Concurrent Surgery at UMass Memorial Health Care

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Abstract

TITLE: Concurrent Surgery at UMass Memorial Health Care

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Purpose: Concurrent and overlapping surgery scheduling, a common practice at academic medical centers, has received recent attention in the media for being potentially harmful to patients. In light of these recent events, the executive staff and Board of Trustees at UMass Memorial Health Care wished to better understand the prevalence of the practice at their medical center and what risk factors may affect this prevalence.

Methods: Surgery scheduling data on all surgeries from 2013-2015 (inclusive) was selected for analysis. Concurrent surgery was defined as any time one attending surgeon was responsible for two open incisions at one time. Scheduled overlapping surgery was defined as any time two procedures were electively scheduled to overlap for the same surgeon. Prevalence ratios were calculated for the total number of concurrent surgeries over the three-year time span and stratified by location, specialty, and surgeon. Multivariate logistic regression was used to calculate odds-ratios for relevant risk factors.

Results: In total, 87,980 procedures were performed from 2013-2015, of which 84,881 were eligible for analysis. During this time span, there were 1,070 concurrent surgeries (1.3%) across all three UMass campuses. The median concurrent time varied from 12.5 minutes (range 0-327 minutes) at the Hahnemann campus to 14 minutes (range 0-250 minutes) at the Memorial campus to 50 minutes (range 0-985 minutes) at the University campus. Orthopedics accounted for the most concurrent surgeries at each campus. Of the risk factors investigated, scheduled overlapping surgeries and the specific surgeon significantly increased the risk of causing a concurrent surgery at each campus. Interestingly, the add-on cases did not pose a significantly increased risk of causing concurrent surgery.

Conclusions: Overall, 1.3% of UMass Memorial Health Care's surgical cases are concurrent by our definition, and scheduling surgeries to overlap on the elective surgery schedule as well as the surgeon mix significantly increased the risk of a concurrent surgery occurring.

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Glossary of Abbreviations

OR – Odds Ratio

aOR – Adjusted Odds Ratio

UMass – University of Massachusetts

Section 1: Introduction

Recently, the concept of a "concurrent surgery" was thrust into the public view from a Boston Globe article profiling the practice.[1] While many definitions for "concurrent surgery" and "overlapping surgery" have been proposed, the general concept concerns one attending surgeon being responsible for two surgeries simultaneously. While the *Globe* article inspired some outrage from the public on this little-known scheduling practice, others have argued the practice is practical for training tomorrow's surgeons.[2,3] While recent studies have shown relatively little impact on patient outcomes,[4] including in cardiothoracic surgery,[5] neurosurgery,[6] and outpatient orthopedic procedures,[7] public concern nonetheless persists.

Approximately one year after the original *Globe* article, the United States Senate Finance Committee commissioned a report with two conclusions. First, there will be a ban on all "concurrent surgeries" (defined as when the critical portion of two surgeries, attended by same primary surgeon, overlap). Second, there should be stricter regulations on "overlapping surgeries" (defined as when the critical portion of two surgeries, attended by the same primary surgeon, do not overlap, but the entire lengths of both surgeries do overlap).[8]

In response to increased public and government attention being directed at the practice of concurrent and overlapping surgeries, UMass Memorial Health Care executive staff and Board of Trustees were interested in understanding the extent of the practice at their institution. as well as potential risk factors that may increase the likelihood of a concurrent surgery occurring.

UMass Memorial Health Care is the largest academic medical center in Central Massachusetts, serving as the primary health care delivery center for the region.[9] Their services are spread across three different campuses totaling 781 inpatient beds: University, Memorial, and Hahnemann. The Hahnemann campus delivers primarily outpatient services (including surgical) and the University and Memorial campuses deliver secondary and higher level tertiary care. These three campuses combine to average over 28,000 procedures per year.

