

# Influence of weekday of surgery on operative complications. An analysis of 25.000 surgical procedures

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## Abstract

**Background:** Surgical procedures need to be performed safely on every day and night of the week. Operations on certain weekdays have recently been shown to be associated with increased risk. Patient concerns about their safety have to be taken seriously when surgery needs to be planned. Many patients also believe in negative effects of lunar constellations or Friday 13<sup>th</sup>. To establish a scientific basis for reassurance, we retrospectively analyzed surgical complications at a maximum care center, addressing these issues.

**Methods:** All surgical procedures and their complications from 2007-2014 were registered in the departmental morbidity registry. Complications resulting in the necessity for reoperations were analyzed and matched with the day of the week of the primary procedure, the day the complication occurred, the lunar cycle and Friday 13<sup>th</sup>.

**Results:** Over 25.000 procedures were performed, resulting in a total of 635 registered surgical complications requiring reoperations. Male and female patients were equally affected. Weekdays of the primary procedure did not show a difference in subsequent complications ( $P = 0.227$ ), but weekdays of revision surgery reached statistical difference of  $P = 0.05$ , with most reoperations taking place on Fridays. No correlation with any lunar constellation or Friday 13<sup>th</sup> could be found,  $P = 0.763$  and  $P = 0.144$ , respectively.

**Discussion:** This retrospective analysis could not show a heightened risk for reoperations due to the primary procedure being performed on certain weekdays. Patients can also be reassured that there is sufficient evidence that lunar cycles do not affect the occurrence of complications and reoperations, nor does Friday 13<sup>th</sup>.

**Conclusion:** This study proves surgical procedures to be being equally safe on any given weekday and any date of the month.

## Introduction

Patient safety is the priority of surgeons, and the number one question of patients having to undergo any surgical procedure is, what risk it entails. This question should be answered as objectively as possible with respect to the department's quality data. But do we need to discuss the perfect day of the week for the surgery now? Recent analyses of possible effectors on mortality could show that the day of the week, on which the procedure was performed, had a significant influence. A study on mortality after nonemergent surgery found an increased rate for procedures performed on fridays versus monday to wednesday [1] another one showed higher mortality rates in patients with elective colorectal resections being performed on fridays versus monday to thursday [2]. Also there is a cultural belief in more than ten percent of the Western European population, that the moon affects health care and is assumed to have a negative effect on procedures, as the occurrence of Friday 13<sup>th</sup> is supposed to be associated with worsened outcome [3]. Studies have been performed to analyze the effect of the lunar cycle on birth rates [4], emergency department presentations [5], cardiopulmonary resuscitations [6,7] and psychiatric disorders [8]. Surgery specific studies looked into the incidence of postoperative hemorrhage [9,10], intraoperative blood loss [11], morbidity and mortality after lung and breast cancer surgery [12,13] and quality of radical cystectomy for bladder cancer [14] in relation to the lunar cycle. These studies could not show any effect of the moon. Therefore, the question ought to be addressed, whether surgical complications in general occur with different frequencies on certain weekdays and are possibly interrelated with lunar cycles. The current study analyzed the

incidence of surgical complications requiring reoperations for more than 25.000 primary procedures with respect to weekday of the initial operation, lunar constellations and Friday 13<sup>th</sup>.

## Material and methods

All surgical procedures from 2007-2014 at a maximum care center and their registered complications from the departmental morbidity registry were analyzed. They resulted in 635 cases with a surgical complication requiring a reoperation. Operations were performed by board certified surgeons or under their supervision, encompassing the departmental spectrum of general, visceral, thoracic and vascular surgery. Dates and weekday of the primary operation, occurrence of complications and date of the reoperation were analyzed and matched with the lunar phase, new moon, full moon, waxing and waning moon. Occurrences of Friday 13<sup>th</sup> were also identified. Patient characteristics with respect to age, gender, weekday of the operation, type of primary procedure and type of complication were recorded. Age was calculated

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from the date of birth for the operation date and age groups were formed for analysis. Incidences of complications requiring reoperations were calculated between groups. The Statistical Package for Social Sciences Software, SPSS<sup>®</sup>, was used for statistical analysis. Pearson's Chi-square test was used for testing on equal distribution and confidence intervals on binomial distribution were generated according to Clopper-Pearson, Jeffreys and Likelihood calculations of probability. Fisher's Exact test was used to compare age among patients with complications. For numeric data, differences were analyzed by ANOVA and in case of significance confirmed by T-Test. P-values < 0.05 were considered to be significant.

