta et al. 2017), and our study could not take these into account. Nonetheless, we are reassured that the main effect of high proportions of night work on sickness absence has been found in different countries and larger samples, where employees might have displayed a variety of sleep, exercise, and dieting behaviours (Ropponen et al. 2019, 2020).

Studies in more than one hospital and in settings that include intensive care units and paediatrics, which are able to link objective electronic rostering data to individual staff records of age, gender, and length of experience, as well as including personal commitments, are warranted to advance our knowledge of the effect of night work on sickness absence. Our ongoing programme of work is addressing some of these limitations, by expanding data collection and analysis of several hospitals, and by

exploring the opportunity to link data around age and gender from Human Resources systems.

Conclusions

When nurses and nursing assistants work high proportions of night shifts, their long-term sickness absence is increased. This may indicate worse health for nurses, and suggest that implementing permanent night rotas might not be beneficial for organizational efficiency. While our findings provided some evidence that rotating shifts were associated with increased short-term sickness, the evidence is less conclusive, and the consequences of short-term sickness absence for both employees and employer is likely to be less.

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Declaration of interests

The authors report no conflict of interest.

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Table 1. Sickness episodes distribution by night work in the past seven days

Proportion of night shifts over worked shifts in past 7 days	Sickness episodes n (%)	Total n (%)
0%	6183 (1.5)	420,134 (100)
>0 - ≤25%	160 (1.1)	15,462 (100)
>25 - ≤50%	432 (1.5)	28,382 (100)
>50 - ≤ 75%	264 (1.4)	19,265 (100)
>75%	1051 (1.6)	66,050 (100)

Table 2. Associations between night work and sickness absence

Shift characteristics	OR	95% CI	aOR [†]	95%CI
Proportion of night shifts over shifts worked in past 7 days				
(0% reference category)				
>0% - ≤25%	0.81*	0.69-0.94	0.91	0.78-1.07
>25% - ≤50%	1.09	0.99-1.21	1.11	1.00-1.23
>50% - ≤ 75%	1.00	0.88-1.13	1.06	0.94-1.21
>75%	1.12*	1.04-1.22	1.12*	1.03-1.21

Generalised linear mixed model; random effect: Nurse ID

* Statistically significant at $p < 0.05$

[†] Adjusted Odds Ratio, model controlling simultaneously for proportion of long shifts worked in the past 7 days, proportion of days worked over the past 7 days, proportion of overtime shifts worked in the past 7 days, and nurse grade (Registered Nurse vs Nursing Assistant)

Table 3. Associations between night work and long-term and short-term sickness absence

Shift characteristics	Long term sickness absence (≥ 7 days)		Short term sickness absence (≥ 7 days)	
	aOR [†]	95% CI	aOR [†]	95% CI
Proportion of night shifts over shifts worked in last 7 days				
(0% reference category)				
>0% - $\leq 25\%$	0.72	0.51-1.01	0.97	0.81-1.15
>25% - $\leq 50\%$	1.04	0.85-1.26	1.16*	1.03-1.30
>50% - $\leq 75\%$	1.18	0.93-1.49	1.01	0.87-1.17
>75%	1.31*	1.15-1.50	1.02	0.92-1.13

Generalised linear mixed model; random effect: Nurse ID

[†] Adjusted Odds Ratio: all generalised linear mixed models controlling for proportion of night shifts worked over past 7 days; proportion of worked shifts over past 7 days; nurse grade (HCA vs RN)

* Statistically significant at $p < 0.05$

Figure 1

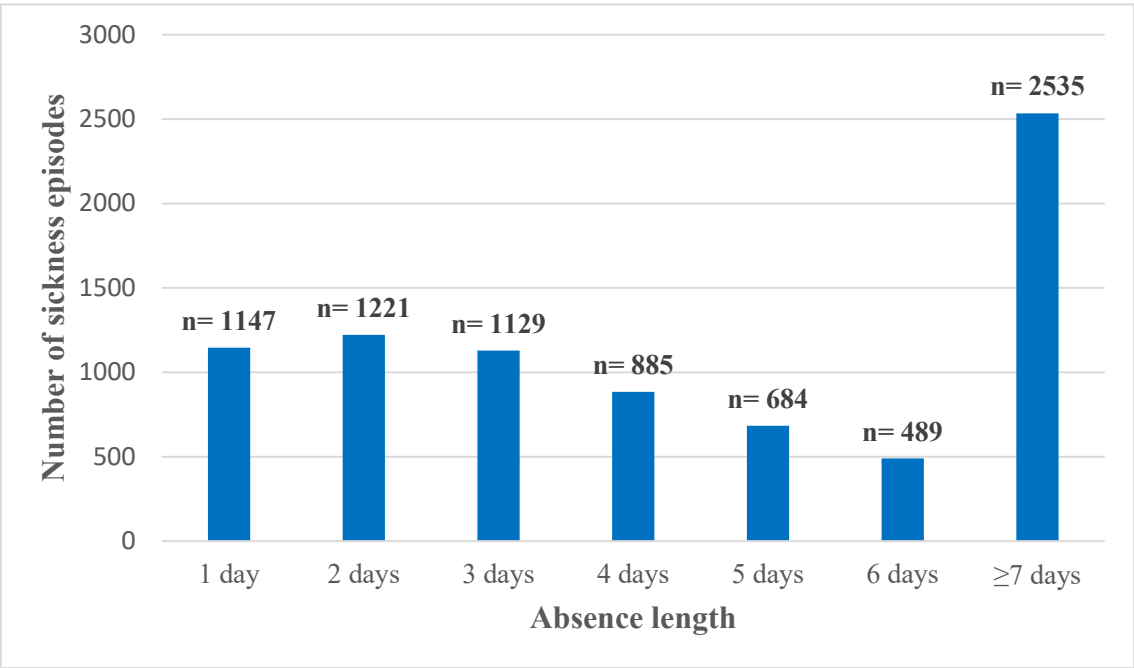


Figure captions

Figure 1 Distribution of sickness episodes according to absence length