Section 2: Student Role

My specific role in this project was shared with my student colleague, Jose Mozo. We began by interviewing key stakeholders from a variety of departments within UMass Memorial

Health Care including the Department of Surgery, Department of Anesthesiology, and various administrative departments. After collating recommendations from these various stakeholders, we then received scheduling data for all UMass Memorial surgeries from 2013-2015 (inclusive). We worked with a statistician at the Harvard T.H. Chan School of Public health to clean the data for missing scheduling values that would affect our analysis. After cleaning the data, we calculated a variety of descriptive statistics that the executive staff found most useful in potentially informing future policy decisions regarding concurrent and overlapping surgery. In order to investigate risk factors for causing concurrent or overlapping surgery, we then constructed multivariate logistic regression models to calculate odds ratios for each risk factor. Finally, my colleague and I assembled our results into a PowerPoint presentation that we presented to the UMass Memorial Health Care executive staff and Board of Trustees.

After finishing the MPH degree, I pursued this project further with a UMass Memorial staff member to investigate how concurrent surgery may affect surgical outcomes, specifically if concurrent surgery is a risk factor for surgical adverse events occurring. This portion of the project is in the early stages and on-going.

Section 3: Methods

Case Selection

Raw scheduling data was initially collected from the UMass Memorial data warehouse team for the years 2013-2015 (inclusive) which totaled 87,980 procedures. Variables in this raw data include surgeon ID, procedure ID, scheduled start/stop time, enter room time, exit room time, surgery start/stop time, anesthesia start time, department, and procedure description. Procedures that were missing any of the above scheduling data would preclude them from analyses and thus were excluded from the final data set. After exclusion of these cases, the final dataset for analysis contained 84,881 cases.

Definitions

Because there is no consensus definition of "concurrent surgery", we used a strict definition: a surgery was defined as "concurrent" if there was any time overlap between it and the preceding case. A sensitivity analysis was performed (see Figure 1), to qualitatively assess if there was a large drop-off when concurrent surgeries were binned into categories of what time percent of the preceding case was concurrent. The curve appeared to follow an exponential decay model, which was expected, with no qualitatively large drop off in number cases between bins; thus, the previous definition was kept moving forward and not modified to include a percent cut-off.

End Points of Interest

UMass Memorial Health Care executive staff, Board of Trustees, and other stakeholders expressed interest in a variety end points to be investigated. To describe the current state of practice at the institution, the general end point of interest was percent of surgical cases that were concurrent. This was investigated for all cases performed over the three-year sampled time span and stratified by campus (the campus variable was assumed to be an effect modifier based on the large variation in types of surgical cases performed at each center). This was then further sub-stratified by department and separately sub-stratified by surgeon ID (results by surgeon ID were redacted here due to risk management concerns). Also of interest was time of concurrent surgery overlap which, again, was stratified by campus.

Risk for concurrent surgery occurring on any specific day was assessed by examining variables pertinent to creating a schedule for an individual day. This included how many overlapping surgeries were scheduled for the day, how many total surgeries were electively scheduled for the day, how many add-ons were scheduled, and “surgeon mix” which was calculated as the percent of total cases performed that day by the top five surgeons ranked by total number of concurrent surgeries performed. Day of the week was an additional covariate.

Statistical Method

The general end point of percent of surgical cases that were concurrent was calculated as a prevalence ratio with the numerator and denominator adjusted accordingly for the level of sub-stratification (i.e. all cases stratified by campus, sub-stratified by department, and independently sub-stratified by surgeon ID). Time of concurrent surgery was calculated as median time stratified by campus, because the concurrent time distributions were heavily right-skewed. Finally, univariate and multivariate logistic regression were used to estimate risk attributed to a concurrent surgery occurring from the covariates listed above.

