**Paper format**

Papers are to be 8-10 pages, single spaced with 1 inch margins using 11 or 12 point Times New Roman or Arial fonts. This limit does not include Literature Cited, Appendices (see Figures, below), Figure legends, or the cover page. It does include the Abstract. The format is of a typical scientific/medical manuscript with each section described in detail below. Pages must be numbered sequentially.

Cover page: This is the first page of the manuscript. It should state the title of the work, the names of authors (Discovery student should be first author) and their affiliations. The last author should be the lead mentor or official advisor. For any non-Emory mentor, please include contact information. The cover page **does not count** toward the page limit.

The Value of a Saturday Dedicated Orthopaedic Trauma Operating Room

Robert Runner BS, Thomas Moore Jr. MD, William Reisman, MD

Emory University Department of Orthopaedics

**Abstract:** This is the second page of the manuscript. Begin page numbering at this page. The abstract should be no more than 1 page, with a limit of 350 words maximum. Abstracts typically contain a few sentences of background, a description of the research question addressed in the manuscript, description of the findings and consideration of the significance of the findings.

Hospital administrations constantly face cost-benefit decisions in balancing financial and patient care interests. These pressures are greatly enhanced at a large academic level 1 trauma center with recurring financial hardships like Grady Memorial Hospital. Providing quality care for patients in an efficient delivery model is imperative. One potential way to increase efficiency within the Orthopaedic Department is to clear cases by operating more often, which could potentially reduce costs by reducing length of stay (LOS).

Beginning November 1, 2010, the Orthopaedics and Anesthesia departments implemented a new policy to have a dedicated Saturday orthopaedic operating room to provide more continuous care for patients and efficiently work through a large caseload. The aim of this study is to assess the efficacy of this additional operative day by the primary outcomes of reduced LOS and decreased surgical waiting time by comparing trauma patients admitted with femur or tibia fractures one year prior to the implementation of this dedicated orthopaedic trauma OR to patients admitted in the year after this policy change.

We found that after the addition of a dedicated Saturday orthopaedic operating room, the overall LOS for patients admitted with femur or tibia fractures after this policy change was significantly reduced by 2.7 days from a mean of 14.0 days to 11.3 days (p value 0.018). Additionally, there was a trend towards shorter waiting time to surgery, average reduction of 25.1 hours, for patients admitted on a Friday (48.6 hrs vs 23.5 hrs, p value 0.06). Furthermore, there was an increase in the number of cases performed on Saturday by 59% (6.2% of the total caseload) while the originally disproportionally high proportion of cases on Monday was appropriately reduced by 33% (6.7% of the total caseload). Overall, these findings support the continuation of a dedicated Saturday orthopaedic trauma OR and can provide the foundation for other departments with similar circumstances to negotiate for more operative time on weekends to improve efficiency.

**Introduction:** This section provides the necessary background for the study to introduce the topic and put it in context, the purpose of the study and a lead-in to the work that will be done. This section should be approximately 1.5 to 2 pages.

Given the current economic and political climate, it is important for hospital administrations to analyze financial data and support cost reduction strategies in healthcare, especially at a government funded hospital like Grady Memorial Hospital. Grady is a level 1 trauma center serving patients across Georgia and has faced significant financial strain in recent years. Orthopaedic trauma accounts for a substantial portion of operations; therefore, adjusting orthopaedic protocols or operating room (OR) scheduling can significantly impact the overall cost that Grady and its patients incur. One major contributor to healthcare spending is length of hospital stay (LOS) as it costs between $1,000 - 3,000 for each additional hospital day. Systems based changes that reduce length of stay while maintaining quality of care can directly decrease healthcare costs and benefit both the patient and the hospital.

Each orthopaedic trauma case requires significant resources. In addition to the attending surgeon, at least one scrub nurse and a surgical assistant of a resident or surgical nurse is needed for instrument delivery and patient manipulation. Additionally, a circulating nurse, a dedicated radiographer, and an anesthesiologist are required (Griffiths). Due to these high costs, Grady did not have a dedicated orthopaedic trauma OR on Saturdays until November 2010. Prior to this time, the most urgent cases that presented on weekends were covered using ORs meant for all surgical specialties; however, some surgeries needed to be delayed until the beginning of the workweek as there were a limited number of surgeons and operating support staff available. This study’s hypothesis is that these delays in patient care impact healthcare costs, LOS and possibly even patient morbidity.

