ORIGINAL ARTICLE

A Study of Weekend and Off-hour Effect on Mortality in a Public Hospital in Malaysia

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SUMMARY

Introduction: Several studies have found higher in-hospital mortality for admissions during weekend or off hours, known as "weekend or off-hour effect". However, data for this on Malaysian populations is limited. This study was conducted to analyze the 3-year mortality trend in a secondary hospital and its relation to time and date of admission.

Methods: The clinical data of 126,627 patients admitted to Taiping Hospital from 1st January 2008 to 31st December 2010 obtained via patient registry database of hospital was analyzed. This study compared mortality during weekdays with weekends, office hours (0800-1700) with off hours (1701-0759), and subanalysis of office hours with evening (1701-2259) or night hours (2300-0759), adjusted for age and gender.

Results: Although the overall staff-to-patient ratio is improving, analyses showed a statistically significant increased risk of mortality for those patients admitted during weekends (OR = 1.22; 95% confidence interval [CI] = 1.14-1.31) or off hours in a weekday (OR = 1.67; 95% CI = 1.57-1.78). In the comparison between time of admission, there was statistically significant increased risk of mortality for admissions during evening hours (OR = 1.44; 95% CI = 1.28-1.62) and night hours (OR = 1.92; 95% CI = 1.71-2.16). Diseases of cardiovascular and respiratory system remained the top two causes of death over the three years.

Conclusion: The risk of mortality is significantly higher as a result of "weekend or off-hour effect". Recognition and intervention addressing these issues will have important implications for the healthcare system setting, hospital staffing and training, quality and timeliness of medical care delivery.

KEY WORDS:
Mortality, Weekends, Off hours, Weekend effect

INTRODUCTION

Off-hour and weekend admission may pose a higher risk for patients. Bell and Redelmeier were among the first to find higher in-hospital mortality rate for patients admitted on weekends for a selective group of conditions in Canada [1]. Barba R *et al* in their study of Spanish hospital data revealed that the mortality risk within the first 48 hours is significantly higher for weekend admissions [2]. This phenomenon is known as the "weekend effect"[1-5]. Similar studies done for intensive care unit admissions [6-7], various specific medical and surgical conditions such as stroke [8-9], cardio-respiratory diseases [10-15], gastrointestinal bleeding [16-18], acute kidney injury[19] and infectious disease[20] have concluded similar results, and this phenomenon is shown to be prevalent in many countries over different continents. In a recent large multicentre United Kingdom study, it was found that the weekend effect has possibly caused an excess of death more than road accident mortality in the same year [21]. It appears that the management and expected outcome of patients admitted during off hours or weekends may be compromised due to the lower level of staffing in the hospital, lack of supervision or inconsistency in quality of care [1-3]. Some studies have also attributed this adverse effect to higher complication rate [22], restricted service availability or procedures over weekends and off hours [3,6,23].

There is paucity of data pertaining to "weekend or off-hour effect" and overall in-patient mortality in the Malaysian population. We sought to determine if this effect is prevalent in our local setting, by analyzing the three-year mortality rate in our hospital and its relation to time and date of admission. In view of increasing geriatric population (defined as 65 years and above) in the nation [24], we also specifically looked at the mortality rate and causes of death of this subgroup.

MATERIALS AND METHODS

We retrospectively identified every admission from 1st January 2008 to 31st December 2010 via the patient registry database of Taiping Hospital, which is the second largest hospital in the state of Perak, Malaysia. It is a 608-bedded secondary care hospital with ten specialty departments. The data set contains detailed administrative data regarding all admissions during this period. Data of hospital staff number was obtained from hospital Human Resource Unit.

The weekend was defined as the period from midnight on Friday to midnight on Sunday, including national and state public holiday. All other days are defined as weekday. For analyses of time of admission, we aggregated blocks of time into office hours and off hours. Office hours were defined as the period from 0800 to 1700 in a weekday. Off hours (1701 to 0759) was further divided to evening (1701 to 2259) and

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night (2300 to 0759) hours. In the comparison between time of admission, weekends were excluded as the hospital setting is similar in office and off hours, with regard to level of staffing and service availability. All causes of hospital mortality were classified using International Classification of Diseases (ICD), tenth revision codes [25].

The study was approved by the National Institute of Health (NIH) and Medical Research Ethic Committee (MREC) of Malaysia.

Statistical Analysis
Statistical analyses were conducted using SPSS (Version 17.0). Binary logistic regression analysis was used to assess the independent effects of day (weekdays versus weekends) and time of admission (office hours versus off hours, office hours versus evening hours or night hours) to hospital mortality. To assess for statistical significance, both unadjusted and adjusted odds ratio (OR) to age and gender were calculated, with the corresponding 95% confidence interval (CI). P value is taken as statistically significant when it is <0.05.

