

Temporal Factors of In-Hospital Surgical Complications

2/22/2024, Kath Fillman

Introduction. This is an analysis of the effect of an elective general surgery's timing in relation to hour, day of the week, month, and moonphase on if an in-hospital surgical complication will arise.

Dataset. The dataset 'Surgery Timing.csv' was provided by the instructor and is a cleaned version of the data from Sessler et al. "Operation Timing and 30-Day Mortality After Elective General Surgery". *Anesth Analg* 2011; 113: 1423-8. It contained information from 32001 patients' elective general surgeries which included 25 variables which includes a binary variable indicating if there was an in-hospital surgical complication and information about the surgery's timing (hour, day of week, month, and moon phase). The variable hour was adjusted to include only the greatest integer as opposed to both hour and minutes; this was done to ease interpretation.

Exploratory Data Analysis. Of the 32001 patients included in this analysis, 4264 of them experienced in-hospital surgical complications. Figure 1A shows the distribution of the hour of operation grouped by the presence of a complication, the most common time of operation for both groups was within the hour of 7am. The proportion of in-hospital complications fluctuated considerably throughout the day and were higher within the hours of 7am, 9am, 10am, 2pm, 3pm and 4pm. The variable containing the day of the week the surgery was performed on (dow) includes only weekdays (Monday-Friday). Figure 1B shows the distribution of the day of the week the surgeries took place grouped by if there was an in-hospital complication. The proportion of in-hospital complications is consistent throughout the week despite the number of surgeries fluctuating (table 1). Figure 1C shows the distribution of the month of operation grouped by if there was a complication present. The proportion of in-hospital complications is consistent throughout the months despite the number of surgeries fluctuating (table 1). Figure 1D shows the distribution of the moonphases grouped by if there was an in-hospital surgical complication. The proportion of in-hospital complications is consistent throughout the moon phases despite the number of surgeries fluctuating (table 1).

Methods. An association between in-hospital complications and the surgery's time of day, day of the week, month, and moon phase was quantified using logistic regression. A logistic model was chosen as the outcome of interest was binary (presence of a surgical complication). Two models were constructed using the glm() function from the R jtools package. One with all variables and one with only the statistically significant predictors; these will be compared later to choose the better fitting model. Creating one model was chosen over multiple, individual models for each predictor as it delivers the greatest accuracy in its prediction of in-hospital complications while adjusting for temporal factors. P-values less than 0.05 were considered significant. All analyses were performed in R-studio version 2023.12.1, build 402 and R version R-4.1.3.

Results. The results of the logistic regression model are shown in table 2. The predictors hour and day of week were both found to be statistically significant with p values of 0.0002 and 0.0045 respectively. Predictors month and moon phase were not found to be statistically significant with p values of 0.6226 and 0.5085 respectively. The first model created using table 2 is $\log(\text{odds}) = 0.1163 + 1.0216(\text{hour}) + 1.334(\text{day of week}) + 0.9976(\text{month}) + 0.9903(\text{moon phase})$. The second model created is $\log(\text{odds}) = 0.1140 + 1.0207(\text{hour}) + 1.333(\text{day of week})$. A likelihood ratio test was performed and found that the models fit equally well (p-value of 0.7167), thus the less complex model was chosen. Likelihood ratio tests between models with singular predictors and the second model were also performed (p-value of 0.0047 for hour and 0.0002 for day of week) and found that the model with two predictors was a better fit. A Hosmer and Lemeshow goodness of fit (GOF) test returned a p-value of 0.0298, indicating that this model is not a good fit for the data. This model has an AIC of 25106.1488, which is very high and corroborates poor model fit.

Conclusion. After testing for model fit, it does not seem that temporal factors are meaningful predictors of in-hospital surgical complications. Given their statistical significance in the model, variables such as the hour of operation and day of the week may be predictors of in-hospital complications, however due to poor model fit it is unlikely they are meaningful. Based on the model, the odds of surgical complication are increased by 2.1% every hour after 6am when surgeries begin each day). Likewise, the odds ratio for the day of the week is 2.81 times the day prior. The temporal factors hour of operation, day of the week may have an effect on in-hospital surgical complications while variables month and moonphase do not.

Appendix.

Table 1. Number of In-Hospital Complications Based on Day of the Week, Month, and Moon Phase