Recent studies show that immediate surgical intervention represents one way to reduce complications. One study performed at Grady and published in 2007 demonstrated that femoral shaft fractures fixed using intramedullary nailing within 24hours from presentation to the emergency department (ED) had significantly lower LOS. (Pendleton) The average LOS for a patient with an isolated femoral shaft fracture was 3.9 days with 25% of patients staying over 4 days. At that time, the average time from arrival to the hospital to surgery was 17.2 hours (Pendleton). Additionally, a systematic review specifically analyzing hip fractures published in 2009 concluded that early surgery within 48 hours of admission reduced hospital stay (Khan 2009). The reduction in LOS with early intervention is further supported by the prospective cohort study performed in 2004 which found a reduction in LOS and pain scores associated with early surgery, while mortality was not affected (Orosz). These studies of isolated fractures may not fully represent the caseload of an orthopaedic trauma service which oftentimes cares for multiply injured patients who require multiple surgeries and continually works with the general surgery trauma service managing these patients. Part of the assessment of trauma patients is the injury severity score (ISS), a quantitative measure of the significance of patient injuries. Isolated fractures of the femur or tibia correlate to an ISS of 4 and 9 respectively. Many patients seen at larger trauma centers have multiple injuries, larger ISS, and longer hospital stays. There are many scoring mechanisms for assessing trauma patient injuries including the Injury Severity Score (ISS), Trauma and Injury Severity Score (TRISS), and ICD 9 Code Based Injury Severity Score (ICISS). The overall goal of these scoring indices is to predict not only outcomes for patients but also resource utilization, LOS and overall cost. (Rutldege)

As a large publically funded level 1 trauma center serving the greater Georgia community, Grady must adapt to efficiently work with its limited resources. Prior to November 2010, there were only two active trauma operating suites on weekends. One remained open for potential immediate general trauma surgery cases, while the other was shared by subspecialty services like orthopaedics, urology, neurosurgery, and ENT. Posted or scheduled orthopaedic cases could be delayed or even cancelled if other services had a more immediate need for the OR. This lead to an overloaded surgical schedule on Mondays in order to catch up from the weekend admissions. The Orthopaedics Department began working with the hospital administration and was able to obtain a dedicated orthopaedic trauma OR on Saturdays starting November 1, 2010. Since the implementation of this policy, definitive analysis of the effect of this change has yet to be completed. Examining the outcomes, like LOS and waiting time to surgery for patients admitted one year pre- and post-policy change will be important. This analysis seeks to capture the effects of this policy change and to determine if it should be continued at Grady. Additionally, this analysis could serve as the foundation for other institutions that do not currently have dedicated Saturday orthopaedic operating rooms to adopt this new policy.

**Materials and Methods:** This section describes how the data were collected and analyzed. The information should be sufficient to allow others to reproduce the study. For analysis of patient data, include information on how/where the data was collected. Include a statement regarding human subjects/IRB approvals if relevant. Include a description of statistical analyses performed if appropriate; do not just give the name of a software package. This section will likely be 1 to 2 pages, depending on the number of different approaches used.

This study is a retrospective chart review. Patients were identified by querying the Grady Trauma Registry which stores data from all trauma patients who are evaluated in the Grady emergency department. Eligible medical record numbers of patients with a lower extremity fracture as documented by an ICD-9 code of femur or tibial shaft fracture who were admitted to Grady Memorial Hospital from November 1, 2009 through October 31, 2011. 475 patients with femur or tibia fractures were identified as being admitted to the hospital during this eligibility period. Of these 475 total patients, 167 were directly admitted to the orthopeadic trauma team, while the other 308 were admitted to the general surgery trauma team and had the orthopaedic team in consultation. Patients who had no operation during their admission were excluded from the study. Patients who were misclassified as having a femur or tibia fracture in the trauma database but on further chart review did not have an operative femur or tibia fracture were excluded as well. Specific patient charts were collected from the Grady Medical Records office over a period of 4 months using a combination of paper charts and EPIC electronic medical record. A thorough chart review was performed for each subject and data stored using Microsoft Excel. Specific data points collected included: date of injury, date presented to emergency department, arrival time in emergency department, date of surgery, surgical incision time, date of discharge, age, gender, race, ISS, and mechanism of injury. Length of stay was calculated using the difference in the date of arrival and date of discharge. Waiting time to surgery was calculated by determining the length of time in hours from arrival in the emergency department to surgical incision time as documented in anesthesia reports. There were no significant changes in number of faculty caring for these patients during the analyzed two year period.

