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SURGICAL OVERLAP ANALYTICS AS A KEY PRODUCTIVITY INDICATOR: A CASE STUDY USING REAL WORLD EVIDENCE

ABSTRACT

Overlapping surgeries, where a surgeon has two patients in different operating rooms, is a practice that is currently under scrutiny. Although the practice has been in use for many decades, especially at teaching hospitals where it is part of the training of new surgeons, the subject is still an area of active research; and it is still unclear if the practice affects patient outcomes despite several recent studies being published. We hypothesized that if Overlapping Surgeries is used as a key performance indicator (KPI), it can provide a means for better management of the processes underlying a surgical case through understanding productivity to support quality improvement measures and control costs by identifying and eliminating sources of waste or inefficiency. This retrospective case study uses the Overlapping Surgeries KPI and new analytics software in order to understand the productivity of de-identified surgeons at an orthopedic specialty hospital using real-world evidence collected from 3,296 total orthopedic surgery cases over approximately 6 months. We show that surgeons at this institution performed 2,007 total Overlap Surgeries, that overlaps were associated with particular types of surgeries (knee and hip arthroplasty), and a small subset of surgeons were primarily responsible for the overlaps. Focusing on the four surgeons who were highest in overlapping cases in the most prevalent procedure (knee arthroplasty), we next evaluated the overall productivity of this group. These four surgeons were similar to their peers in terms of other indicators within the surgeon's control: case volume, on-time starts, scheduling accuracy, block utilization, and materials cost. Interestingly, these surgeons were more likely to perform Triple Overlaps than their peers on the same procedure without affecting PACU recovery times, and they also operated on patients with lower ASA Levels, though the sample size was too small for statistical evaluation. Finally, we introduce here another new KPI for surgeries, Cadence, which measures the timing of intra-operative and post-operative metrics and provides more detailed information than typical Length of Surgery or Wheels-In to Wheels-Out times. We show that the 4 surgeons are similar or superior to their peers performing less overlaps in the tempo of their cases, so the relatively higher number of overlaps was not due to differences in surgeon skill. We are currently extending these results to cost per case and evaluating patient outcomes.

INTRODUCTION

A 2015 Boston Globe article, "Clash in the Name of Care" (1) brought to the publics' attention a practice that has been utilized by some high-volume medical centers: concurrent or overlapping surgical procedures. The article

centered on a case in which a complication arose during a surgical procedure that was one of two procedures performed by a single attending surgeon, at the same time, in separate operating rooms. Whether the complication arose from known risks of the surgical procedure or from unknown added risk due to concurrent surgery is debated. The article called for transparency in disclosing the practice and safety of simultaneous surgery.

It is currently unknown if there is added risk when a surgeon oversees two surgical procedures compared with one surgical procedure and there are varied published studies. Safety has been assumed given the longstanding practice of concurrent surgery, although a search of the literature shows that there are not yet sufficient data to address this question. In April 2016, the American College of Surgeons revised its "Statements on Principles" to specifically define concurrent surgeries (2): "Concurrent or simultaneous operations occur when the critical or key components of the procedures for which the primary attending surgeon is responsible are occurring all or in part at the same time." Here, "critical" or "key" portions are defined as segments of the operation when essential technical expertise and surgical judgment are required for optimal patient outcome and determined by the primary attending surgeon.

Many institutions allow for the practice of overlapping surgery (overlapping surgery being different from simultaneous surgery), which occurs when cases are staggered so that before one case is fully completed, the surgeon may start another case in a separate operating room. But it is expected that the primary surgeon still performs critical portions of each case as the attending physician. There is a time frame for overlap while patients are in both operating rooms, but true simultaneous or concurrent surgery with two patients undergoing operations at the exact same time and the attending surgeon absent for critical portions is avoided, though there is very little published data on the subject. The overlapping time usually involves the time that it takes to transport patients in and out of a room, to place a patient under anesthesia or to wake a patient from anesthesia, to properly position a patient, to close and dress the surgical wound, to provide appropriate nursing care, and to prepare instruments and equipment. The intended benefits of allowing a surgeon to oversee two surgical procedures at once include efficiency, cost-effectiveness, and increased reimbursement.