Section 4: Results

Descriptive Statistics

Overall, UMass Memorial Health Care performed 87,980 procedures between 2013 and 2015, of which 84,881 were used for the final analysis after excluding cases with missing data. From this pool, there 1,070 concurrent surgeries, accounting for 1.3% of the final dataset (see Figure 2). When stratified by campus, Hahnemann campus had the highest percent of concurrent surgeries at 2.1% (476 concurrent cases), University the second most with 1.3% (354 concurrent cases), and Memorial campus with the least at 0.7% (240 concurrent cases).

When these results were further sub-stratified by department, orthopedics had the highest percentage of concurrent cases at each campus: Hahnemann 86.7% of total cases (413 concurrent cases), Memorial 77.5% of total cases (186 concurrent cases), and University 40.1% of total cases (142 concurrent cases) (see Table 1). Plastic surgery comprised the bulk of the remainder of concurrent cases for Hahnemann (11.5%, 55 concurrent cases) and University (21.1%, 75 concurrent cases) while Minimally Invasive Surgery (5.8%, 14 concurrent cases) and Surgical Oncology (4.5%, 11 concurrent cases) were the second and third, respectively, most common concurrent surgery services at the Memorial campus.

Finally, the median time of concurrent surgery was also calculated for each campus (see Figure 3). Hahnemann had the shortest median concurrent time at 12.5 min (range 0-327 min), then Memorial with 14 min (range 0-250 min) median concurrent time, and University campus had the longest median concurrent time at 50 min (range 0-985 min).

Risk of Concurrent Surgery by Day

Univariate ("crude", see Table 3) logistic regression models had significantly increased unit odds ratios for each additional scheduled overlapping surgery at all three campuses (Hahnemann: OR 2.48, 95% CI 2.13-2.89). All of these unit odds ratios remained significant after adjustment in the multivariate model (Hahnemann: aOR 1.90, 95% CI 1.62-2.62). Furthermore, each additional scheduled elective case had a significant unit odds ratio in the crude Hahnemann model (OR 1.07, 95% CI 1.04-1.10) which remained significant after adjustment (aOR 1.05, 95% CI 1.02-1.08). None of the other campuses had significant unit odds ratios for each additional scheduled elective case. Each additional add-on case did not significantly increase the odds of a concurrent surgery occurring across all three campuses. Finally, surgeon mix did have a significantly increased unit odds ratio in unadjusted and adjusted models at all three campuses.

Section 5: Discussion, Limitations, Conclusion, Suggestions for Future Work

In this project, we investigated the state of practice of concurrent and overlapping surgery at UMass Memorial Health Care. The executive staff and Board of Trustees were specifically interested in a descriptive breakdown of the practice prevalence throughout their system and what risk factors may increase the chance that a concurrent surgery will occur. Through our investigation, we found that 1.3% of all UMass Memorial procedures are concurrent by our strict definition, and the orthopedics department accounts for a majority of all concurrent surgeries at each of UMass Memorial Health Care's three campuses. Furthermore, how many surgeries that are electively scheduled to overlap as well as the surgeon mix for the day both significantly increase the chance that a concurrent surgery will occur.

Prior to this investigation, little research had been done at UMass Memorial to investigate their practice of concurrent and overlapping surgery. Similarly, little has been published about other institutions' entire state of practice, with perhaps the only exception being the recently published report from the Mayo Clinic;[4] however, their study methodology used case-matching, so it was not possible to directly compare their prevalence of concurrent surgery to UMass Memorial's system. Given the newly focused public[1,2] and government[8] attention to the matter, the UMass Memorial Health Care executive staff and Board of Trustees were eager to understand the practice better.

While little can be said about comparing UMass Memorial's overall concurrent surgery rate to other institutions, inter-campus interpretation can be made. The Hahnemann campus had the highest rate of concurrent surgery out of the three campuses, and this is understandable given that Hahnemann provides primarily ambulatory surgical services. This high frequency, high turnover procedure center has lower complexity than the inpatient procedures seen at University and Memorial campuses. Because the procedures take less time and are of lower complexity, surgeons are incentivized to schedule the procedures to overlap, where a senior resident or fellow can finish one case, while the attending moves on to the next case thereby optimizing billing volume per day. Many of these ambulatory procedures are orthopedic in nature, thus explaining why the orthopedics department contribute a majority of the concurrent surgeries.