Strict patient confidentiality was maintained throughout the data collection process. Ethical consideration and permission from the Emory Institutional Review Board (IRB) and Grady Research Oversight Committee to perform this study was obtained prior to data collection. Personal health information of subjects was de-identified in accordance with IRB guidelines.

Statistical analysis: Kruskal-Wallis one way analysis of variance was used to analyze the continuous variables as it is a non-parametric method and does not need the assumption of a normal distribution of the outcomes as required by traditional student t-test. The Kruskal-Wallis test was used to analyze the waiting time, LOS, ISS, and age. Two-tailed Fisher’s exact test was used to analyze the categorical variables of race, day of the week of injury, and mechanism of injury. Additionally Spearman’s rank correlation coefficients were calculated to assess the nonparametric measures of statistical dependence between ISS and LOS. Further analysis using Hoeffding Dependence coefficients was performed to test the non-linear correlation between ISS and LOS. To assess for a linear relationship between ISS and LOS, linear fitting plots were obtained and R-square values calculated. All the analyses were performed with SAS 9.3 (SAS Institute Inc., Cary, NC; 2011).

**Results:** This section presents the study findings and may refer to tables, graphs, images, and other types of data. The data are presented in Figures, which should be included individually at the end of the paper. Results should briefly state the experiment or study performed (details are found in Materials and Methods), present and describe the results with enough information and interpretation to explain the data and provide the basis for the subsequent experiments/studies performed. This section will most likely be the longest of the paper and may be 3-5 pages.

Based on this retrospective chart review of 475 patients with operative tibia or femur fractures seen at Grady Memorial Hospital from November 1, 2009 to October 31, 2011, 20 patients were excluded from analysis. 4 of the 475 patient charts were unable to be located by the medical records service. 6 patients in the pre group and 6 in the post group were removed as they were treated with non-operative management. 4 patients were misclassified as having a femur or tibia fracture in the original MRN search from the Grady trauma registry, when on full chart review these patients actually had a patella, calcaneus, or metatarsal fracture; thus a total of 455 charts were analyzed.

As shown in table 1, the demographic data of age and mechanism of injury were not significantly different between the groups. The mean age was 37.8 and 38.8 for the pre and post-policy change groups respectively. Major mechanisms of injury included falls, gunshots, motorcycle crash and motor vehicle crash and were not significantly different between the groups. There was a significant difference in the racial distribution between the two groups (p value <0.0001) with a larger portion of African-American patients admitted (55.2% vs 71.5%) in the post policy change group as compared to a relative decrease in Caucasian (34.3% vs 21.5%) and Hispanic (7.1% vs 0.9%).

In comparing the injury severity score between the pre and post groups, there was a significant difference (p value 0.022) with a reduction in mean ISS from 12.1 to 10.6. In order to determine if the reduced LOS in the post policy group could be accounted for by the reduction in ISS, several methods were used to assess independence of these two variables. First the co-linearity of LOS and ISS using linear fitting plots (Figure 1) were calculated and showed R-square values of 0.24 and 0.15 for the pre and post groups respectively; both were below the standard 0.5 cutoff for acceptable linear relationship, indicating that a direct linear relationship was unlikely between ISS and LOS. Additionally the Spearman Correlation between ISS and LOS was calculated as 0.42 and the Hoeffding Dependence coefficient D=0.055. These nonparametric measures of statistical dependence are used to evaluate if continuous variables such as ISS and LOS are independent of one another. From these calculations, ISS and LOS do not directly show a linear or nonlinear relationship between ISS and LOS. Thus, it appears the overall reduction in LOS (as described below) between the two groups is not fully dependent on the difference in ISS between the groups.