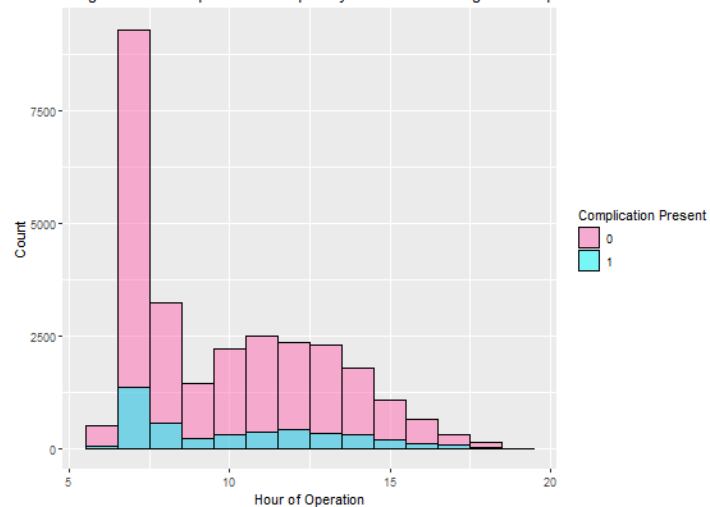
		Number of In-Hospital Complications				Number of In-Hospital Complications	
		No	Yes			No	Yes
Hour	6	514	48	Month	January	2263	407
	7	9290	1341		February	2163	343
	8	3236	571		March	2373	324
	9	1446	218		April	2377	321
	10	2204	297		May	2321	333
	11	2492	363		June	2584	410
	12	2359	404		July	2024	301
	13	2294	329		August	2715	462
	14	1775	288		September	2784	424
	15	1066	201		October	2312	377
	16	631	114		November	2219	325
	17	295	61		December	1602	237
	18	134	29	Moon Phase	New Moon	6641	1067
	19	1	0		First Quarter	7067	1033
Day of the Week	Monday	6097	908		Full Moon	6963	1088
	Tuesday	9796	812		Last Quarter	7066	1076
	Wednesday	5339	927	Total		27737	4264
	Thursday	4841	794				
	Friday	5264	823				

Table 2. Model Summaries

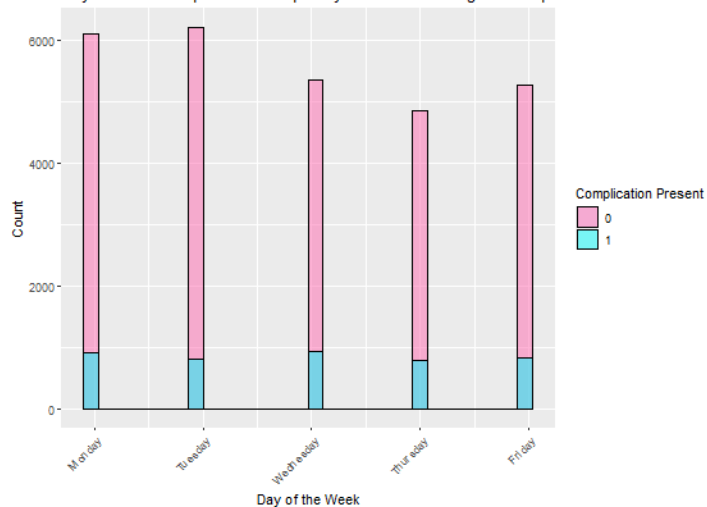
Model 1			
	Log(odds)	95% Confidence Interval	p-value
Complication (intercept)	0.1163	0.0985, 0.1373	N/A
Hour	1.0208	1.0098, 1.0318	0.0002
Day of the Week	1.0334	1.0102, 1.0571	0.0045
Month	0.9976	0.9880, 1.0073	0.6226
Moon Phase	0.9903	0.9620, 1.0194	0.5085
Model 2			
	Log(odds)	95% Confidence Interval	p-value
Complication (intercept)	0.1140	0.0999, 0.1301	N/A
Hour	1.0207	1.0097, 1.0317	0.0002
Day of the Week	1.0333	1.0101, 1.0570	0.0047

Figure 1. Distributions of Variables of Interest

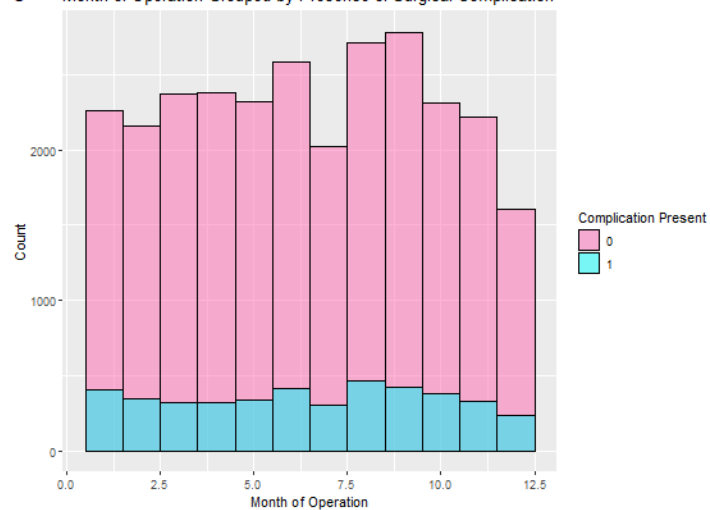
A Surgical Hour of Operation Grouped by Presence of Surgical Complication



B Day of Week of Operation Grouped by Presence of Surgical Complication



C Month of Operation Grouped by Presence of Surgical Complication



D Moon Phase During Operation Grouped by Presence of Surgical Complication