There are conflicting studies published regarding overlapping surgeries. One study examined the effects of ambulatory orthopedic surgical procedures completed in an overlapping manner on factors such as procedure time and total operating room time, as well as 30-day complications and outcomes (3). This 2017 population-based, matched cohort study reported a significant association of overlapping surgery with Increased risk for complications following hip surgery using data from over 38,000 hip fractures and 52,000 total hip arthroplasties. Another study however at a single institution reported a highly-significant lower mortality rate

for overlapping surgeries (1.3% vs 2.5%, P= 0.0005, n=3,725) as compared to the non-overlapping surgical cohort. Non-overlapping surgery patients were younger and had a lower American Society of Anesthesiologists score (ASA), severity of illness, and mortality risk (4) than non-overlapping surgeries. Overlapping surgery patients were more likely to have longer procedure times, and shorter length of stays. More recently, a multi-center retrospective cohort study was published (5) which concluded that overlapping surgeries are significantly longer, but the outcomes were not significantly different.
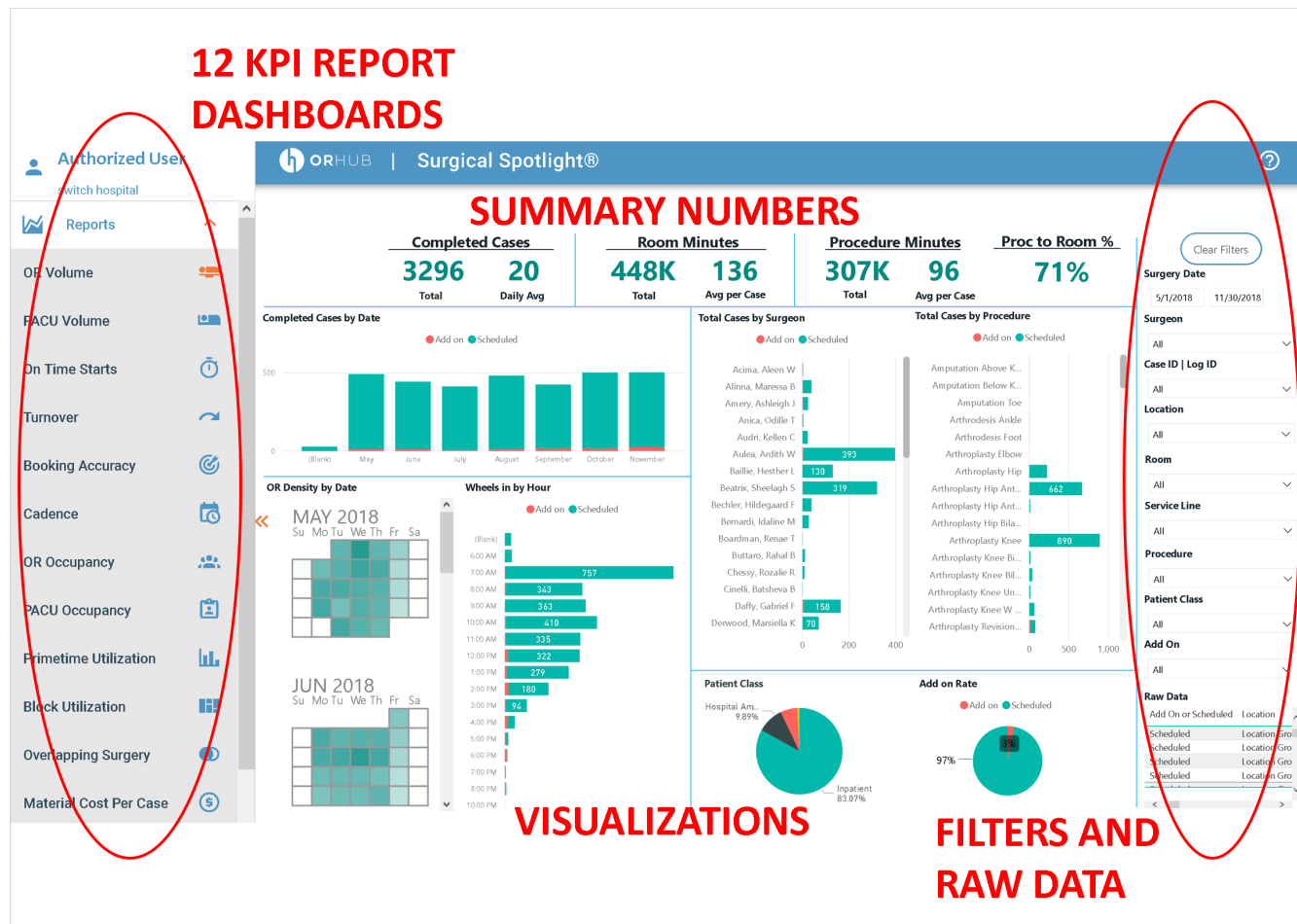
This case study introduces ORHub's Surgical Spotlight™ a cloud-based analytics service with new KPIs for monitoring and managing Overlapping Surgeries. This software is currently in use at both Hospitals and Ambulatory Surgery Centers (ASCs) as a cloud-based analytics tool that helps hospital administrators gain visibility into the key metrics that drive efficiency in the Perioperative lifecycle, without requiring use of PHI or integration with an EMR. The software processes the data into KPI Report Dashboards for each of the 12 KPIs listed in the Table below.