With respect to the distribution of the case load shown in table 2, there was an increase in the number of cases performed on Saturdays after the addition of the dedicated Saturday orthopaedic trauma OR. Prior to the policy change, 10.5% of the cases (25/239) were completed on Saturday.  After the new policy 16.7% of cases (36/216) were performed on a Saturday.  This is a relative 59% increase in the number of cases done on Saturday (p-value 0.055) and corresponds to an absolute increase of 6.2% of the overall case load. Additionally, there was a trend towards a reduction in cases performed on Mondays with 20.1% (48/239) performed prior and 13.4% (29/216) performed after the implementation of the Saturday OR (relative decrease of 33%, p value 0.062). Although neither of the calculated p values was below 0.05, they do display the strong trend towards the change in case distribution. Additionally, the more balanced workload is reflected in the overall comparison between the caseload distribution pre and post policy change (p value 0.09).

Additionally, overall LOS and LOS based on the day of the week the patient presented to the ED were analyzed between the two groups. As seen in table 3, the overall LOS was significantly reduced by 2.7 days from average 14.0 days to 11.3 days (p value 0.018). The most significant reductions in LOS between the groups were seen in the subset of patients admitted on a Monday or Wednesday. The mean LOS for patients admitted on a Monday was reduced from 20.5 days to 11.3 days (p value 0.011) while the mean LOS for patients admitted on a Wednesday had reduced mean LOS from 13.7 to 9.2 days (p value 0.088).

Another primary outcome analyzed was the waiting time to surgery, which was calculated as the time between the patient’s arrival time in the ED to surgical incision time. These data are displayed in table 4. Although there was no significant reduction in overall waiting time after the extra OR day, there was a strong trend towards a reduction in the waiting time for patients who presented on a Friday. Patients presenting on Friday had on average a 25.1 hour reduced waiting time (48.6 vs 23.5 hours) after the addition of a dedicated Saturday orthopaedic trauma OR (p value 0.060). There was no significant decrease in waiting time for patients presenting on any other day of the week.

**Discussion:** This section is where the interpretation and conclusions drawn from the data are presented, as well as consideration of the results in the context of what is known from other published studies. Do not simply repeat the findings as in Results, this is your opportunity to explain to others the ***significance*** of what you have found. This section will likely be about 2 pages.

Based on this retrospective chart review comparing patient data from one year prior to the implementation of a dedicated Saturday orthopaedic trauma OR to one year after this policy change, three major conclusions were observed. First, the overall length of stay was reduced by a mean of 2.7 days in patients seen after the implementation of the Saturday dedicated orthopaedic trauma OR. This reduction from 14.0 days to 11.3 days was an appropriate decrease and larger than the expected 1-2 day decrease in LOS from a single additional OR day. From analysis of the subgroups based on date of admission, the major reduction in LOS was in patients admitted on Monday (mean LOS reduced from 20.5 days to 11.3 days, p value 0.011) and Wednesday (mean LOS reduced from 13.7 to 9.2 days, p value 0.088). Logically, the longer a patient stays in the hospital, the higher the cost of care and sicker patients tend to remain in the hospital longer. These straightforward conclusions have been proven specifically for trauma patients as prior studies have shown increased cost associated with longer hospital stays and higher injury severity scores (Dinh). Reducing the average LOS for patients is a major focus of hospital administrations as reduced LOS is a surrogate for reducing the cost of patient care. The business model of the hospital is to provide quality patient care while efficiently treating and discharging patients. Given the changes occurring in the healthcare model with the potential for a flat rate reimbursement for admission diagnosis, these efficiencies will be critical in maintaining hospital solvency in the near future. Policy changes that decrease LOS such as this additional operative day could be part of the solution to reduce overall hospital costs. Further microeconomic specific marginal cost-benefit analysis utilizing the confidential salaries of the necessary OR personnel (attending orthopedist, anesthesiologist, scrub nurses, circulator, radiographer) required to run the room can be compared to the reduction in LOS and estimated overall cost savings calculated. Assuming each procedure is profitable at baseline, the higher volume of cases capable of being performed should yield higher revenue and profits for the hospital while also cutting costs by reducing LOS. Overall this transition to a more factory style or seven days per week operating schedule may be part of the future of hospitals in order to remain profitable.

