

# No evidence of “weekend effect” for complications of medical and surgical care

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## Abstract

We performed an electronic search in CDC WONDER online database (years 2018-2022) to explore whether the higher risk of dying during the weekends may be related to complications of medical and surgical care. One-way ANOVA and Tukey’s HSD multiple comparison test revealed no significant variation in mean number of deaths during the seven days of the week in the US. No significant difference was observed between the mean number of deaths during the weekend and those recorded during the weekdays (675±130 vs. 711±112;  $p=0.339$ ). The mean ratio of mortality due to complications of medical and surgical care to the total number of deaths was not significantly different on weekends and weekdays (151 vs. 158×100,000 deaths;  $p=0.255$ ). The results of this analysis suggest that the so-called “weekend effect” may not be apparently attributable to complications of medical and surgical care and may hence be more related to patient-specific factors.

## Introduction

Reliable evidence has been provided that the risk of unfavorable outcomes for hospitalized patients may not be evenly distributed across the seven days of the week, resulting in a higher risk of death on weekends than during the rest of the week.<sup>1</sup> This well-known aspect in healthcare, called as the “weekend effect”, has been attributed to a combination of factors such as reduced medical staffing levels, a tendency of general practitioners to admit more severe patients on Fridays (thereby avoiding problems over the weekend), as well as societal problems such as financial issues, relatives’ working patterns, and even selection biases because a lower rate of patients seeking for emergency care on weekends are then admitted to hospital, and so forth.<sup>2</sup> We hence planned a short study to explore whether the “weekend effect” may also be related to a significant burden of complications of medical and surgical care.

## Materials and Methods

We conducted an electronic search in the most recent version of the US Centers for Disease Control and Prevention (CDC) WONDER online database (years 2018-2022),<sup>3</sup> which provides mortality data for US citizens across locations and over time. The search was expanded to the available five years (2018-2022), for total mortality or using specific International Statistical Classification of Diseases and Related Health Problems 10<sup>th</sup> Revision (ICD-10) codes Y40-Y84, which include all “complications of medical and surgical care” stratified by day of the week (Table 1).<sup>4</sup> Mortality data were reported as the mean number of deaths ± Standard Deviation (SD) over the four years. Data were graphically plotted in Microsoft Excel (Microsoft, Redmond, WA, USA) and analyzed using one-way ANOVA and the Tukey’s honestly significant difference test (Tukey’s HSD; StatsDirect, StatsDirect Limited, Birkenhead Wirral, UK). Statistical significance was determined at  $p<0.05$ . The study was performed in accordance with the Declaration of Helsinki and under the terms of local legislation.

## Results

Figure 1 summarizes the results of our analysis. Although there was an apparent trend of increased mortality for complications of medical and surgical care in the middle of the week and a visible decline on Sundays, the one-way ANOVA revealed no significant variation (F-statistics: 0.183;  $p=0.979$ ; Figure 1A). Overall, the mean number of deaths for complications of medical and surgical care was 699±114 on Mondays, 706±90 on Tuesdays, 719±119 on Wednesdays, 716±123 of Thursdays, 718±124 on Fridays, 703±126 on Saturdays and 646±135 on Sundays. The Tukey’s