Table 1. Summary of Surgical Spotlight KPIs. New KPIs are highlighted in red.

OR VOLUME	OR OCCUPANCY
PACU VOLUME	PACU OCCUPANCY
ON TIME STARTS	BLOCK UTILIZATION
TURNOVER	ROOM UTILIZATION
BOOKING ACCURACY	MATERIAL CASE COSTS
CADENCE	OVERLAPPING SURGERIES

The overall data is laid-out on a single page or screen, with a left panel that lists the 12 KPI dashboards, and a second right panel that has useful pre-configured filters to sort and "slice" the data by secondary parameters, like date and surgeon or procedure type. The center contains set of pre-configured graphic visualizations specifically tailored to each KPI. For example, in Figure 1 we can see completed cases by date, total cases by surgeon and procedure, and wheels-in by hour of the day in bar graphs, as well as OR density in calendar view, and pie charts for patient classification and overall add-on rates. This one KPI Report Dashboard for OR Volume, displays 8 total graphic visualizations for a comprehensive evaluation of the OR Volume KPI, and in a format that can be seen in a single field.

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Figure 1. Overall Layout of Surgical Spotlight Showing OR Volume KPI Report Dashboard
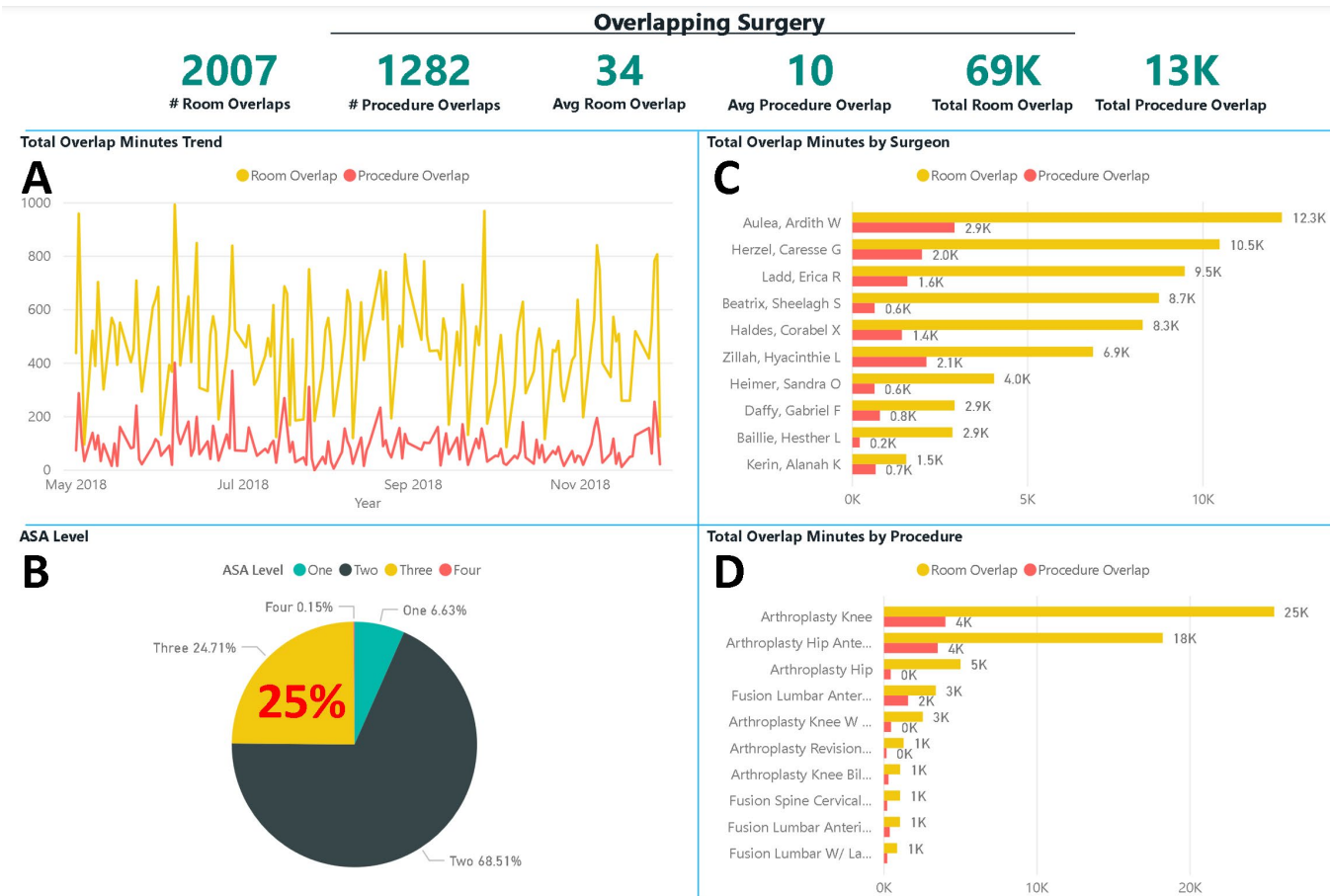