Prior data from Grady have shown a reduction in LOS for patients with isolated femoral shaft fractures if they were treated with early fixation and surgery within 24 hours. (Pendleton). The subjects analyzed in our sample often had multiple injuries and higher injury severity scores (overall average 11.4) than isolated femoral shaft fracture patients. Additionally our group of patients had a longer average waiting time to surgery of 33.3 hours compared to the average 17.2 hours for isolated femur fracture patients. Factors such as longer time to surgery likely compounds in the multiple trauma patient with more severe injuries under current analysis and could contribute to the higher overall mean LOS of 12.7 days compared to Pendleton’s findings of 3.9 day mean LOS. Additionally, patients with isolated femur fractures are often immediately treated with a single surgery for definitive fixation. Many of the patients in our sample required temporary external fixation followed by a second surgery for definitive fixation during their inpatient stay that directly contributed to the higher mean length of stay when compared to isolated fracture patients. Additionally, both of these groups have similar reasons for unnecessarily prolonged lengths of stay in the Grady population that likely continue to increase hospital costs. One significant factor found by Pendleton et. al. was a delayed time to first physical therapy visit, greater than one day, which was found to contribute to a longer LOS. Time to first PT visit was not specifically analyzed in our sample; however, many social, medical and hospital delays can contribute to a patient’s prolonged hospitalization. Some social factors such as inadequate living situation required to maintain cleanliness of external fixation devices are not under direct control of physicians. However, some hospital system based factors that can be directly affected by physicians should be adjusted to increase efficiency. One proposed solution to reducing unnecessarily prolonged LOS for a patient is to have ancillary services like physical therapy and social services function in a greater capacity on weekends as well. Transition to a more continuous delivery model for healthcare can help improve efficiency within the hospital system. Additionally, providing appropriate pathways for prompt outpatient follow-up and outpatient surgical scheduling for definitive fixation in appropriate cases can help directly reduce inpatient length of stay and hospital costs. By achieving these goals through improved clinic scheduling and dedicated outpatient facilities, limited resources can be utilized more efficiently.

Given the trend towards damage control orthopaedics with temporary fixation over immediate definitive fixation, the use of temporizing external fixation devices have become more prevalent. Many patients, especially multi-trauma patients, are often too unstable for definitive treatment with an intramedullary nail and require quick stabilization, followed by a staged surgery with a subsequent procedure days to weeks later for definitive fixation (Nowotarski). In other patients with open fractures or severely damaged surrounding soft tissue, it may be more beneficial to delay definitive fracture fixation to reduce the risk of infection (Jenny). The use of delayed fixation could contribute to longer a LOS in the multi-trauma patient. Alternatively, anther subset of patients with delayed fixation for an isolated injury and stable social support may actually have a lower LOS. These reliable patients can be sent home with a temporary external fixation device and return after 7-10 days for outpatient surgery for definitive fixation. Thus with reliable follow-up and an efficient outpatient surgery team, inpatient hospital LOS and costs can be reduced for these kinds of patients.

Additionally, the waiting time to surgery was decreased by an average 25.1 hours in patients admitted on a Friday after the policy change. Before the orthopaedic department had dedicated access to a Saturday OR, these “cold trauma” patients would often wait until Monday or Tuesday of the next week for surgical fixation as emergent cases could bump them from the shared Saturday schedule. Although the overall waiting time to surgery did not change between the two groups, our isolated result of the decrease in waiting time for patients admitted on Friday is as expected since these patients have the best ability to take advantage of shorter waiting time with the Saturday OR being the next day.

It was surprising that this increased efficiency in getting Friday patients to surgery faster did not reflect in a shorter LOS for this subset of patients. Although they trended towards a lower LOS after the policy change (11.4 days vs 10.0 days), the calculated p value of 0.21 was not significant. One explanation could be a delay in working with physical therapy (PT). Often, there are delays in physical therapists seeing patients on weekends. The time to first PT visit was not obtained during initial chart review to assess a delayed initiation of PT on LOS for our patient group; however, future analysis would be beneficial in assessing this outcome.