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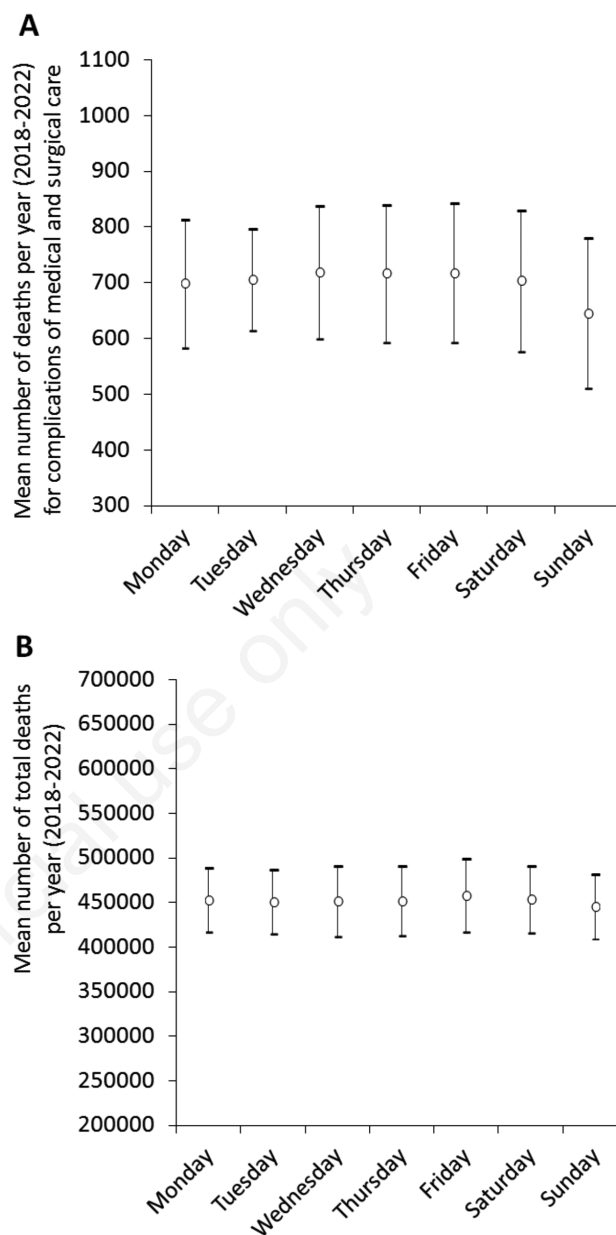
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HSD multiple comparison test also revealed no significant difference between multiple comparisons of mortality for complications of medical and surgical care across the different days of the week (all  $p > 0.989$ ). No statistically significant difference was also observed when the mean number of deaths for complications of medical and surgical care during the weekend ( $675 \pm 130$ ) was compared to that recorded during the weekdays ( $711 \pm 112$ ;  $p = 0.339$ ). Overall mortality in the US is also shown in Figure 1B. There was no statistically significant trend (F-statistic: 0.040;  $p = 0.999$ ). Again, no statistically significant difference was found when the mean number of total deaths on weekends ( $449592 \pm 36969$ ) was compared to weekdays ( $453007 \pm 38384$ ;  $p = 0.451$ ). Accordingly, the mean ratio of mortality due to complications of medical and surgical care to the total number of deaths in the US was not significantly different on weekends and weekdays (151 vs.  $158 \times 100,000$  deaths;  $p = 0.255$ ).

### Discussion

The seminal study published by Bell and Redelmeier in 2001,<sup>5</sup> including nearly 4 million Canadian patients over a 10-year period, paved the way to the definition of the so-called “weekend effect”, in that the authors found that several causes of death were associated with a higher risk of mortality during the weekends. These results were then confirmed in several other studies, as recently meta-analyzed by Pauls and colleagues.<sup>1</sup> For example, in the large study by Walker *et al.* in 2017,<sup>6</sup> the authors found that the 30-day mortality of patients emergently admitted on a weekend was higher than that of those emergently admitted on a weekday (5.1 vs. 4.7%;  $p < 0.001$ ). The authors also found that adjusting mortality rates for routine test results effectively reduced the excess mortality associated with weekend and holiday emergency admissions. Regardless of this apparently straightforward phenomenon, the underlying causes remain largely enigmatic. One possible explanation that has been given, is an insufficient medical staffing level during the weekends, both in terms of quantity and quality, which may hence be associated with increased risk of complications or even malpractice.<sup>2</sup> Nonetheless, the results of our analysis on the last online version of the CDC WONDER database provide evidence that the so-called “weekend effect” may not be apparently attributable to complications of medical and surgical care, and may hence be more related to patient-specific factors. Nevertheless, equalization of hospital resources for emergency admissions on all days of the week in many countries remains a very important public health issue. Notably, not all deaths attributable to suboptimal care are necessarily coded as such. For example, an inexperienced physician might not recognize that his or her inexperience contributed to a patient’s death. Similarly, hospital understaffing is unlikely to be considered a sufficient reason for coding a death as Y40-Y82, although it may well be the cause of delayed or inappropriate care.



**Figure 1.** Mean number of deaths (with standard deviation; SD) for complications of medical and surgical care (A) and total number of deaths (B) in the US during the years 2018-2022, stratified according to the day of the week. The results of the statistical analysis are provided in the text of the manuscript.

**Table 1.** International Statistical Classification of Diseases and Related Health Problems 10<sup>th</sup> Revision (ICD-10)<sup>3</sup> codes encompassing the generic definition of “complications of medical and surgical care” used in this analysis.

ICD-10 Code	Description
Y40-Y59	Drugs, medicaments and biological substances causing adverse effects in therapeutic use
Y60-Y69	Misadventures to patients during surgical and medical care
Y70-Y82	Medical devices associated with adverse incidents in diagnostic and therapeutic use
Y83-Y84	Surgical and other medical procedures as the cause of abnormal reaction of the patient, or of later complication, without mention of misadventure at the time of the procedure

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