Investigating risk factors for a concurrent surgery occurring on any specific day, it was not surprising that each scheduled overlapping surgery increased the risk of a concurrent surgery occurring. For the Hahnemann campus, each scheduled overlapping surgery on the elective schedule for the day increased the risk of a concurrent surgery occurring that same day by 90% (81% for Memorial and 88% for University). Not surprisingly, if the scheduling process in place allows for surgeries to overlap, then a concurrent surgery is much more likely to occur. However, it was interesting that each additional add-on case for a day did not significantly increase the risk of a concurrent surgery occurring. It would be logical to assume that additional cases added to a schedule, either throughout the day for emergencies or at the end of the day, would strain an already filled elective surgery schedule. However, it appears that UMass Memorial Health Care has been able to accommodate the additional volume without significantly increasing the risk of a concurrent surgery occurring.

There are multiple limitations to this project. A number of cases were omitted from the final dataset due to incomplete records, and this omission could have biased the final results and conclusion. Furthermore, it was unclear how timing data was entered into UMass Memorial's data warehouse which could cause inconsistencies that would be nearly impossible to pick up in the final dataset. For example, if start/stop time data was entered using in-room clocks, and not all of the clocks across all operating rooms were synchronized, then two procedures may appear concurrent when the concurrent time data may have just been due to unsynchronized clocks between rooms. Additionally, some procedures had excessively long concurrent/overlap times; for example, the longest concurrent time at University was over 16 hours. When investigating this further, these situations involved multiple surgeons being involved in parts of a long and complex procedure. These surgeons would technically have "concurrently" running surgeries, per the scheduling data set, but in actuality, these surgeons would pass off responsibility on the long and complex case to the incoming surgeon and proceed to start another case in a different room (see Figure 4 for an example). Essentially, these surgeons most likely were never directly responsible for two incisions simultaneously, even though the scheduling made it seem so. However, it was impossible to ascertain this information exactly with only scheduling data. Finally, the terms "concurrent" and "overlapping" surgery do not have strictly defined definitions, with multiple entities[1-3,8,10] choosing their own interpretation of the terms as we did here. This lack of standardization could possibly prevent the generalization of these results to other institutions.

Conclusion

In conclusion, 1.3% of all UMass Memorial surgical procedures were concurrent by our definition. Of these, the orthopedic department contributed a majority of the concurrent cases across all three campuses. Scheduling cases to overlap and the surgeon mix significantly increase the risk of a concurrent surgery occurring, while the add-on volume appears to not increase the risk significantly. In terms of potential policy changes to reduce the number of concurrent surgeries at UMass Memorial Health Care, we recommend working to implement processes that reduce the number of surgeries that are scheduled to overlap in the first place. Furthermore, a handful of surgeons account for the majority of concurrent cases, and one-on-one remediation regarding their scheduling practices could also reduce the number of concurrent cases the system has.

Suggestions for Future Work

The ultimate end point for concurrent surgery is whether or not the practice actually harms patients. Thus, the logical suggestion for future work would be to investigate whether or not UMass Memorial Health Care has an increased risk of surgical adverse events (e.g. surgical site infection, re-operation, mortality, etc.) in a concurrent surgery versus a non-concurrent surgery. Some work in this area has already been completed at other institutions. Yount et al. presented an abstract on the work with specific respect to cardiac and thoracic surgery and found concurrent surgery did not impact surgical outcomes or operative time.[5] Guan et al. then published a retrospective review on 1,018 neurosurgical cases at their institution, concluding no increased risk for complications.[6] Zhang et al. investigated the effect of concurrent surgery on operative time and 30-day complication rates for outpatient orthopedic surgery and found no increase in risk.[7] Finally, Hyder et al. looked at all surgical procedures performed at the Mayo