RESULTS

Of the 126,627 hospitalizations over the three years, weekend admissions account for 27%. In weekdays, off-hour admissions account for 41% of total admissions. Female and geriatric group mortality rate is increasing, with mean age of geriatric mortality as shown in Table I. Diseases of the circulatory and respiratory system, classified in ICD-10 categories, are the top two common causes of mortality and remain consistent over the three years (Table II).

Overall, higher mortality rates were observed in those patients admitted during weekends or off hours (Table III). After adjusted for age and gender, analyses showed a statistically significant increased risk of mortality for those patients admitted during weekends (OR = 1.22; 95% confidence interval [CI] = 1.14-1.31) or off hours in a weekday (OR = 1.67; 95% CI = 1.57-1.78). In the comparison between time of admission, there was statistically significant increased risk of mortality for admissions during evening hours (OR = 1.44; 95% CI = 1.28-1.62) and night hours (OR = 1.92; 95% CI = 1.71-2.16). The core clinical staff number has increased over three years, with improving staff-to-patient ratio (Table I).

DISCUSSION

Our analysis supported the presence of "weekend or off-hour effect" in our local setting, and this finding is consistent with the oversea studies. The increase in mortality persisted after being adjusted for age and gender, in a consistent pattern over three years. An overall excess of 22% in weekend mortality means that 918 patients died as a result of the "weekend effect" over the three years. The off-hour effect was pronounced – a 67% greater risk of dying than patients who were admitted during off hours, and up to 1.92 times higher risk if admitted during night hours in a weekday.

Our data revealed an increasing trend in overall mortality rate, this applies to female as well as geriatric population. The top two causes of mortality – diseases of the circulatory and respiratory systems are similar in both general and geriatric population, which are in keeping with our national health facts data of the same years [24, 26-27]. Despite the improvement of staff-to-patient ratio, there was however no corresponding expected reduction observed in the mortality rate.

These results inevitably raised a question: Is there a discrepancy in quality of care between office hours and off hours, or between weekdays and weekends? Patients come to hospital anytime in a day, and they expect the same standard of care, regardless of the time and day they are admitted. It is imperative that the following issues should be addressed and prioritized.

The first is staffing. It is known that lower level of staffing throughout all hospital services over weekends and off hours, along with less supervision, results in service deficiency, delays in diagnostic services, and staff fatigue due to relatively higher workload [1-3,28]. During these period, hospital wards are covered by less staff scheduled to be on duty. Moreover, those who work on weekends often have less seniority and experience than those who work on weekdays[1,5]. Coverage of wards by weekend staffs that are less familiar with the patients was also shown to be strongly associated with potentially preventable adverse events [29]. Many or all of these issues may be relevant here. However, in our study, despite better staff-to-patient ratio over three-year period, it did not translate to a lower mortality rate. We can only postulate that there are other factors which may influence mortality rate beside number of staff. The quality, experience, distribution of staff in different units and among shifts may play an important role in reducing mortality. Higher rates of suboptimal management and non-adherence to protocols were also observed during the weekends [30]. L Schmulewitz et al. found that consistent staffing levels and the apparent equality of care between weekends and weekdays facilitates optimization of patient outcomes, in terms of in-hospital mortality, length of stay and rate of readmission [5]. Nevertheless, it was also found that the level of staffing is not a complete measure of the quality of patient care, as skills and education of registered nurses are also sensitive contributing factors to it [31].

The next concern is the effect of long working hours and sleep deprivation. In our hospital, a call duty starts from 0800 to 0800 the next day. Overall sleep deprivation strongly impairs human functioning. It has detrimental effects on mood, cognition, motor performance and decision making [32-34]. Previous studies have also emphasized the negative role of fatigue in physicians' performances [35], inappropriate antibiotic therapy[36] and prescribing errors [37]. The adverse effect of circadian biorhythm disruption on human performance during the night shift is a known factor [38]. It was also shown that the survival rates from in-hospital cardiac arrest are lower during night hour [39]. These factors probably explained the risk of mortality of patients admitted during night hours were the highest that we observed in our study.

Interestingly, Khanna R et al. in his recent study, found that the adverse weekend and off-hour outcome was not present in a tertiary care hospital with the following factors: a general medicine service staffed during night by in-house

Table I: Mortality rate and staff-to-patient ratios in three consecutive years from 2008 to 2010.
SD – Standard deviation

Year	2008	2009	2010
Total admission	44,428	41,043	41,156
Total mortality (Mortality rate, %)	1,320 (2.97)	1,436 (3.50)	1,419 (3.44)
Male mortality (Mortality rate, %)	828 (1.86)	864 (2.10)	844 (2.05)
Female mortality (Mortality rate, %)	492 (1.10)	572 (1.39)	575 (1.40)
Geriatric mortality (Mortality rate, %)	565 (1.27)	638 (1.55)	654 (1.59)
Mean age of geriatric mortality, years (SD)	74 (8)	74 (9)	75 (7)
Specialist number	35	44	50
Medical and House officer number	192	263	258
Staff nurse number	470	503	665
Total Staff number	697	810	973
Staff-to-patient ratio	1:63.7	1:50.7	1:42.3

Table II: Three most common causes of mortality in general and geriatric population.

