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Twenty-four/seven: a mixed-method systematic review of the off-shift literature

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Abstract

Aim—This article is a report of a review that aimed to synthesize qualitative and quantitative evidence of ‘off-shifts’ (nights, weekends and/or holidays) on quality and employee outcomes in hospitals.

Background—Healthcare workers provide 24-hour-a-day, 7-day-a-week service. Quality and employee outcomes may differ on off-shifts as compared to regular hours.

Data sources—Searches for studies occurred between the years 1985–2011 using computerized databases including Business Source Complete, EconLit, ProQuest, PubMed and MEDLINE.

Review design and methods—Design was a mixed-method systematic review with quantitative and qualitative studies. To be included, studies met the following criteria: (1) the independent variable was an off-shift; (2) the article was a research study and peer-reviewed; (3) the article could be obtained in English; and (4) the article pertained to health care. Studies were not excluded on design.

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Author contributions

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- substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data;
- drafting the article or revising it critically for important intellectual content.

Conflict of interest

No conflict of interest has been declared by the authors.

Supporting Information Online

Additional Supporting Information may be found in the online version of this article:

Table S1. Quality assessment criteria.

Table S2. Quality appraisal outcome for each study.

Table S3. Characteristics of 60 studies in the systematic review.

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Results—Sixty studies were included. There were 37 quality outcome, 19 employee outcome and four qualitative studies. In the quality outcome studies, researchers often used quantitative, longitudinal study designs with large sample sizes. Researchers found important differences between patients admitted on weekends and mortality. Important differences were also found between nighttime birth and mortality and rotating night work and fatigue, stress and low mental well-being. Most studies (9 of 12) did not find an important association between patients admitted at night and mortality.

Conclusion—Patient outcomes on weekends and employee outcomes at night are worse than during the day. It is important to further investigate why care on off-shifts differs from weekly day shifts.

Keywords

After hours; fatigue; mixed-method systematic review; mortality; nursing; patient outcomes; patient safety

Introduction

Nurses provide 24-hour, 7 day-a-week care to patients; and, nursing care often extends beyond the traditional 9–5 Monday through Friday work week. Researchers have found that the routine of 7 AM to 7 PM, Monday through Friday, is not representative of the environment where most nursing work takes place (Hamilton *et al.* 2010). To ensure patient coverage, some nurses work after hours or out of hours, or otherwise known as ‘off-shifts’, which include nights, weekends and holidays. On off-shifts, there may be lower levels of nurse staffing and less resources available. Specifically for weekends, researchers have found that clinical personnel staffing levels in acute care hospitals tend to be lower on weekends than on weekdays; and, hospitals function less effectively on weekends (Bell & Redelmeier 2001).

Night nurses may have higher levels of fatigue than day nurses. In other industries where employees work around the clock, researchers found that shift workers rarely report getting the recommended eight hours of sleep (Akerstedt 2003). In addition, night nurses may suffer from sleep disturbances, which may have an impact on patient safety. Sleep deprivation jeopardizes not only patient safety, but also the safety and general health of nurses themselves (Rogers *et al.* 2004). It is often the second half of the night where nurses reported that they frequently struggle to stay awake (Berger & Hobbs 2006). In addition, working at night can impact employees’ circadian rhythm, social and family life and overall health such as digestive and health conditions (Rosa & Colligan 1997).

The review

Aim—The aim of this review was to synthesize the evidence on off-shifts and quality patient care. The term off-shift is often used interchangeably with terms including, but not limited to, as ‘out-of-hours’, ‘after-hours’ and ‘off-peak hours’. For simplicity, we use the term ‘off-shift’ throughout this review. An additional aim was to synthesize the evidence on healthcare providers who work night shift, or rotated to work night shift and their risk for sleep disorders or decreased well-being as compared to providers who worked more regular hours.

Design—A systematic review including quantitative and qualitative studies of the off-shift literature in hospitals was conducted. The review process was guided by the Centre for Reviews and Dissemination manual from York University on identifying and organizing published literature for health care (University of York 2009). This manual provides

systematic review methods including how to search for evidence, develop inclusion and exclusion criteria, extract data, appraise evidence and synthesize the results. The authors also give guidelines on how to synthesize relevant qualitative studies to help interpretation of the quantitative findings (University of York 2009). To be comprehensive, all types of study designs were included in the review. Due to study heterogeneity, a meta-analysis could not be performed.

Search methods—Searches for studies occurred between the years 1985–2011 using computerized databases. These databases included Business Source Complete, EconLit, ProQuest, PubMed and MEDLINE to identify studies that may have not been located in health-related databases. Key words included ‘shift work’, ‘nights’, ‘weekends’, ‘off-peak hours’, ‘off-shifts’, ‘patient outcomes’, ‘productivity’ and ‘quality’. The reference lists of included articles were reviewed to retrieve additional studies. To be included in the review, the studies meet the following criteria: (1) the independent variable of interest was an off-shift; (2) the article was a research study and peer-reviewed; (3) the article could be obtained in English; and (4) the article pertained to health care.

Search outcome—The search identified 680 titles and abstracts, which were reviewed to determine eligibility. Five hundred and eighty-six of these were excluded after reading the abstract and/or browsing text: A total of 94 full-text articles were identified as potentially eligible. Of these, 34 were further excluded because off-shifts were not clearly defined, independent and dependent variables were not pertinent to the search and/or lack of information. Sixty articles were reviewed. Figure 1 displays the flow chart of the study selection process. Studies were not excluded based on the quality of the research methodology.

