ORIGINAL ARTICLE

Effect of the full moon on mortality among patients admitted to the intensive care unit

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Abstract

Objective: To determine the lunar effect on mortality among patients admitted to the intensive care unit.

Methods: The retrospective study conducted at Rosalind Franklin University of Medicine and Science, North Chicago, and comprised data of 4387 patients in intensive care unit from December 2002 to November 2004. The subjects were divided into two groups: patients who died on full moon days (the 14th, 15th, and 16th days of the lunar month); and patients who died on the other days of the month. The mortality rates were calculated for patients in both groups. Parameters including patients' age, gender, acute physiology and chronic health evaluation scores, predicted mortality rates, type of intensive care unit, and actual mortality were compared, and non-parametric tests were performed to determine whether there were any differences between the groups.

Results: Of the 4387 patients who were followed for 23 months, 297 patients died, including 31 on full moon days and 266 patients on the other days of the month. Both groups were similar in terms of mean age (73.6 ±14.59 vs. 71.07±16.13 years; p=0.599), acute physiology and chronic health evalutation scores (82.06±24.19 vs. 76.52±27.42; p=0.258), and predicted mortality (0.405±0.249 vs. 0.370±0.268; p=0.305). There was no difference in the frequency of death between the full moon days and the other days (10.33±0.58 vs. 9.8 ±3.46; p=0.845).

Conclusions: The full moon does not affect the mortality of the patients in intensive care unit.

Keywords: Full moon, Mortality, Intensive care unit, Lunar cycle. (JPMA 64: 129; 2014)

Introduction

The effects of the full moon on human behaviour have long fascinated researchers. Numerous beliefs, theories and hypotheses regarding the lunar effect on the human body have been proposed throughout human history. Notions such as the "gravitational pull hypothesis" and the "tidal force hypothesis" have been extensively analysed, but the impact of the moon on the human body via these mechanisms could not be empirically confirmed.[1]

There are considerable disagreements about the lunar effect on the human body and on human behaviour. There is a body of literature claiming to demonstrate a correlation between the full moon and the incidence of psychological crises,[2] suicide,[3] child behavioural disorders,[4] crime,[5] homicide and aggravated assault,[6] accidents and injuries,[7] animal bites,[8] the timing of childbirth,[9] gout attacks,[10] increased emergency room (ER) and hospital admissions due to various causes,[11-13] and increased sudden unexpected death in epilepsy.[14]

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However, many other studies have not supported any correlation between the full moon and increase in suicide rates,[15] crisis calls,[16] violent behaviour and aggression,[17] agitation among nursing home residents,[18] the use of psychiatric community services,[19] psychiatric hospital admissions,[20] or the frequency and volume of admissions to ER.[21] Furthermore, no relationships have been found between the full moon and cardiopulmonary arrests in emergency departments,[22] the incidence of myocardial infarction and sudden cardiac death,[23] the survival time of bladder and breast cancer patients,[24,25] numbers of surgical complications,[26] numbers of patient falls in hospitals,[27] the workload in the labour and delivery ward,[28] and the number of obstetric deliveries.[29]

The intensive care unit (ICU) mortality rate has been studied in relation to the numbers of admissions during weekdays,[30] weekends,[31] the daytime,[32] night shifts,[33] off-hours,[34] and specific months.[35]

However, no study is found on the correlations between the full moon and ICU mortality rates. Therefore, the goal of this study was to determine whether there were any changes in the ICU mortality patterns during the full moon phase of the lunar cycle. In the event that our hypothesis was confirmed, there may be significant implications for ICU practices, e.g., increased efforts to improve the management of the ICU during such

particularly vulnerable times.

Patients and Methods

The retrospective observational study was conducted at Rosalind Franklin University of Medicine and Science, North Chicago, and involved data of patients in ICU from December 2002 to November 2004. It reviewed the de-identified data of the entire adult (≥18 years old) population admitted to two non-university community hospitals (teaching and non-teaching) that were monitored by electronic ICU (eICU) systems during a 23-month observation period. The study was approved by the institutional review board of the Rosalind Franklin University of Medicine and Sciences (RFUMS).