METHODS

Data was provided from a 5-star rated, hospital-owned orthopedics institute in metropolitan California that included a total of 3296 surgical cases from 5/1/2019 until 12/31/2019. These surgeries comprised approximately 80% inpatient, 10% ambulatory, and 10% extended hospital outpatients. No personal healthcare information was used at any time and all individual physician's names were de-identified. Data was obtained from 2015 CEHRT-certified EMR software via automated data transfers that did not require EHR or ORIS integration. All data was securely uploaded to the ORHub web server and was processed with ORHub's Surgical Spotlight™ cloud platform and proprietary software algorithms using Microsoft PowerBI tools. Since the data is provided as a single web-portal with real-time filtering and drill-down capabilities, the entire analysis was completed by a single person in a matter of hours, although preparing the automated data feeds required some analytics training skills.

RESULTS

Surgical Overlap KPI

The Surgical Overlap KPI Report Dashboard summary data for this case study is shown below in Figure 2. Analysis showed that there were 2,007 total Room Overlap cases and 1,282 total Procedure Overlap cases from 5/1/2018 to 12/31/2018. Data is shown for all surgeries with overlaps in Room Times or Procedure Times.

Figure 2 Surgical Overlap KPI Report Dashboard for All Procedures.

Panel A shows the line graph of all cases over the time period specified in the filter (May 2018 to December 2018), panel B shows the American Society of Anesthesiologists (ASA) ratings for the identified Overlap cases with ASA Level 3 case averages overlaid in red; panel C and D show the breakdown by Surgeon and Procedure type, respectively. Panel D also shows that unilateral total knee and hip arthroplasty accounted for most overlap

cases, and knee arthroplasty procedures were single highest during this time period, and thus we further analyzed these cases as a separate cohort