Quality appraisal—An article quality assessment tool (available from authors) was adopted and used to appraise evidences for the quantitative studies included in this review (Aboelela *et al.* 2007). This tool was adapted from previously published review, which used standardized, well developed methodology and allowed assessment of study quality on five domains: These domains include description of setting, sample and study design; representativeness of study population; defined independent variables and outcomes, statistical approach and clarity of the results (See supporting information Table S1 in the online version of the article in Wiley Online Library). Based on the five domains, the methodological quality of each study was graded as A (completely adequate with detailed description), B (partially adequate with fair description) and C (not specified or inadequate with poor description) or (not applicable). The quality appraisal outcomes are available as a concise web-based (See supporting information Table S2 in the online version of the article in Wiley Online Library). The full evidence-based tables for the 60 studies are available from the authors. Due to the diversity of settings, samples and study design, a meta-analysis of the grades could not be calculated. Qualitative research studies were appraised using the Dixon-Wood *et al.* (2004) criteria presented in Table S1 in the online version of the article in Wiley Online Library.

Data abstraction and synthesis—Data were abstracted by the first author (PdC) and all abstracted data were reviewed by the senior author (PWS). The following data were abstracted: setting, sample, study design, definition of off-shift studied (e.g. nights, nights and rotation, weekends, holidays and/or combination), conceptualization and operationalization of outcome(s) (for quantitative studies) and results. Data synthesis included examining relationships between how researchers defined off-shifts and what type of outcomes were studied. The studies were first divided by type of outcome and/or finding (e.g. patient or employee). Quantitative patient outcome studies were further grouped by

specific independent variables (e.g. time of admission/discharge, time of birth, time of procedures and nurse staffing).

Results

There were 60 studies representing a diversity of countries which reflects the international importance of this topic. A slight majority (53%, $n = 32$) of the studies were from North America. In the studies, researchers utilized case-control, cross-sectional, longitudinal, interventional and qualitative designs. No randomized controlled trials were identified. Researchers often used longitudinal study designs (62%, $n = 37$). Both case-control and interventional designs were rare. Four teams used qualitative methods. Approximately half of the studies were multisite. The majority (66%, $n = 37$) pertained to patient quality and the remainder of the studies pertained to the employees (See supporting information Table S3 in the online version of the article in Wiley Online Library).

Definition of off-shifts

All researchers identified whether an off-shift occurred at night and/or on the weekend. Off-shifts were also defined as 'after hours', 'off-hours', 'non-office hours' and 'off-peak hours'. There were inconsistent definitions. For example, in one study 'nights' began at 1800 and in another study, 'nights' began at 1701 (Morales *et al.* 2003, Pilcher *et al.* 2007). Although researchers consistently defined 'weekends' as Saturday and Sunday, they disagreed on the exact time when the weekend began. In the quality outcome studies, the exact times of the off-shift were often provided. Conversely, employee outcome or qualitative methods did not clearly define the exact time of the off-shift.

Quality outcomes studies

There were 37 studies that examined patient quality outcomes. These outcomes included mortality, length of stay, frequency of procedures and treatment delays. Twenty-two studies examined the association between time of admission and/or discharge and patient outcomes. Eight groups of researchers studied the time of birth as the independent variable. Five studies examined the time of procedures and patient complications on off-shifts and two studies examined the association between nighttime nurse staffing and outcomes.

Relationship between time of admission and/or discharge and quality outcomes—The majority (85%, $n = 18$) of researchers examining relationships between time of admission and/or discharge and quality outcomes focused on weekends as the off-shift variable (Table 1). Although the hospital settings varied, 63% of the researchers examined patients in intensive care units (ICUs). There were three studies that examined patients discharged from ICUs. All study designs were longitudinal. The sample sizes in these studies varied (range from 611–3,789,917 patients). There was also a variety of patient populations included. A majority (90%, $n = 20$) of the researchers sampled adult patients, yet medical specialty differed including nephrology (James *et al.* 2010), neurology, (Saposnik *et al.* 2007) cardiology, (Kostis *et al.* 2007) and burn patients (Taira *et al.* 2009). Two studies sampled neonates and/or children (Hixson *et al.* 2005, Abdel-Latif *et al.* 2006). Only five studies occurred in a single site (Morales *et al.* 2003, Hixson *et al.* 2005, Arabi *et al.* 2006, Barba *et al.* 2006, Sheu *et al.* 2007).

In these 22 studies, all the researchers examined mortality as one of the outcomes. Most of the researchers (86%, $n = 19$) defined mortality as in-hospital mortality. However, other definitions of mortality were used. For example, Saposnik *et al.* (2007) sampled stroke patients and defined mortality as death 7-day from stroke onset whether it occurred in the hospital or not. A strength of many these studies is the use of multivariate logistic regression

controlling for the following confounders: age, sex, severity of illness, medical complications and treatment facility.

In the nine studies that defined off-shifts as weekend-only, the results were mostly consistent and researchers found that patients were more likely to die if they were admitted on weekends as compared to during the week (Bell & Redelmeier 2001, Barnett *et al.* 2002, Cram *et al.* 2004, Ensminger *et al.* 2004, Barba *et al.* 2006, Kostis *et al.* 2007, Saposnik *et al.* 2007, James *et al.* 2010, Schilling *et al.* 2010). While Ensminger *et al.* (2004) found that patients admitted to a surgical ICU on weekends were more likely to die; this effect was not found for medical ICU patients. The results were also mixed when off-shifts was defined as nights exclusively; one group of researchers found that patients were more likely to die if they were admitted at night (Pilcher *et al.* 2007) and the other did not find this effect (Morales *et al.* 2003).