Clinic and, using a ACS-NSQIP risk-prediction model, also concluded that there was no increased adverse event risk for overlapping vs. non-overlapping procedures.[4]

Future work can progress in two manners. There are still other classes of popular and common surgical procedures that could be retrospectively investigated to determine the safety of concurrent surgery, such as knee and hip arthroplasties or bariatric surgery. To strengthen study design, further work could also focus on prospective studies to eliminate potential case selection bias that is naturally present in retrospective work.

Section 6: Acknowledgements

I would like to acknowledge the help of multiple individuals for contributions towards my scholarly project. Jose Mozo, MD/MPH, was a classmate of mine at the Harvard T.H. School of Public Health, and he and I partnered on all aspects of this project to complete it as our MPH practicum project. Dr. Amy Cohen, a statistician at the Harvard T.H. Chan School of Public Health, was instrumental in helping us clean our dataset and correctly frame our analyses. Margaret Hudlin, MD/MPH at UMass Memorial Health Care, provided oversight and mentoring on the project as well as a voice as to what the executive staff's goals for the project were. Finally, Richard Siegrist, MBA, provided oversight and mentoring on the project as well as insight on the Board of Trustee's goals for the project.

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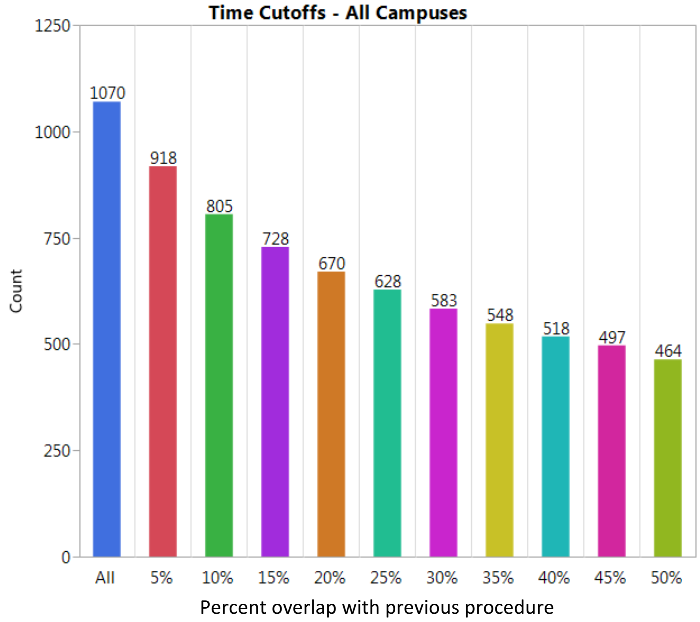
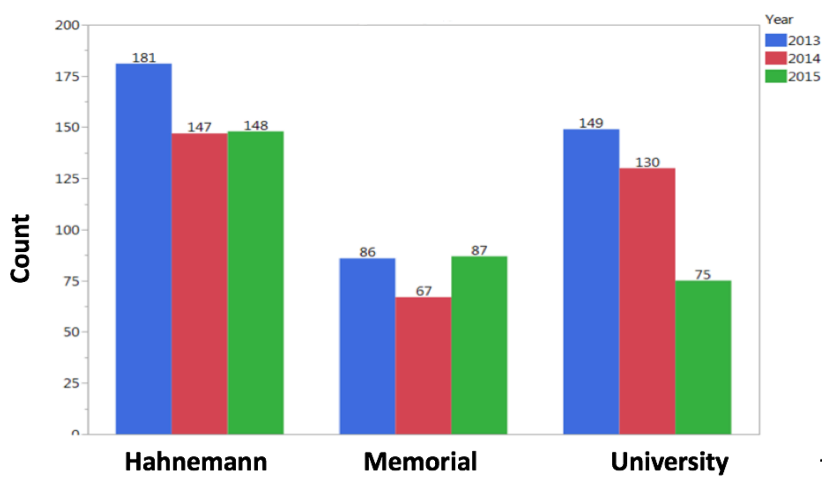
Figures and Tables

Figure 1 – Concurrent Time Sensitivity Analysis



Number of procedures categorized by the percent of time overlap. Percent of time overlap was calculated as total time of overlap divide by the length of the previous procedure.