## Results

Over 25.000 procedures were performed from 2007-2014, resulting in a total of 635 registered complications requiring reoperations. Most of the complications occurred within one week from the primary operation. Male and female patients were equally affected by complications, matching their proportions in the department's patient population, with 60% male (N=381) and 40% female patients (N=254). Mean age of the patients with complications was 61 years (median 63 years). Incidence of surgical complications was independent of age and gender. Main complications were wound infections (N=178), vascular occlusions (N=115), postoperative hemorrhage (N=89), anastomotic insufficiencies (N=75), hematomas (N=45) and pneumothoraces (N=26).

Within the eight-year period there were 418 Mondays, 418 Tuesdays, 418 Wednesdays, 417 Thursdays, 417 Fridays, 417 Saturdays and 417 Sundays. Full moon and new moon occurred on 99 days, waxing and waning moon on 1.361 and 1.363 days. Proportionately the majority of the procedures with subsequent surgical complications were performed during waxing or waning moon (47.6% and 44.9% respectively) and 3.9% took place at full moon, 3.6% at new moon (Table 1). No increased incidence of operative complications could be shown for any lunar period, with  $P = 0.763$ . More than 50% of the complications occurred within 4 days of the primary procedure, more than 70% within 7 days postoperatively. Therefore, the lunar constellations changed only slightly, leading to similar results without statistically significant differences.

As for Friday 13<sup>th</sup>, altogether 417 Fridays occurred within the time-span, of which 3.4% happened to be on a 13<sup>th</sup>. Confidence intervals were calculated with three different methods (Clopper-Pearson, Jeffreys and Likelihood) with neither showing a heightened incidence of operative complications beyond the incidental distribution,  $P = 0.144$  for the primary procedure and occurrence of the complications and reoperations happened to be on a Friday 13<sup>th</sup> in only 1.6%. Primary procedures took mostly place on weekdays with only 3% and 3.6% occurring on Saturdays and Sundays. No statistical significance in the incidence of operative complications could be observed for the weekdays ( $P = 0.227$ ), despite absolute numbers showing that most operations leading to subsequent complications were performed on Tuesdays and Wednesdays (Table 2). Day of revision surgery though was different in its incidence, reaching just about statistical significance with  $P = 0.05$ . Most revision procedures were performed on Fridays, with 19.4%, in comparison to Mondays with only 12.6 % revision procedures (Table 3).

## Discussion

In summary, our data could not show any effect of lunar phases on the incidence of surgical complications requiring reoperations. Any influence of the occurrence of Friday 13<sup>th</sup> could be equally ruled out.

**Table 1.** Lunar phase of primary operations and reoperations in patients with surgical complications.  $P = 0.763$ .

Lunar phase	Primary operation	Reoperation
New moon	3.6 %	3.1 %
Waxing moon	47.6 %	45.5 %
Full moon	3.9 %	4.4 %
Waning moon	44.9 %	46.1 %

**Table 2.** Day of the week of primary operations with subsequent reoperation due to complications.  $P = 0.227$ .

Week day	Percentage
Monday	16.9
Tuesday	21.3
Wednesday	19.7
Thursday	19.2
Friday	16.4
Saturday	3.0
Sunday	3.6

**Table 3.** Day of reoperation due to surgical complication.  $P = 0.05$ .

Week day	Percentage
Monday	12.6
Tuesday	16.4
Wednesday	15.3
Thursday	16.7
Friday	19.4
Saturday	10.4
Sunday	8.5

This is supported by previous studies on the impact of lunar phases on patients presenting to the emergency department, incidence of myocardial infarction and cardiac death, on emergency operations and intraoperative blood loss and postoperative haemorrhage after thyroid surgery and tonsillectomies [5,7,9,15].