In 11 studies where researchers examined nights and weekends, both the methods of analyses and the results varied. Among these studies, 45% ($n = 5$) of researchers analysed nights and weekends together, another 45% ($n = 5$) analysed them separately and one group performed their analyses together and separately. When nights and weekends were analysed together, researchers did not find that patients who were admitted on off-shifts had higher mortality (Abdel-Latif *et al.* 2006, Luyt *et al.* 2007, Sheu *et al.* 2007, Taira *et al.* 2009, Laupland 2010). For example, Carr *et al.* (2011) found that patients presenting to trauma centres at night were not likely to die or have a delay in procedures compared with patients presenting during the day. In addition, patients presenting on weekends were less likely to die than patients presenting during weekdays (IRR = 0.89; 95% CI 0.81–0.97). Laupland (2010) found that admission with community onset bloodstream infection during after hours as compared to regular hours (614/4867 vs. 268/2056; $P = 0.6$) did not increase the risk of mortality. These results were also similar for two of the studies that analysed nights and weekends separately, that is, in these two studies neither nights nor weekends were associated with mortality (Hixson *et al.* 2005, Arabi *et al.* 2006).

Patient length of stay was conceptualized as a quality outcome in seven studies (Barnett *et al.* 2002, Morales *et al.* 2003, Arabi *et al.* 2006, Kostis *et al.* 2007, Sheu *et al.* 2007, Taira *et al.* 2009, Carr *et al.* 2011). The setting in four of these seven studies was an ICU (Barnett *et al.* 2002, Morales *et al.* 2003, Arabi *et al.* 2006, Sheu *et al.* 2007) and in only one study was there a statistically significant difference in intensive care length of stay for weekend or Friday admissions compared with midweek admissions (Barnett *et al.* 2002). However, the study by Barnett *et al.* was multi-site and the other three studies occurred in a single setting and had smaller sample sizes. Therefore, statistical power may have been an issue.

Relationship between time of birth and quality outcomes—Eight research teams examined the association between time of birth and neonatal outcomes (Table 2). A majority (75%, $n = 6$) of the researchers studied outcomes of those babies born at night compared to days (Stewart *et al.* 1998, Luo & Karlberg 2001, Gould *et al.* 2005, Urato *et al.* 2006, Badr *et al.* 2007, Caughey *et al.* 2008). The sample sizes in these studies also varied (range 1015 to over 3 million babies). One study used a case–control design, whereas the other studies were longitudinal. Most researchers used database registries (Stewart *et al.* 1998, Luo & Karlberg 2001, Stephansson *et al.* 2003, Gould *et al.* 2005, Urato *et al.* 2006, Bell *et al.* 2010). Infant mortality was the quality outcome in all studies, but other neonatal outcomes including short-term morbidity and neurodevelopmental outcomes were included. All the researchers used logistic regression and controlled for confounders, which included maternal age, birth weight, prenatal care, number of pregnancies, race and delivery by midwife.

In two studies, researchers did not find an association between time of birth and mortality. In these studies, both Bell *et al.* (2010) and Caughey *et al.* (2008) compared neonatal outcomes by three time periods – day, evening and night. Bell *et al.* (2010) conducted their analyses at institutions that had resident duty-hour restrictions and concluded that restrictions on resident duty-hours reduced resident fatigue and increased supervisory surveillance. All the other results were mostly consistent and the researchers found that babies born at night were more likely to die than those born during the day (Stewart *et al.* 1998, Luo & Karlberg 2001, Stephansson *et al.* 2003, Gould *et al.* 2005, Urato *et al.* 2006, Badr *et al.* 2007).

Relationship between time of procedures and patient complications on off-shifts—Five groups of researchers studied treatment delays and/or complications on off-shifts (Table 3). Authors provided clear definitions and the sample sizes were large (range over 1000 to almost 5 million patients). Cardiac patients were sampled in four of the five studies (Sadeghi *et al.* 2004, Becker 2007, Peberdy *et al.* 2008, Uyarel *et al.* 2009). The other group examined complication rates of eight patient safety indicators including postoperative haemorrhage, newborn trauma, vaginal deliveries and obstetric trauma during caesarean sections (Bendavid *et al.* 2007). Of the five groups, three found that patients were more likely to have delays in treatment and/or develop complications on off-shifts as compared to more regular hours (Becker 2007, Bendavid *et al.* 2007, Peberdy *et al.* 2008).

Night nurse staffing and quality outcomes—There were two studies that examined the association of night nurse staffing and hospital mortality. Secondary outcomes included patient length of stay and total hospital cost (Amaravadi *et al.* 2000, Dimick *et al.* 2001). These researchers studied the effect on patient outcomes when night nurses cared for one or two patients as compared to three or more patients in ICUs (Amaravadi *et al.* 2000, Dimick *et al.* 2001). In both studies, the researchers found no important difference in mortality, but found that length of stay and cost increased when night nurse-to-patient ratio was greater than 1:2 (Amaravadi *et al.* 2000, Dimick *et al.* 2001).