Since unilateral total knee arthroscopy (TKA) was the single procedure responsible for the greatest number of overlap minutes, we next identified the surgeons who were the largest contributors to overlap minutes to begin to understand the factors that contribute to the increased Procedure Overlap Figure 3 shows surgeon Aulea, Beatrix, Haldes, and Ladd were the top 4 and were responsible for 3,079 of 4,016 total Procedure Overlap minutes (77%).
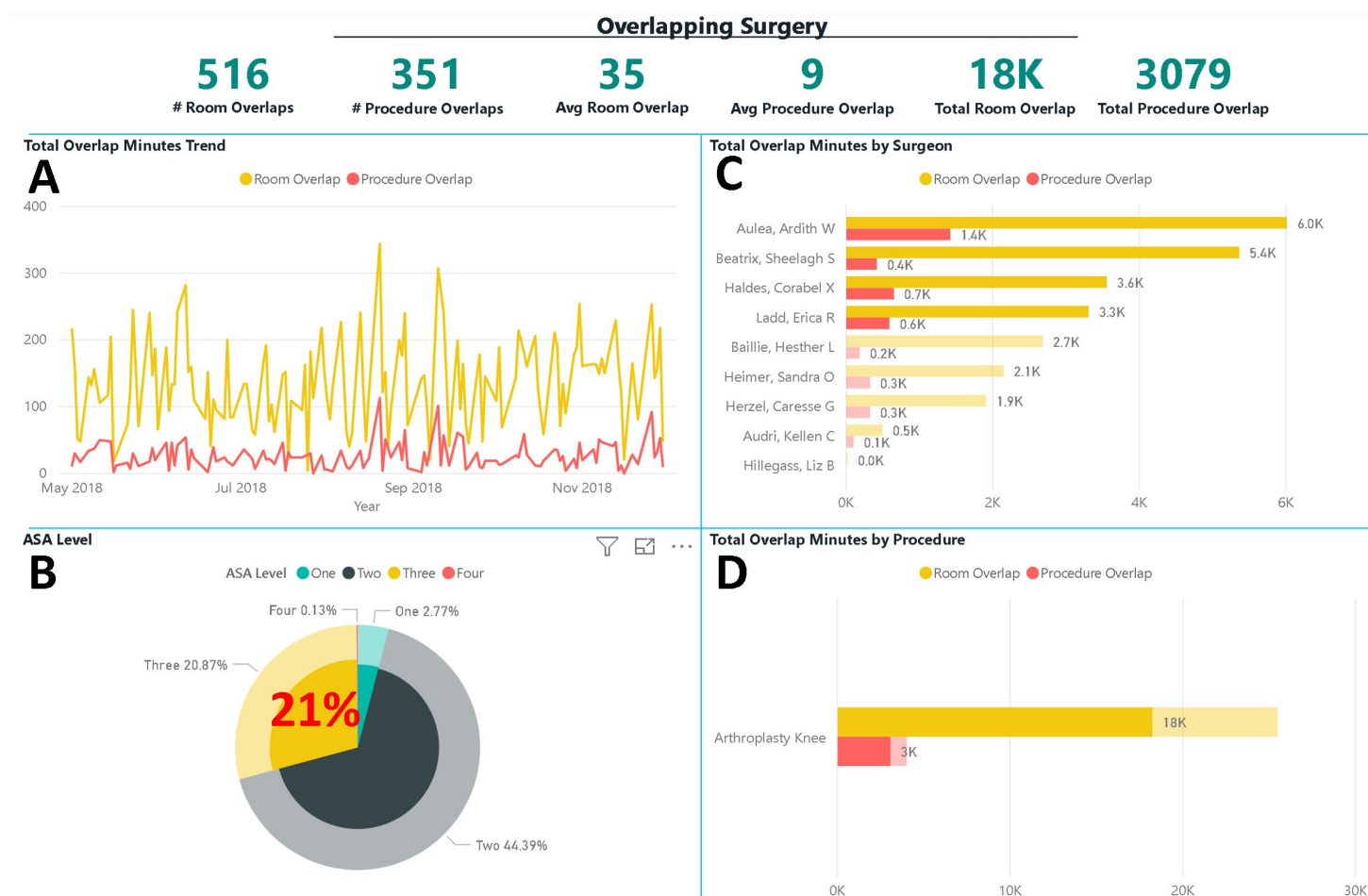
Figure 3. Surgical Overlap KPI Report Dashboard- Filtered for Unilateral Total Knee Arthroplasty Procedures

Comparing Figures 2 and 3, panel B shows that the TKA cases were in fact composed of a slightly higher incidence of ASA Level 3 patients; these patients would be expected to be more complicated surgical cases, considering the increased morbidity within the TKA cohort (25% total vs 29% UKA cohort).
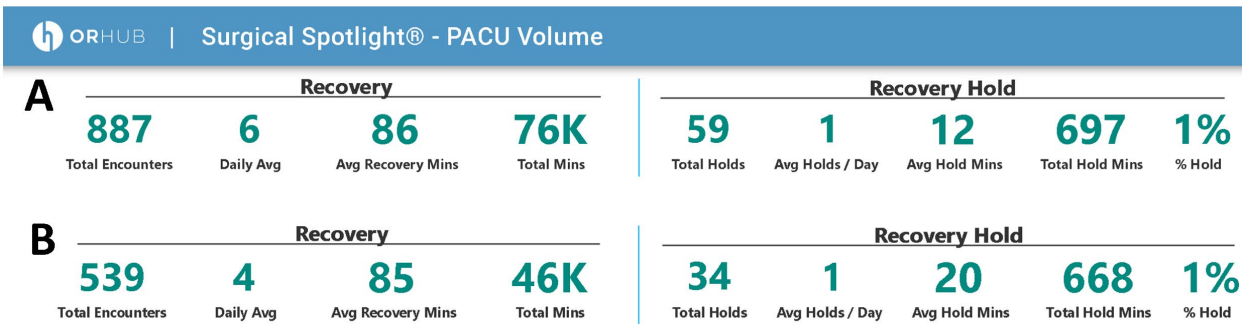
However, when the top 4 surgeons with most Procedure Overlap minutes were compared as a separate cohort, they in fact were positively-associated with lower ASA Levels. The surgical cases (see Figure 4 below) for these 4 surgeons, when analyzed as a separate cohort, were approximately 21% ASA Level 3.