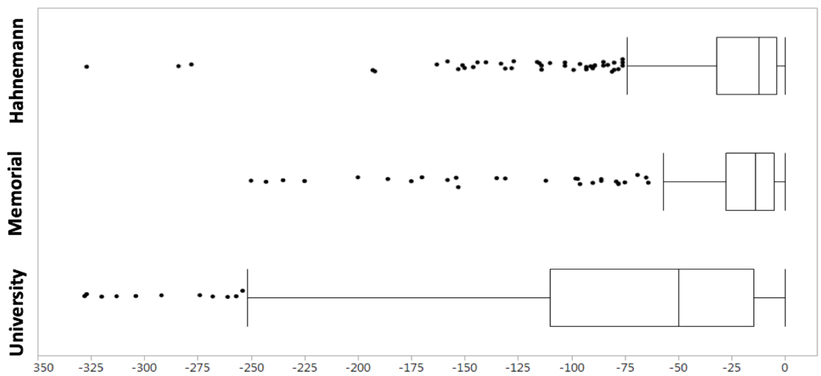
Figure 2 – Concurrent Surgeries by Site & Year



	Hahnemann	Memorial	University	Total
Totals:	**476**	**240**	**354**	**1,070**
% All Cases:	**2.1%**	**0.7%**	**1.3%**	**1.3%**

Count of number of concurrent procedures stratified by both year (colors) and campus.

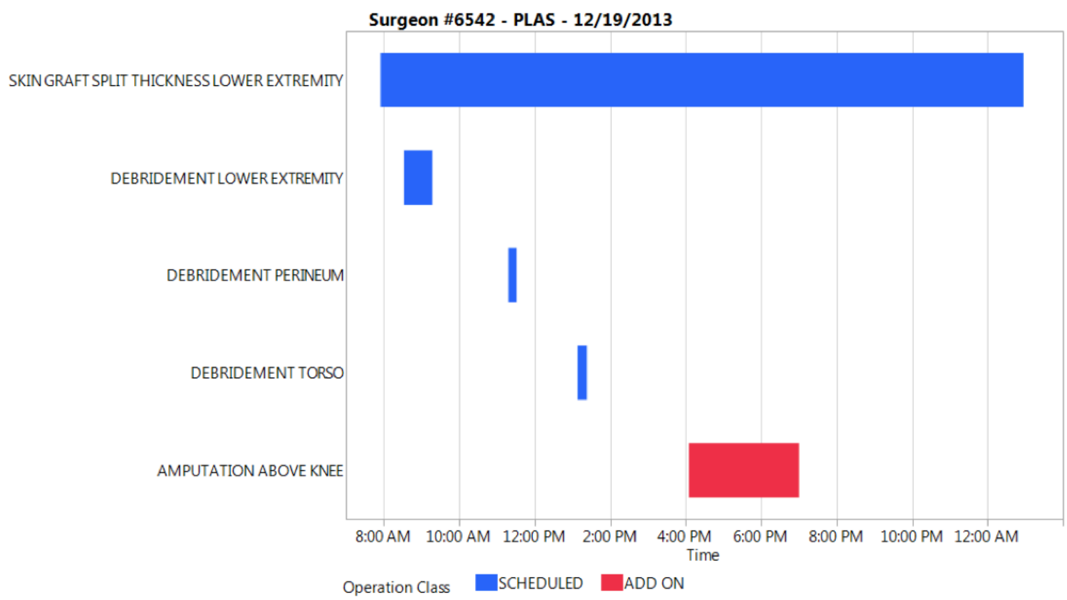
Figure 3 – Amount of Concurrent Time



	Hahnemann	Memorial	University
Median Time (min):	12.5	14	50
Range (min):	0 - 327	0 - 250	0 - 985

Box-and-whisker plot distributions of the concurrent times stratified by campus. Median concurrent times in minutes and ranges for each campus are listed in the table below the distrubtion plot.