Employee outcomes studies

There were 19 studies that examined employee outcomes (Table 4). Off-shift was defined as nights in ($n = 7$) or nights with rotation ($n = 12$). In the studies where researchers focused on nights, a variety of healthcare workers were sampled. The sample sizes for these seven studies ranged from 38–7717 participants. Most ($n = 5$) used cross-sectional designs. In the study with the largest sample, researchers longitudinally examined 7717 workers' compensation claims in Oregon and found that nurses who worked at night had more injuries (Horwitz & McCall 2004). Only two studies occurred in a single setting (Arora *et al.* 2006, West *et al.* 2007).

Twelve groups of researchers examined the association between nights with rotation and multiple employee outcomes (Gold *et al.* 1992, Jamal & Baba 1992, Barton 1994, Costa *et al.* 2004, Geiger-Brown *et al.* 2004, Choobineh *et al.* 2006, Samaha *et al.* 2007, Admi *et al.* 2008, Camerino *et al.* 2008, Leff *et al.* 2008, Burch *et al.* 2009, Korompeli *et al.* 2009). Similar to the 'night-only' studies, researchers sampled a variety of healthcare workers. Most investigations were cross-sectional, however, one group also used an interventional strategy to evaluate surgical skills after a resident rotates to night shift (Leff *et al.* 2008). Half of these studies were multisite.

Fatigue and sleep disturbances—In both the nights and nights with rotation studies, most groups of researchers ($n = 13$) examined fatigue and sleep disturbances as an outcome (Gold *et al.* 1992, Barton 1994, Ruggiero 2003, Newey & Hood 2004, Arora *et al.* 2006, Choobineh *et al.* 2006, Samaha *et al.* 2007, West *et al.* 2007, Admi *et al.* 2008, Camerino *et*

al. 2008, Leff *et al.* 2008, Burch *et al.* 2009, Korompeli *et al.* 2009). Ruggiero (2003) found that providers that worked at night had less quality sleep than those who worked during the day. Arora *et al.* (2006) tested a sleep intervention and found an important effect that sleep efficiency improved when an intern napped. Four groups of researchers found statistically significant associations between night rotation and poor sleep (Gold *et al.* 1992, Choobineh *et al.* 2006, Leff *et al.* 2008, Korompeli *et al.* 2009). In addition, one researcher found that nurses had significantly more sleep difficulties when they rotated than did permanent night shift nurses (Barton 1994).

Health and well-being—Some of these researchers ($n = 7$) also examined health outcomes including well-being (Peterson 1985, Ruggiero 2003, Costa *et al.* 2004, Geiger-Brown *et al.* 2004, Horwitz & McCall 2004, Newey & Hood 2004, Barnes-Farrell *et al.* 2008). These groups found important associations between night work and lower well-being. Specifically, Ruggiero (2003) found that permanent night nurses had significantly more depression than day nurses. In addition, in 539 nursing assistants, researchers found that assistants who rotated to work at night were more likely to meet the criteria for a depressive disorder (Geiger-Brown *et al.* 2004). In addition, researchers found that more company-flexibility, (e.g. variability) was associated with decreased health and well-being (Costa *et al.* 2004).

Job satisfaction—Job satisfaction was also examined in six studies with mixed results (Peterson 1985, Jamal & Baba 1992, Barton 1994, Choobineh *et al.* 2006, West *et al.* 2007, Korompeli *et al.* 2009). For example, one researcher found that the shift on which a nurse usually worked was not associated with poor outcomes (i.e. tension or job dissatisfaction) (Peterson 1985). Korompeli *et al.* (2009) did find an association between night work and poor job satisfaction; however, only 32 nurses were studied. Barton (1994) reported that permanent night nurses preferred to work at night rather than rotating to work at night. Camerino *et al.* (2008) found that work schedule did not significantly predict changes in work ability. However, these researchers found that sleep, satisfaction and rewards were significantly lower in rotating nurses as compared to day workers and even permanent night nurses (Camerino *et al.* 2008).

Errors—Three groups examined clinical errors as an employee outcome (Gold *et al.* 1992, Admi *et al.* 2008, Leff *et al.* 2008). Two of the three teams found statistically significant associations between employees who worked nights and rotated and the error rate (Gold *et al.* 1992, Leff *et al.* 2008). For example, Leff *et al.* (2008) found that residents who rotated took significantly longer ($P = 0.002$) and made more errors ($P = 0.025$) on a surgical simulator task following their first night shift compared with their pre-nights baseline performance. In addition, Gold *et al.* (1992) found that nurses who rotated were almost two times more likely to report an accident and/or errors compared to nurses who worked day and/or evenings (OR 1.97, 95% CI 1.07–3.63).

Qualitative method studies

Four groups of researchers used qualitative methods to understand off-shift nursing work (Campbell *et al.* 2008, Hamilton *et al.* 2007, Nilsson *et al.* 2008, Nasrabadi *et al.* 2009). In these studies, the research questions were clear and qualitative methodology was appropriate. These researchers inductively examined nurses' perceptions about quality outcomes (e.g. neonatal mortality) and employee outcomes (e.g. fatigue). Different qualitative data collection methods were used including open-ended interviews, semi-structured interviews and focus groups. The purposeful sampling procedures were clearly described in all studies. Three groups of researchers explored nurses' perceptions of working at night (Campbell *et al.* 2008, Nilsson *et al.* 2008, Nasrabadi *et al.* 2009). The other group's

aim was to identify differences between weekend and weekday nurse work environments in the labour and delivery department (Hamilton *et al.* 2007). In all these studies, how the researchers collected and qualitatively analysed their data was appropriate to address their research questions.