Figure 4. Surgical Overlap KPI Report Dashboard- Filtered for Both UKA Procedure and Top 4 Surgeons

Overlapping Surgery

516	351	35	9	18K	3079
# Room Overlaps	# Procedure Overlaps	Avg Room Overlap	Avg Procedure Overlap	Total Room Overlap	Total Procedure Overlap

Total Overlap Minutes Trend

A

Room Overlap ● Procedure Overlap

Total Overlap Minutes by Surgeon

C

Room Overlap ● Procedure Overlap

- Aulea, Ardith W — 6.0K / 1.4K
- Beatrix, Sheelagh S — 5.4K / 0.4K
- Haldes, Corabel X — 3.6K / 0.7K
- Ladd, Erica R — 3.3K / 0.6K
- Baillie, Hesther L — 2.7K / 0.2K
- Heimer, Sandra O — 2.1K / 0.3K
- Herzel, Caresse G — 1.9K / 0.3K
- Audri, Kellen C — 0.5K / 0.1K
- Hillegass, Liz B — 0.0K

ASA Level

B

ASA Level ● One ● Two ● Three ● Four

21%

- Four 0.13%
- One 2.77%
- Three 20.87%
- Two 44.39%

Total Overlap Minutes by Procedure

D

Room Overlap ● Procedure Overlap

Arthroplasty Knee — 18K / 3K

Since patients with higher ASA Levels were not associated with cases with highest overlap minutes in these surgeon's same-procedure cases, we next evaluated if these overlap procedures affected recovery times in the Perioperative Anesthesia Recovery Unit (PACU), and the same 4 surgeons were evaluated on another KPI Dashboard Report, PACU Volume. Figure 5 shows the results of comparison of all surgeons TKA cases for PACU recovery metrics (row A in Figure 5) in comparison to the 4 surgeons with relatively higher Overlap Surgeries (row B in Figure 5). The results showed that there was no apparent differences in recovery minutes, (86 minutes vs 85 minutes for High Overlap surgeons), although boarded recovery minutes, where the patient is essentially waiting in the PACU but is clinically-released by the anesthesiologist for various administrative reasons, were slightly higher for the High Overlap Surgeons (20 minutes vs 12 minutes). Further examination of the raw data for these PACU cases showed that a small number of outlier cases where the Ambulatory and Outpatient were waiting for reasons outside the surgeon's and anesthesiologists control (data not shown).