	General population		Geriatric population	
Year	Disease Classification	%	Disease Classification	%
2008	Diseases of the circulatory system	34.24	Diseases of the circulatory system	45.66
	Diseases of the respiratory system	20.68	Diseases of the respiratory system	21.59
	Neoplasms	9.10	Diseases of the digestive system	8.67
2009	Diseases of the circulatory system	30.71	Diseases of the circulatory system	40.75
	Diseases of the respiratory system	25.56	Diseases of the respiratory system	29.94
	Diseases of the digestive system	9.61	Diseases of the digestive system	10.34
2010	Diseases of the circulatory system	29.32	Diseases of the circulatory system	37.46
	Diseases of the respiratory system	27.84	Diseases of the respiratory system	31.65
	Neoplasms	9.58	Neoplasms	9.17

Table III: In-hospital Mortality According to the Day and Time of Admission.
***Adjustment was made for age and gender.**

Year	Day or Time of admission	Patient number	Mortality	Mortality rate (%)	Unadjusted odds ratio	Adjusted odds ratio*	95% confidence interval	p-value
2008	Weekends	11,695	414	3.52	1.29	1.30	1.15-1.47	<0.001
	Weekdays	32,733	906	2.77				
	Off hours	12,175	473	3.89	1.87	1.90	1.70-2.13	<0.001
	Office hours	20,558	433	2.13				
	Evening hours	6,580	240	3.65	1.69	1.66	1.45-1.90	<0.001
	Night hours	5,595	233	4.18	2.07	2.21	1.93-2.53	<0.001
2009	Weekends	11,112	440	4.00	1.20	1.23	1.09-1.38	<0.001
	Weekdays	29,931	996	3.31				
	Off hours	12,772	513	4.02	1.48	1.52	1.36-1.69	<0.001
	Office hours	17,159	483	2.82				
	Evening hours	7,317	290	3.96	1.47	1.47	1.30-1.67	<0.001
	Night hours	5,455	223	4.09	1.49	1.59	1.39-1.82	<0.001
2010	Weekends	11,188	423	3.54	1.14	1.14	1.02-1.29	<0.05
	Weekdays	29,968	996	3.41				
	Off hours	12,852	531	4.13	1.54	1.60	1.44-1.79	<0.001
	Office hours	17,116	465	2.72				
	Evening hours	7,350	300	4.08	1.49	1.52	1.34-1.73	<0.001
	Night hours	5,502	231	4.20	1.60	1.72	1.50-1.96	<0.001
Overall	Weekends	34,012	1,277	3.68	1.21	1.22	1.14-1.31	<0.001
	Weekdays	92,615	2,898	3.15				
	Off hours	37,793	1,517	4.02	1.62	1.67	1.57-1.78	<0.001
	Office hours	54,822	1,381	2.53				
	Evening hours	21,241	830	3.91	1.44	1.44	1.28-1.62	<0.001
	Night hours	16,552	687	4.16	1.76	1.92	1.71-2.16	<0.001

nocturnists and night float residents; equal staffing during weekends; recognized qualified staffs; integrated electronic medical record to facilitate morning hand off; and hospital teams rotating at regular schedules to protect against discontinuity of patient care [40]. We can extrapolate from this finding that "weekend and off-hour effect" can potentially be overcome with dynamic and appropriate measures.

LIMITATION

Our study has a number of limitations. The study was conducted using administrative data, and despite quality control measures, data entry error remains a possibility. This is a single-center study, and we did not risk-adjust all admissions by considering their severity of illnesses or underlying co-morbidities, and it is possible that patients admitted during weekends or off hours had more severe disease than those admitted during weekdays or office hours. Our study did not include deaths declared outside the hospital, which may result in an under- or over-estimation of the magnitude of the weekend effect. Therefore, our findings need confirming in a larger prospective study with odds ratio adjusted to illness severity scores. Nevertheless, several aspects have helped us to strengthen the findings. We had a large sample size and by inclusion of all admissions to hospital, we minimized the risk of selection bias associated with conduct in a single selected group. In contrary to many other studies, we included public and state holidays as weekends in order to obtain more accurate results.

CONCLUSION

Overall mortality rate is significantly higher for patients admitted during weekends or off hours, possibly as a result of the "weekend or off-hour effect", along with contribution by multiple potentially preventable factors. Although working on weekends is unpopular, a match between staff manpower and hospital healthcare needs is necessary to achieve ideal quality and effectiveness of care. However, this remains a challenge to most of the hospitals which are faced with economic constraints and limited resources. Still, we strongly think it should be an important goal for every hospital to deliver optimal and unfragmented care regardless of day and time of the week. Recognition and interventions addressing these issues will have important implications for the health system setting.

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