In two studies, decreased staffing themes on off-shifts emerged. Nilsson *et al.* (2008) found that night work assignments were similar to those in the daytime, but are carried out by fewer staff. Hamilton *et al.* (2007) found that the reduced number of clinicians, supervisors and patients made it possible to give better care, although others felt there were lapses in patient safety. The other two studies found that there were learning situations at night; in addition, night nurses sometimes demonstrated more independent thinking due to decreased resources available (Campbell *et al.* 2008, Nasrabadi *et al.* 2009). These interpretations were supported by sufficient evidence that the researchers analysed.

Discussion

Hospitals will always function 24-hour-a-day, 7-day-a week. Therefore, it is important to understand if in the current organization of the healthcare system off-shifts are associated with poor patient and employee outcomes. To our knowledge, this is the first systematic review examining relationships between off-shifts and outcomes. In an attempt to be comprehensive, studies were not excluded based on design. Although the findings were mixed, weekends were associated with poor quality outcomes even among diverse patient populations. At night, there was minimal evidence that quality outcomes suffered, except in the labour and delivery room. When nights and weekends were analysed together, the evidence was also mixed. Since weekends were associated with poor patient outcomes, it is possible that grouping nights and weekends together may mask the negative effect of the weekend.

In the employee outcomes studies, there was statistically significant evidence that providers who work at night and rotate to work at night were more likely to have poor outcomes (e.g. fatigue, decreased mental well-being and job dissatisfaction). However, from this review, it cannot be determined if those poor employee outcomes impacted quality care. There were only three studies that evaluated errors in addition to employee outcomes and the results from those studies were mixed.

Some of the studies in this review are publications based on work of the Working Time Society (2011). This Society is committed to improving, health, safety and well-being of shift workers in Europe and around the world and researchers in this Society have published work about both short and long-term health effects of shift workers (<http://www.work-ingtime.org>). Some studies that were included in this review include work from journals such as Applied Ergonomics, Chronobiology International and Occupational Medicine. These studies demonstrate the interdisciplinary interest in further understanding shift work and employee outcomes.

Limitations and strengths of the evidence

Employee outcome studies had generally smaller sample sizes than the quality outcome studies and researchers often used cross-sectional designs based on self-report. An employee may not report fatigue if she/he has adapted to and chose to work at night. Having control over one's schedule may contribute to why researchers found higher rates of fatigue, but did not find any differences in attitude or job satisfaction at night as compared to during the day (West *et al.* 2007).

The majority of the studies examining quality outcomes were longitudinal, which is a stronger research design than the cross-sectional studies. However, there were also weaknesses in the investigations studying patient outcomes. For example, the researchers often used administrative databases, which have inherent limitations. First, although the majority of researchers implemented quality control measures for data abstraction, there may have been errors in this process and/or the data may be incorrectly coded in the database. In addition, using existing databases for analysis, there may be unmeasured confounders.

Another limitation of the quality outcome studies is that researchers only studied the relationship between time of admission/discharge and mortality. Admission and discharge time may be the easiest to operationalize in large databases. However, this does not inform the processes of care. Researchers often acknowledged this limitation and commented that staffing levels or decreased resources on off-shifts may impact quality care. A comprehensive examination staffing and characteristics of the off-shift staff compared to regular hours may further assist in understanding quality on off-shifts.

Patient mortality was the most common quality outcome studied. This is not surprising since mortality is clearly important and easily identified in the datasets. It is also a common measure of quality care and has been endorsed by the National Quality Forum (2004). Patient length of stay in the hospital was also infrequently examined. In only five studies identified rates of procedures and complications on the off-shifts were examined. This was surprising given the increased international interest in patient safety and nursing sensitive outcomes (Clarke & Aiken 2008, Chaboyer *et al.* 2010). We encourage future researchers to study these other important quality outcomes.

Although the majority of studies that compared quality of care provided on weekends to mid-week found outcomes to be less desirable on the weekends, the overall results of off-shifts and quality outcomes were mixed. An explanation may be from the diversity of patient populations. Although known confounders were often controlled for, underlying patient differences may have contributed to the mixed results. Also, many studies where researchers did not find an association between off-shifts and quality outcomes occurred in a single institution. In these single site studies, a hospital may have similar staffing and/or education level of healthcare providers and/or continuous on-site coverage by qualified intensivists on both regular and off-shifts or sample sizes and a lack of statistical power may have contributed to the lack of differences. Overall, multi-site studies were stronger in design and increased the generalizability of results.

There was inconsistency on how off-shifts were defined and how researchers analysed the off-shifts. Some researchers who studied both nights and weekends, conducted their analyses together, as opposed to performing separate analyses of nights and separate analyses of weekends. Again, this posed challenges when synthesizing the results.

Limitations and strengths of the review

There are strengths and limitations to this review. The search was conducted over several months and although every effort was made to be comprehensive, it is still possible that some studies were missed. Publication bias may be present; however, we did find studies that found no differences diminishing our concern about this potential bias. Only studies published in English were included in the review. Study appraisal was conducted using a well developed instrument; however, due to the inconsistencies of definitions, study designs and outcomes there was no meta-analysis conducted. Finally, due to the volume of studies included in the review, quality appraisal was conducted by the first author and supervised by the senior authors.