Figure 4 – Example of Schedule with Long Overlapping Case



This is an example of one surgeon's schedule who was assumedly involved partially in a long complex case. This surgeon most likely only involved for a part of the long case at the top of the chart, and then scheduled other cases during the long procedure when they were not responsible for the incision of the long procedure. This would be marked as a "concurrent case" in the scheduling data, when in reality, the surgeon was not running concurrent cases.

Table 1 – Concurrent Surgeries by Service

HAHNEMANN			MEMORIAL			UNIVERSITY		
Service	N (% Total by Site)	Median Concurrent Time (min)	Service	N (% Total by Site)	Median Concurrent Time (min)	Service	N (% Total by Site)	Median Concurrent Time (min)
Orthopedics	413 (86.7)	12	**Orthopedics**	186 (77.5)	11	**Orthopedics**	142 (40.1)	51.5
Plastics	55 (11.5)	16	MIS	14 (5.8)	20	Plastics	75 (21.1)	68
MIS	5 (1)	2	Surgical Oncology	11 (4.5)	44	Vascular	54 (15.2)	36
Ophthomology	2 (0.4)	53.5	Colorectal	7 (2.9)	64	MIS	36 (10.1)	43
Colorectal	1 (0.2)	N/A	Urology	6 (2.5)	82	Trauma	11 (3.1)	14

Summary table of number of concurrent cases and percent of total cases by campus for the top five services at each campus.

Table 2 – Concurrent Surgeries by Surgeon – ***Redacted here due to risk management concerns***

Table 3 – Univariate and Multivariate Logistic Regression for Concurrent Surgery Risk

Unit Odds Ratios		**Each Scheduled Overlap Surgery**	**Each Scheduled Surgery**	**Each Add-On Surgery**	**Surgeon Mix****
Hahnemann	**Crude**	**2.48 (2.13-2.89)**	**1.07 (1.04-1.10)**	**0.87 (0.73-1.03)**	**1.05 (1.04-1.06)**
	Adjusted*	**1.90 (1.62-2.26)**	**1.05 (1.02-1.08)**	**0.97 (0.78-1.19)**	**1.03 (1.02-1.05)**
Memorial	**Crude**	**1.96 (1.70-2.16)**	**1.00 (0.98-1.02)**	**0.97 (0.89-1.05)**	**1.09 (1.06-1.12)**
	Adjusted*	**1.81 (1.59-2.07)**	**1.01 (0.98-1.04)**	**0.94 (0.85-1.03)**	**1.07 (1.02-1.12)**
University	**Crude**	**1.83 (1.58-2.11)**	**1.01 (0.98-1.04)**	**0.99 (0.94-1.04)**	**1.09 (1.07-1.12)**
	Adjusted*	**1.88 (1.61-2.20)**	**1.00 (0.97-1.04)**	**0.94 (0.89-1.00)**	**1.07 (1.05-1.10)**

*Additionally adjusted for day of week
**Surgeon Mix is calculated as % of total cases performed by the top 5 surgeons ranked by total number of concurrent surgeries performed

Unit odds ratios (95% Confidence Intervals) for each risk covariate investigated stratified by campus. Crude odds ratio refers to univariate analysis, and adjusted odds ratio refers to multivariate model including all four covariates listed in the table and additionally adjusted for day of the week variability.