The dates of the synodic lunar months within the study period were identified using the National Aeronautics and Space Administration (NASA) software, SKYCAL (Sky Event Calendar). The following definitions were used. One synodic lunar month is the time required for the moon to travel from one position relative to the sun as observed from the Earth and return to the same position; this period lasts 29.531 days (29 d, 12 h and 44 min). The day counts begin with the new moon at day 0, the full moon is observed between days 14 and 15 and the day counts end before the next new moon, on day 28 or 29.[27] The full moon is the phase of the moon in which it is fully illuminated when observed from the Earth. The full moon is defined as a three-day period in the 29.531-day lunar cycle, with the middle day generally referred to as the day of the full moon.[8] We considered the 14th, 15th, and 16th days of the synodic lunar cycle to be the full moon days.

Data regarding mortality were retrieved, and the patient population was divided into two groups: those who died on full-moon days and those who died on other days of the lunar cycle. The demographic data and Acute Physiology and Chronic Health Evaluation (APACHE) III scores of both groups were available. APACHE III score has been validated for estimation of prognosis in ICU patients.[36] The primary reason for the ICU admission (following either emergency surgery or trauma) and the presence of severe chronic illness were documented according to the original APACHE III definitions.[37]

Hospital mortality was the primary endpoint for all mortality predictions. Furthermore, a second approach was employed to determine if the mortality rates followed a cyclic pattern during the lunar month. The daily numbers of recorded deaths were plotted as a function of the days of the lunar month.

Previously collected, de-identified data were used for the statistical analyses. A power calculation indicated that the actual number of deaths would provide 90% power in demonstrating that a 20% surge in death frequency during the full moon was statistically significant ($\alpha = 0.05$). Thus, the data had sufficient power to detect the effect of the full moon on mortality if such an effect existed.

Continuous variables were expressed as means ± standard deviations and were analysed for normal distribution using Kolmogorov-Smirnov and Saprio-Wilk statistics of normality. Because they were not normal, two-sided non-parametric tests (Mann-Whithney) were employed for statistical analysis The grouping variable was defined by the day of the lunar cycle when the death occurred (full moon versus no full moon). Categorical variables were analysed using a chi-squared test. Furthermore, an analysis of variance (ANOVA) with a Bonferroni post-hoc analysis was performed to evaluate the potential differences between each day of the lunar cycle; each individual day was compared to all the other days (one by one) to determine whether there were any significant differences in the death rates, APACHE III scores, predicted mortality or patient age. A p value of ?0.05 was considered statistically significant.

To evaluate the possibility of a cyclic pattern in mortality, the numbers of deaths were plotted as a function of the days of the lunar month. In the event that a cyclic pattern was observed, cosinor analysis was to be performed by fitting the daily number of deaths to a cosinor function with a standard least-squares analysis. No cyclic pattern was observed; therefore, this analysis had to be omitted.