Conclusion

The overall conclusion of this systematic review is that a slight majority of the researchers found that off-shifts may be associated with poor patient and employee outcomes. Specifically, patients admitted to hospitals on weekends are more likely to die and not receive necessary procedures. There was a small effect for patients admitted at night. Specifically, babies who were born at night were more likely to die. Employees who work at night are more likely to suffer from fatigue as compared with employees who work during the day. Furthermore, when employees rotate to cover night shifts, they are also more likely to suffer from fatigue. However, there is minimal evidence that poor employee outcomes may negatively impact quality care. Differences in the evidence exist between nights and weekends, future research should examine these types of off-shifts more closely.

Nursing implications

It is unclear why patient outcomes are worse on off-shifts, specifically on weekends, than during normal day hours. Decreased resources and staffing on off-shifts may impact patient outcomes; however, there is lack of research examining these associations. Future research should also include studying the off-shift workforce, which may differ from the day workforce and the impact on patient outcomes. The nursing work at night may differ than during the day. In addition, training and continuing education programmes may only be offered to nurses during the day limiting the ability for permanent night nurses to further their clinical education; for example, night nurses may not be able to attend clinical educational programmes that are offered during the day due to conflict with other responsibilities (Stewart *et al.* 2010). Without access to continuing education programmes, the night nursing workforce may be less adept at detecting changes in patient's conditions which may result in worse patient outcomes. Therefore, there is a need to increase educational opportunities for permanent night nurses.

Rotating nurses to ensure adequate clinical skills does not seem sensible given that there is little evidence suggesting poor quality of care on these shifts. Furthermore, there is evidence supporting the notion that nurses who work at night and rotate to work at night have worse physical and mental ailments than nurses who work during the day. If possible, nurse administrators should limit the shift rotation of employees and encourage night employees to self-schedule to provide for consistency. Self-scheduling may decrease stress and improve the well-being and job satisfaction of night nurses. It may also behoove administrators to determine which nurses are willing and prefer working at night rather than requiring nurses to take a night position.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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What is already known about this topic

- Hospitals often have decreased resources available at night and during the weekend as compared to during the day.
- Healthcare providers deliver 24-hour, 7-day-a-week care requiring some providers to work at night and on weekends.
- To ensure sufficient coverage for patients, some providers who often work during the day are required to rotate to work at night.

What this paper adds

- The majority of the articles reviewed were longitudinal studies that examined patient mortality (22 studies). Specifically, patients admitted to hospitals on weekends were more likely to die than patients admitted during the week.
- Other longitudinal studies included in this review examined time of birth and neonatal mortality (eight studies). A majority of those studies found that babies who were born at night were more likely to die than babies born during the day.
- There were 19 studies that examined healthcare provider outcomes. The majority of these studies used cross-sectional designs and found that night providers and those that rotated to work at night suffered from more fatigue, more sleep disturbances and less well-being than providers who worked during the day.

Implications for practice and/or policy

- Decreased resources on nights and weekends may impact patient safety, however, there is lack of research examining why these associations occur. Future research should include studying the off-shift nursing workforce which may differ from the day workforce.
- There should be increased education and training opportunities available for permanent night nurses to further their clinical education.
- Administrators should consider minimizing the rotation of day nurses to work at nights and encourage night nurses to self-schedule to decrease fatigue, sleep disturbances and improve well-being.

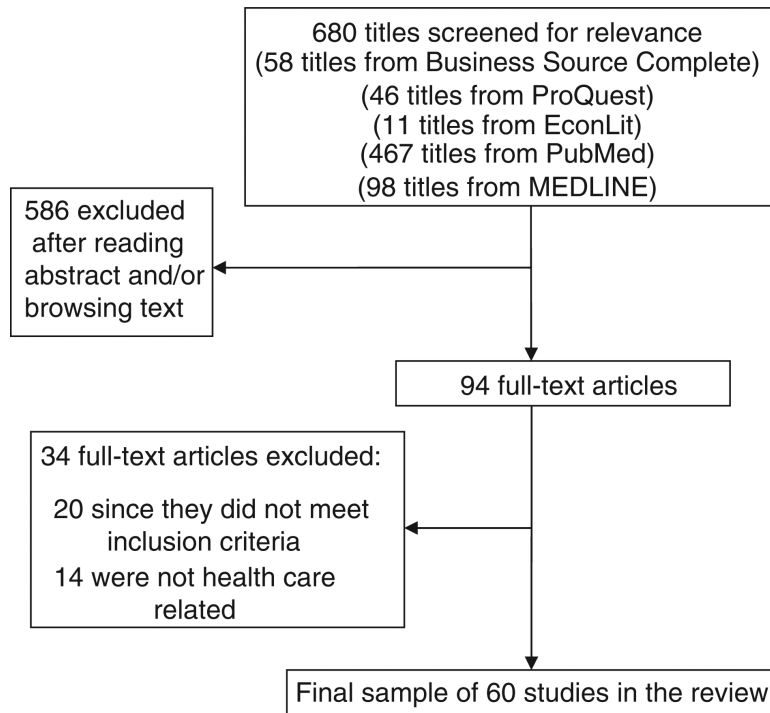


Figure 1.
Flow chart of study selection process.

Table 1

Studies examining time of admission and/or discharge and patient outcomes.