Dubois, *et al.* (2017) investigated the 30-day mortality with 402 499 elective operations between 2002 und 2012 and could not find a significant difference between elective procedures performed on Mondays or Fridays. But it is worth mentioning that most procedures were performed on Tuesdays (n=95 654 vs. Friday, n=65 139) [2].

Nandra, *et al.* analyzed the weekend effect in comparison to the 30-day mortality with 2061 patients with fractures of the proximal femur. They could not show a significant difference in the mortality for patients coming in on weekdays or weekends. There was a slightly higher mortality on weekdays than on weekends (10,2% vs. 9,7% on weekends), and specific in respect to day of the week (12,96% Monday vs. 8,06% Thursday) [16].

Patients with ruptured abdominal aortic aneurysms and their overall mortality rate within a ten-year span were analyzed by Kozka, *et al.* and whereas the mean atmospheric pressure and other weather factors, including phases of the moon, did not correlate with ruptured abdominal aortic aneurysms occurrence or its mortality, the mortality was significantly higher during national holidays and weekends in comparison to weekdays [17].

Vohra, *et al.* demonstrated a higher mortality within one year in patients undergoing major elective colorectal resections on Fridays in comparison to patients being operated on from Monday to Thursday. They stated though that the increased mortality might reflect patient factors rather than hospital variables alone, since patient characteristics differed between the two groups [18]. A previous study compared mortality after nonemergent major surgery performed on Friday

versus Monday through Wednesday. Here a significantly higher 30-day mortality rate was also found for procedures taking place on Fridays, but when adjusting for patient characteristics, the odds ratio decreased, but was still highly significant [19]. This was confirmed by Aylin et al (2013), analyzing 30-day mortality after elective surgery, with a heightened risk, if surgery was performed on Friday (odds ratio 1.44) or a weekend (odds ratio 1.82) compared with Monday [20].

On the contrary Sessler, *et al.* investigated whether the timing of general surgery, specifically increasing time of day, increasing day of week, July/August cases versus other months and moon phase were independently related to 30-day mortality at the Cleveland Clinic between 2005 and 2010. They could not demonstrate any differences between weekday, time of day or different months concerning 30-day mortality, concluding that surgery was safe on any day and any time of the week [21].

No statistical significance could be found with patient collectives for the analysed outcomes and interrelation with moon phases or Friday 13<sup>th</sup>. Nevertheless, a firm belief in lunar influences on humans exist in up to 40% of society and appears difficult to defy [22]. Hardly any study could provide serious evidence for a lunar effect on illness. An exemption being a recent study on 6.250 consecutive stroke admissions in Canada though showed a higher incidence of intracerebral hemorrhage and transient ischemic attack during the first quarter of the lunar phase and full moon, whereas ischemic stroke was not influenced, which is difficult to explain biologically [23].

Quality of radical cystectomy with respect to progression free survival was studied in a smaller sample size of patients with bladder cancer with respect to lunar influences, as well as long-term survival and morbidity and mortality after lung surgery in cancer patients [12,14]. A study on lunar constellations on minor surgical procedures such as herniotomy, hemorrhoidectomy and crosssectomy yielded only 3.7% complications without any major complications [24]. Neither study showed a lunar effect.

## Conclusions

The present retrospective analysis on surgical complications could not show a heightened risk of complications with subsequently needed reoperations due to the primary procedure being performed on certain weekdays. The weekdays of revision surgery were of statistical significance though, with most reoperations taking place on Friday. Since more than 50% of the complications occurred within four days and more than 70% within seven days postoperatively, timing of the primary operation might be worth reconsidering. This study therefore provides no reason to avoid planning of major surgery at the end of the week.

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## Declaration of interest

The authors declare that they have no competing interests.

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