Results

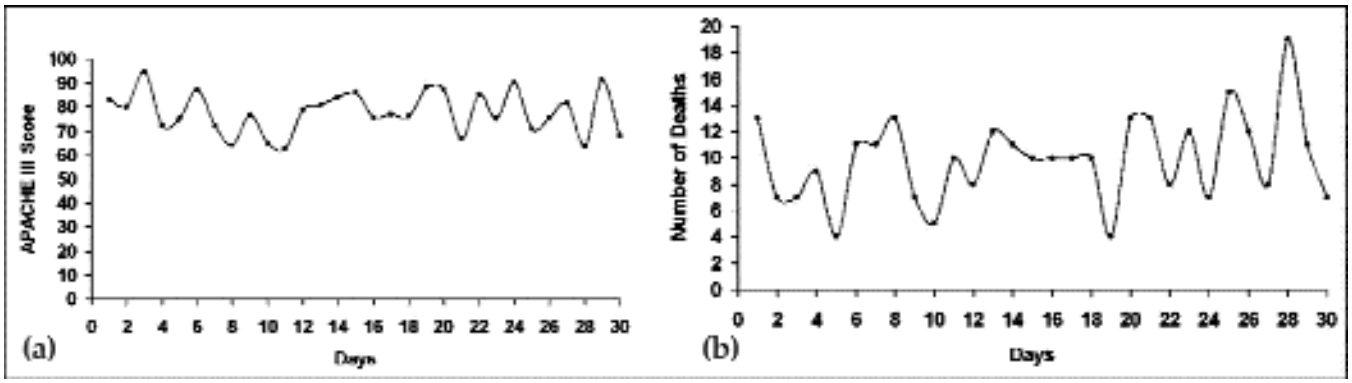
Of the 4387 patients over a period of 23 months, 297 (6.8%) died during their ICU stays, including 31 (0.7%) on full-moon days and 266 (6.1%) on the other days of the month. The mean age of all the patients was 64.68±18.31 years, and the mean APACHE III score was 48.5±22.7.

Both groups of patients, were similar in terms of age, gender composition, APACHE III scores, and predicted mortality calculated by APACHE III scores (Table-1). There was no difference between the groups in terms of the frequency of death (10.33±0.58 vs. 9.85±3.46; p= 0.845).

Table: Patient characteristics.

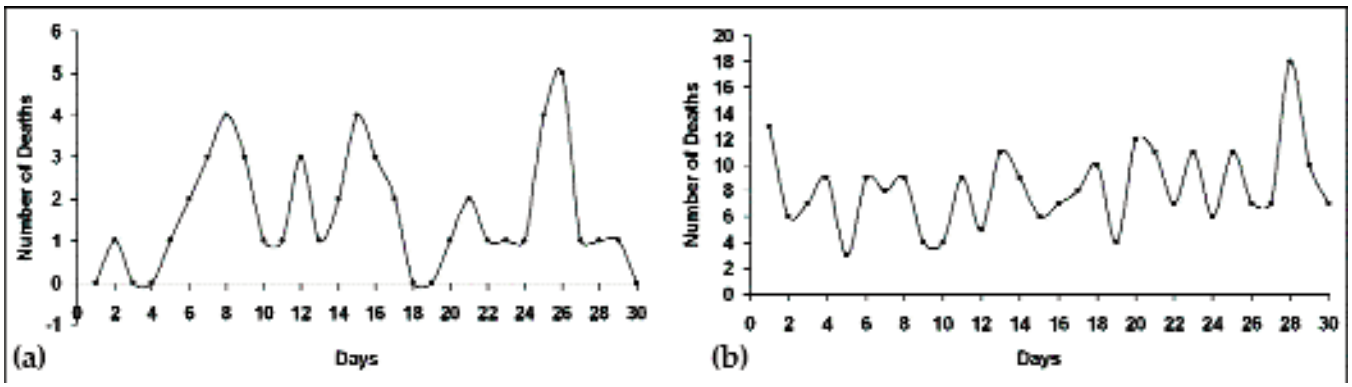
	Full moon	Other than full moon	Pvalue
Age	73.6±14.59	71.07±16.13	0.599
Male/female	15/16	133/133	0.86
APACHE-III scores	82.06±24.19	76.52±27.42	0.258
Predicted mortality	0.405±0.249	0.370±0.268	0.305

APACHE: Acute Physiology and Chronic Health Evaluation.



Acute Physiology and Chronic Health Evaluation.

Figure-1: (a) Distribution of APACHE III Score during the Lunar Month, and (b) Distribution of Deaths during the Lunar Months.



SICU: Surgical Intensive care Unit.

Figure-2: (a) Distribution of Deaths during the Lunar Months SCIU patients only, and (b) Distribution of Deaths during the Lunar Months without SCIU patients.