Author(s) & year, definition of off-shift	Setting, multisite (no. sites), patient sample size	Outcome(s)	Poor quality outcomes
Nights			
Pilcher <i>et al.</i> (2007) 'After hours' 1800–0559	ICUs, Y (40), 84,928	Mortality and ICU readmission rate	Y
Morales <i>et al.</i> (2003) Night: 1701–0659	Single ICU, N, 6,034	Mortality, ICU LOS	N
Weekends			
James <i>et al.</i> (2010) * Sat and Sun	Non-federal hospitals, Y (~1000), 214,962	Mortality for acute kidney injury patients	Y
Schilling <i>et al.</i> (2010) * Sat and Sun	Hospitals, Y (39), 166,920	Mortality	Y
Saposnik <i>et al.</i> (2007) 0000 Sat–2259 Sun	Morbidity Database, Y (606) 26,676	7-day mortality from stroke	Y
Kostis <i>et al.</i> (2007) Sat and Sun	MI Data System, Y (all New Jersey hospitals), 231,164	30-day mortality from myocardial infarction, LOS, use of invasive cardiac procedures	Y
Barba <i>et al.</i> (2006) 0000 Sat–2259 Sun	Acute hospitals, N, 359,993	Mortality (within 48 hours)	Y
Cram <i>et al.</i> (2004) † 0000 Sat–2259 Sun	Acute hospitals, Y (all California hospitals) 641,860	Mortality	Y
Ensminger <i>et al.</i> (2004) 1700 Fri–0700 Mon	ICUs, Y (2), 29,084	Mortality	Mixed
Barnett <i>et al.</i> (2002) 0001 Sat–0001 Mon	ICUs, Y (28), 156,136	Mortality, ICU LOS	Y
Bell and Redelmeier (2001) 0001 Sat–0001 Mon	Acute care hospitals, Y (all Ontario hospitals), 3,789,917	Mortality	Y
Nights and weekends			
Carr <i>et al.</i> (2011) ‡ Weekdays: 0900–1759 Mon–Fri Weeknights: 1800–0859 Mon–Fri Weekends: 1800 Fri–0859 Mon	Trauma facilities, Y (32), 90,461	Mortality and secondary outcomes ICU LOS, hospital LOS and a delay longer than 2 hours to treatment by laparotomy or craniotomy	N
Laupland (2010) ‡ 'After hours' Sat Sun daily 1800–0759 'Regular hours' 0800–1759 Mon–Fri	Acute care hospitals, Y (4), 7722	Mortality for community onset bloodstream infections patients	N
Taira <i>et al.</i> (2009) ‡ 'Off-hours' 1800–0600	Trauma facilities, Y (700) 25, 572	Mortality and LOS for burn patients	N
Laupland <i>et al.</i> (2008) ‡ Night: 1800–0559 Weekend: 0001–Sat 2259 Sun	ICUs, Y (4), 20,446	Mortality	Mixed
Sheu <i>et al.</i> (2007) ‡ 'Non-office hours' 1800–0800 on weekday and all times on weekends	Single ICU, N, 611	Mortality, LOS, ventilator-free days	N
Luyt <i>et al.</i> (2007) ‡ 'Off-hours' 1830 to 0829, Weekend: 1300 Sat–0829, Mon, holidays: 0830–0829	ICUS, Y (23), 51,643	Mortality	N
Abdel-Latif <i>et al.</i> (2006) 'After hours' and holidays 1801–0759	Neonatal ICUs, Y (10), 8654	Mortality within 7 days & major morbidity of infants < 32 weeks	N
Arabi <i>et al.</i> (2006) ‡ Night: 1800 Sat 0759–Tues Weekend: 1800 Wed–0759 Sat	Single ICU, N, 2093	Mortality, ICU LOS, ventilator-free days	N
Hixson <i>et al.</i> (2005) ‡ Eve: 1900–0700 Weekend: Sat and Sun	Single Paediatric ICU, N, 5968	Mortality	N

Author(s) & year, definition of off-shift	Setting, multisite (no. sites), patient sample size	Outcome(s)	Poor quality outcomes
Wunsch <i>et al.</i> (2004) [§] Eve: 1800–2359, Night: 0000–0759 Weekend: Sat and Sun	ICUs, Y (102), 56,250	Mortality	Mixed
Uusaro <i>et al.</i> (2003) [‡] 'Out of office hours' 1601–0759 Weekend: 1600 Fri–2359 Sun	ICUs, Y (18), 23,134	Mortality	Mixed

Y, yes; N, no; ICU, intensive care unit; LOS, length of stay; MI, myocardial infarction.

* Study also examined nurse staffing, seasonal influenza and hospital occupancy.

† Study also examined hospital teaching status.

‡ Analysed nights and weekends together.

§ Analysed nights and weekends separately.

Table 2

Studies examining the association between time of birth on patient outcomes.