Figure 5 PACU Volume KPI Report Summary- TKA Procedures Comparing All Surgeons to 4 Surgeons with Highest Overlaps
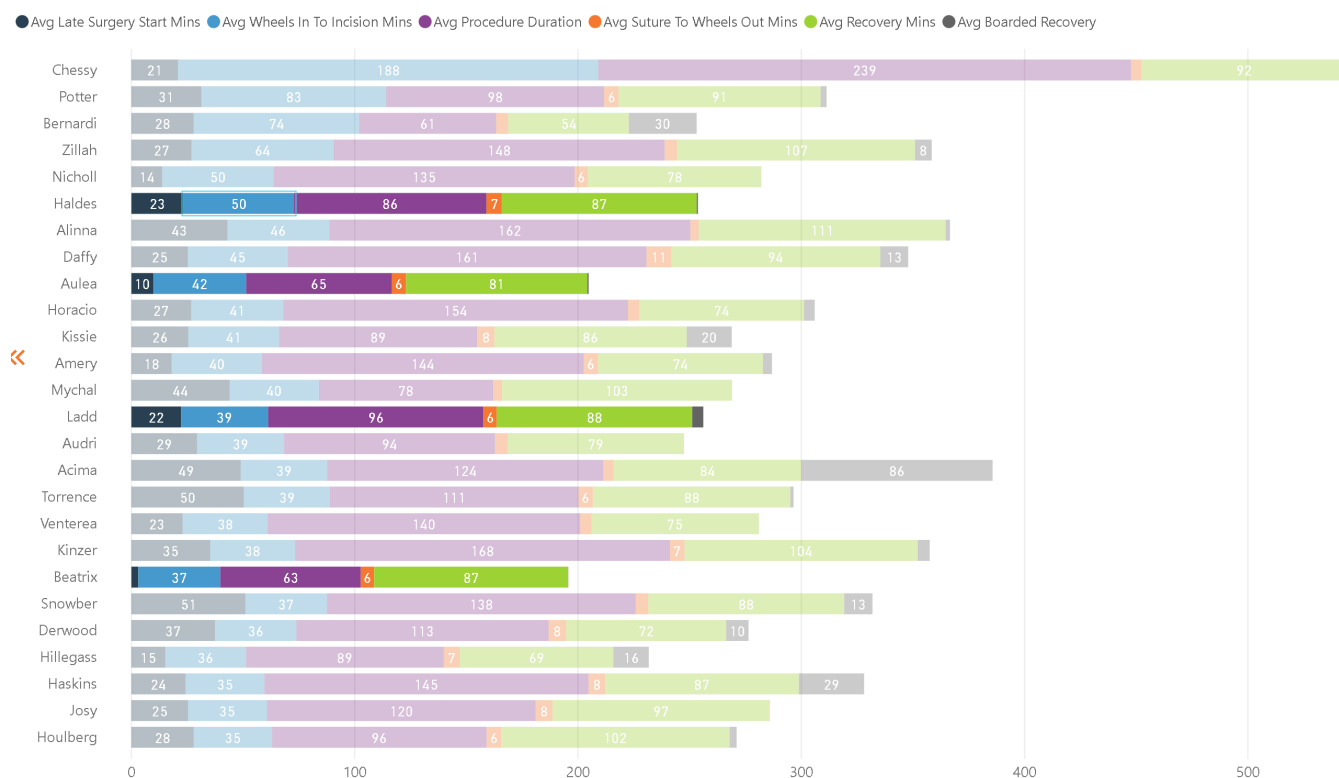

		ORHUB	Surgical Spotlight® - PACU Volume						

A

	Recovery				Recovery Hold			
887	6	86	76K	59	1	12	697	1%
Total Encounters	Daily Avg	Avg Recovery Mins	Total Mins	Total Holds	Avg Holds / Day	Avg Hold Mins	Total Hold Mins	% Hold

B

	Recovery				Recovery Hold			
539	4	85	46K	34	1	20	668	1%
Total Encounters	Daily Avg	Avg Recovery Mins	Total Mins	Total Holds	Avg Holds / Day	Avg Hold Mins	Total Hold Mins	% Hold

Cadence KPI

Since the results indicated that overlapping procedures were not apparently due to cases with more technically-challenging patients displaying relatively poorer overall health, we hypothesized that there was a difference in the efficiency of performing the same procedure, however the standard measure for this is Length of Surgery (i.e. Procedure Times here) these were not sufficient, so ORHub developed another new KPI which provides further granularity within the intraoperative and postoperative phases of the surgery process.