Sub-group analyses comparing the mortality rates of the two groups at different types of ICUs did not reveal a peak in mortality on full-moon days at any particular type of ICU.

The plot of the APACHE III scores for each day of the lunar month did not reveal any peaks on full-moon days (Figure-1a). The plot of the actual mortality over the course of the lunar month showed an intriguing increase before the new moon (Figure. 1b). The one-way ANOVA that was performed to compare the numbers of deaths that occurred on each day of the month to all the other days of the month did not reveal any trends based on age ($p = 0.74$), APACHE III score ($p = 0.35$) or predicted hospital mortality ($p = 0.20$).

Surprisingly, there was also no significant correlation between APACHE III scores and actual mortality ($r= -0.27$; $p= 0.14$). The daily death frequency did not correlate with the days of the lunar month ($r= 0.32$; $p= 0.08$).

The sub-group analysis of the surgical ICU patient mortality demonstrated no surges on any day of the month (Figure-2a), although the non-surgical patient mortality showed a small surge shortly before the new moon (Figure-2b). Death rate on days 27th, 28th, and 29th versus all other days show rising trends (12.7±5.7 versus 9.6±2.9; $p=0.12$).

Discussion

The presence of a full moon did not correlate with ICU mortality, nor were there any differences in age, gender, expected mortality or APACHE III scores between those who died during the full moon versus those who died on other days.

In general, our findings are similar to those of previous studies that documented no relationships between the full moon and hospital admissions or emergency department visits,[21] the utilisation of psychiatric

services,[19] or violent behaviour.[17] Additionally, a study did not find any effects of the full moon on success of cardiopulmonary resuscitation (CPR) conducted in seven emergency departments over the course of 11 years.[22] Another study also did not detect any effects of the full moon on the incidence of acute myocardial infarction or sudden cardiac death.[23]

Our study showed a trend towards elevated mortality just prior to the new moon in non-surgical ICU patients. One study also reported a trend towards increased mortality among patients with acute coronary syndromes on new-moon days but not full-moon days.[38] An analysis of 1437 cases, discovered a trend in the rate of mortality due to cardiovascular emergencies.[39] The lowest mortality occurred close to the new moon and full-moon phases, whereas the highest mortality was observed during the first and last lunar quarters.

Our data demonstrated an adequate correlation between the APACHE III scores and the predicted mortality. A study showed that APACHE III scores independently predicted hospital mortality.[37]

In terms of limitations, the study design was a non-randomised, retrospective chart review of cases and controls. Therefore, the study lacked the strength of evidence characteristic of a randomised, prospective, controlled trial. We analysed patient data from the ICUs of only two hospitals. Both hospitals utilised ICU backup systems, which could affect the patient care that they provided. There is no reason to believe that there would be any differences in care on full-moon days. Therefore, our results are applicable to broad patient populations. Since we studied adult ICUs, our results are only relevant to adult patients. Moreover, the average age of our subjects was 64 years; caution should be used in applying these results to patients in ICUs that serve older populations. This study was conducted in an open ICU system without a 24-hour in-house intensivist, therefore, our results should only be cautiously applied to closed ICUs. If there was a lunar effect that we did not detect, it should not result in the closure of the ICU because the 24-hour in-house intensivist provides care. There was no data available about the composition of the support staff, the level of their training or the shift system that they utilised, all of which could be confounding factors. We did not analyse data for the day, time, season, or part of the week (weekend vs. weekday) of admission.

However, we believe that these factors did not play a major role in our results because full-moon days occurred on all days of the week during the study period. We believe our data sample was large enough (>4000 patients) to detect any obvious effect of the full moon on ICU mortality. Larger trials are needed to assess the effect of the full moon on the outcomes of critically ill patients.

Conclusion

The full moon did not appear to affect the mortality of patients admitted to the ICU. Factors that are known to affect mortality, including age, gender, and the severity of illness, should instead be the subject of focus.

Disclosure

This paper was presented as a poster in the 32nd ISICEM conference March 2012 in Brussels, Belgium.

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