Author(s) and year, definition of off-shift	Multisite (no. sites), patient sample size	Outcome(s)	Poor quality outcomes
Nights			
Caughey <i>et al.</i> (2008), Evening: 1800–0001, Night: 0001–0700	N, 34,046	Mortality and Apgar scores	N
Badr <i>et al.</i> (2007), Night: 2300–0700	Y (4), 5152	Mortality, asphyxia, neonatal morbidity	Y
Urato <i>et al.</i> (2006), Night: 2301–0759	Registry, 80 cases, 999 controls	Mortality	Y
Gould <i>et al.</i> (2005), Early night: 1900–0059 Late night: 0100–0659	Registry, 3,363,157	Mortality	Y
Luo and Karlberg (2001), Night: 2100–0700	Registry, 2,102,324	Mortality	Y
Stewart <i>et al.</i> (1998), Night: 2100–0859	Registry, 1015	Mortality	Y
Nights and weekends			
Bell <i>et al.</i> (2010) *, Early night: 1701–2259, Late night: 0000–0759 Weekend: Sat and Sun	Registry, 11,137	Mortality within 7 and 28 days, short-term morbidity and neurodevelopmental outcomes of low birth weight infants	N
Stephansson <i>et al.</i> (2003) *, Night: 2000–0759, Weekend: Sat and Sun	Registry, 694,888	Mortality	Y

Y, yes; N, no.

* Analysed nights and weekends separately.

Table 3

Studies examining time of procedures and patient complications on off-shifts.

Author(s) & year, definition of off-shift	Multisite (no. sites) Patient Sample Size	Outcome(s)	Poor quality outcomes
Uyarel <i>et al.</i> (2009), Night: 1800–0800	N, 2,644	Angioplasty outcomes, cardiovascular mortality, LOS	N
Peberdy <i>et al.</i> (2008) [*] , Night: 2200–0659 Weekend: 2200 Fri–0659 Mon	Y (507), 86,748	Survival from in-hospital cardiac arrest	Y
Becker (2007), Weekend: Sat and Sun	Registry, 922,074	Angioplasty, cardiac catheterization, bypass rates, mortality	Y
Bendavid <i>et al.</i> (2007), Weekend: Sat and Sun	Registry, 4,967,114	Complications, birth trauma	Y
Sadeghi <i>et al.</i> (2004) [†] , 'Off-peak hours' 2000–0800	Y (76), 1047	Treatment delays, thrombolysis, mortality	N

Y, yes; N, no; LOS, length of stay.

^{*} Analysed nights and weekends separately and together.

[†] Analysed nights and weekends together.

Table 4

Studies examining off-shifts and healthcare employee outcomes.

Author(s) and year	Sample, sample size, multisite (no. sites)	Outcome(s)	Poor employee outcomes
Nights			
Barnes-Farrell <i>et al.</i> (2008)	Healthcare workers, 1014, Y [*]	Work-family conflict, physical and mental well-being	Y
West <i>et al.</i> (2007)	Nurses, 150, N	Chronic fatigue, sleep disturbances, social and domestic stressors, job dissatisfaction, burnout	Mixed
Arora <i>et al.</i> (2006)	Medical Residents, 38, N	Fatigue, on-call sleep, post-call fatigue	Y
Newey and Hood (2004)	Nurses and their partners, 59, Y (2)	Fatigue, health, stress, social factors	Mixed
Horwitz and McCall (2004)	Healthcare workers, 7717, Registry	Injury	Y
Ruggiero (2003)	Nurses, 142, Y [†]	Chronic fatigue, sleep quality, depression, anxiety	Y
Peterson (1985)	Nurses, 272, Y (30)	Physician/nurse relations, role integration, group tension, job dissatisfaction	N
Nights with rotation			
Burch <i>et al.</i> (2009)	Healthcare workers, 376, N	Sleep characteristics, attitude, health symptoms, coping strategies, social and lifestyle factors	Mixed
Korompeli <i>et al.</i> (2009)	Nurses, 32, N	Sleep, health, coping, circadian type, job satisfaction, anxiety, personality inventory, social and domestic factors	Y
Admi <i>et al.</i> (2008)	Nurses, 739, N	Sleep disorders, medical issues, clinical errors, adverse events	N
Camerino <i>et al.</i> (2008)	Nurses, 7516, Y [‡]	Work ability, sleep and satisfaction	Mixed
Leff <i>et al.</i> (2008)	Medical Residents, 21, N	Sleep, surgical skill performance, clinical errors	Y
Samaha <i>et al.</i> (2007)	Nurses, 121, Y (3)	Fatigue, anxiety, mood	Mixed
Choobineh <i>et al.</i> (2006)	Healthcare workers, 432, Y(12)	Insomnia, hypnotic drug use, adverse effects on own, family and social life, health, job satisfaction	Y
Costa <i>et al.</i> (2004)	Healthcare workers, 21,505, Y [§]	Health and well-being from flexible working hours	Y
Geiger-Brown <i>et al.</i> (2004)	Nursing assistants, 539, Y (49)	Depression	Y
Barton (1994)	Nurses, 587, Y (28)	Fatigue, sleep disturbances, health anxiety, job satisfaction, social, domestic, non-domestic disruption	N
Jamal and Baba (1992)	Nurses, 585, Y (8)	Role ambiguity, role overload, job stress and satisfaction, organizational commitment, social support, turnover intention, commitment to nursing	Y
Gold <i>et al.</i> (1992)	Nurses, 635, N	Fatigue, sleep quality, medications and alcohol for sleep, medication errors, medication near misses, car accidents	Y

All study designs were cross-sectional except for Arora, Horwitz & McCall and Leff.

Y, yes; N, no.

* Convenience sample of healthcare workers from four countries; USA, Australia, Croatia and Brazil.

† Random sample of 68,000 members of the American Association of Critical Care Nurses.

[‡]Nurses worked in state-owned and private hospitals in Belgium, Germany, France, Italy, the Netherlands, Poland and Slovakia.

[§]Workers representing 15 European countries as part of the Third European Union Survey on Working Conditions.