Figure 6 shows the results for Cadence KPI for the 4 surgeons with the highest prevalence of Procedure Overlap in relation to all other TKA procedures for the tempo of surgeries. These average times displayed in the Cadence KPI bar graph for TKA procedures did not appear to vary significantly from other surgeons who did not associate with high Procedure Overlap minutes. In fact, they are clearly no different than their peers, though this sample size is too under-powered for a statistical comparison to ascertain significance, we observed that these surgeons were not higher in overlapping surgical cases due to relatively slower tempo of the intra- and post-operative time metrics within this KPI. Additionally, these surgeons were no different than their peers for late starts apparently and were as fast or faster than other surgeons on this procedure.
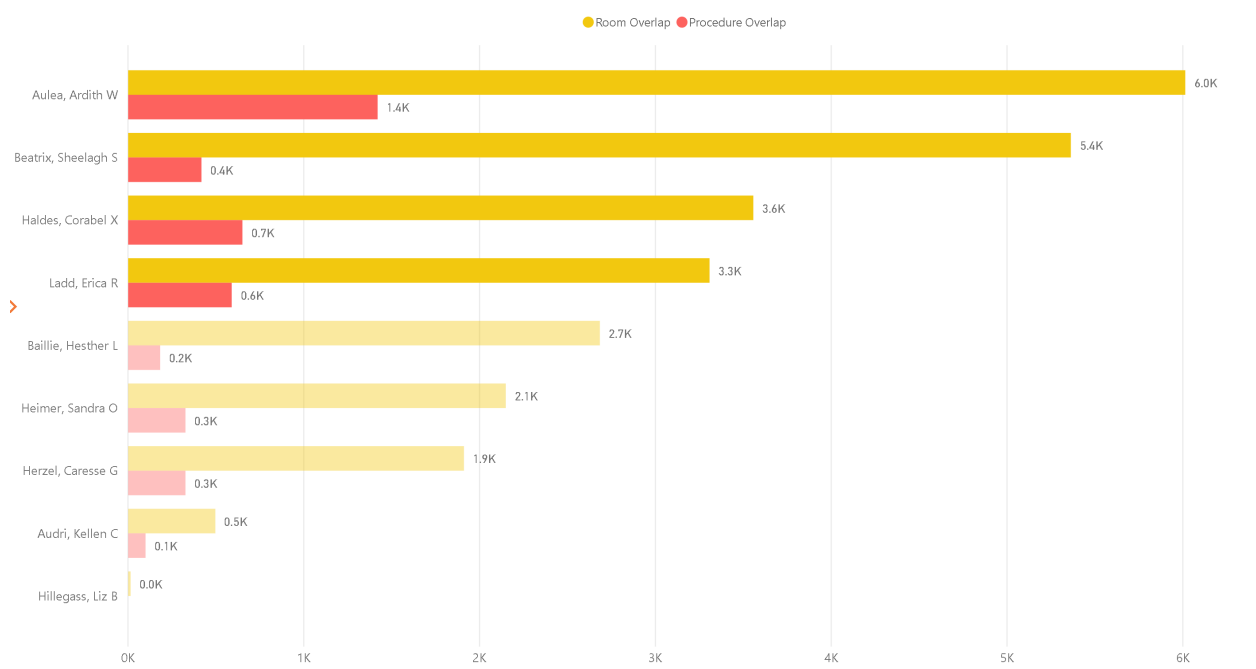
Prevalence of Triple-Overlaps by Surgeons with High Overlap Cases

When these surgeons were analyzed further to determine the reasons behind the high number of overlap cases in other KPI's (data not shown), it was observed that the number of triple-overlap procedures, i.e. having 3 surgeries with overlapping procedure times, was associated with these same surgeons since they also had the highest number of a single overlap. Figure 6 shows the highlighted top 10 cases for Procedure Overlap in the TKA cohort, that also had triple-overlapping procedures.

Figure 7. Triple Overlaps Associated with TKA Procedures and Top 4 Surgeons with High Overlap Minutes.

Discussion

This case study provides an example of a new analytics tool which includes KPIs for Surgical Overlap cases and Cadence metrics during surgery and recovery, for the first time to the best of our knowledge. We have applied this tool using actual RWE from over 3200 cases at a top-ranked specialty surgery hospital using absolutely no PHI, using limited data and minimal time and resources for this retrospective study.

We were able to perform the analysis and investigation parts of this case study in a matter of just hours by a single analyst. This was achievable in part due to the light-weight nature of the minimal data feeds, and in part we also believe due to the uniquely curated KPI Report Dashboards, which are already organized in a fashion that facilitates the types of analyses that most frequently occur when a team of surgeons, nurses, and administrators seek to act cooperatively to apply Lean Manufacturing principles with new surgical analytics.

The utility we present in this case study, in examining efficiencies between and amongst surgeons and OR staff, is not surprising considering the Surgical Spotlight tool was developed with insight from a combined team of ORHub software engineers, practicing surgeons, and surgical operations experts. The approach taken for Surgical Overlap, which is an off-shoot of work on another system that was oriented towards resource management and costs, was to evaluate it as a separate KPI, therefore the KPI Report Dashboard identifies cases

with overlap minutes and associates them by time, surgeon, procedure, and ASA Level for visualization and further analyses.

The need for associating reliable and timely costs data with real dollar values to these types of KPI metrics using web-based analytics tools is clear and vital to any effort to improve the business of surgery but is beyond the scope of this study and will be presented in another article that is currently in preparation.

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