There are many complications associated with long bone fracture fixation such as acute respiratory distress syndrome, fat embolism syndrome and pneumonia given the marrow infiltration into the blood during reaming of the canal. Although the debate in orthopaedic trauma continues, there have been studies showing that early definitive stabilization of femoral shaft fractures is associated with better outcomes, even in patients with multiple injuries (Nahm). Similar results are demonstrated by Brundage et al, who showed that although early fixation did not affect mortality, there was a reduction in complications and hospital stay for patients with early fixation within 24 hours (Brundage). Thus the goal of the orthopaedics department and hospital staff should be early appropriate fixation in patients to not only improve outcome, but also decrease cost by reduced LOS.

Finally, our results show how the additional operative day allows for a more even distribution of caseload within the week. The 6.2% absolute increase and 59% relative increase (p value 0.055) in the percentage of cases performed on Saturday was likely due to specifically scheduling cases for that day in the dedicated orthopaedic trauma OR. The chief residents, who schedule the cases, had additional operative time to schedule the “cold trauma” cases, and these cases would not be cancelled for other service’s emergent or urgent cases. This increase on Saturday was appropriately matched by a 6.7% absolute decrease and 33% relative decrease in the percentage of cases performed on Mondays (p value 0.062). This decrease caseload on Monday was a direct result of the ability to complete cases on the previous Saturday. The overall redistribution of case load creates a steady workflow. Prior to the extra operative day, the trauma team would frequently operate late into Monday evening trying to catch up on the weekend caseload. With the addition of the extra Saturday operative day, these cases are completed sooner and do not overwhelm the start of the workweek. Additionally, residents are able to keep within the duty hour restrictions as the staff who normally are present in house on Saturday can accomplish cases and prevent the backup of cases for Monday.

One of the limitations of this study is the significant difference in injury severity scores between the pre and post policy groups. It would be expected that the patient population and trauma admitted would not have significantly changed in the year before the Saturday OR and the year following. However, the significantly lower ISS values (12.1 vs 10.6, p value 0.022) for the pre and post groups reflect a relatively less injured patient population for the post policy group. Our analysis attempted to identify the effects of this potential confounding variable by comparing ISS and LOS using linear modeling, the Spearman Correlation and Hoeffding’s Independence test. From the scatter plots give in Figure 1 and the calculated r-square values for pre- and post-policy change of 0.24 and 0.15, no obvious linear relationship between LOS and ISS in these patients. The calculated Spearman Correlation coefficient of 0.42 and the Hoeffding Dependence coefficient of 0.055 showed that LOS may not depend on ISS. From this analysis, the change in LOS following the Saturday OR policy was unlikely to be fully due to the difference in ISS. Although it was not directly shown through our statistical analysis, it is likely that the difference in ISS may have partially contributed to the differences in observed LOS between the two groups. Previous studies have even shown a moderately high correlation between hospital cost and ISS. This is appropriate as sicker patients tend to require more invasive procedures, longer hospitalization and utilize more hospital resources (Dinh) Grady has no direct control over the severity of injuries in the population that are seen in the ED; however, more public health related measures focused on motor vehicle safety, fall prevention and reduction in gun related violence could reduce the overall violence in the community and lead to a corresponding reduction in the average ISS of trauma patients.

Another potential confounding influence could be the implementation of the electronic medical record, EPIC, during the study time period. EPIC was instituted hospital-wide in October 2010 which corresponded to the middle of our data collection. Although inpatient use of EMR has been studied in internal medicine and family medicine showing decreased rounding time and more time for interaction with patients (Kochendorfer), the specific effects of EMR have not been well studied in surgical subspecialties and the effect of EMR on patient LOS has not been fully investigated. As the learning curve to become efficient at EMR takes time, the implementation of EMR likely did not significantly affect our subset of patients. During the transition, inefficiencies in learning a new documentation system and glitches could have slowed the initial workflow rather than immediately increasing efficiency early in EMR hospital-wide implementation. Additionally, the improved efficiency of EMR probably has a more direct benefit to general medicine specialties as surgical efficiency would be more directly correlated with the operative time to complete cases. However, analysis of the effect of EMR on patient outcome within surgical fields is a potential future project that was not within the scope of this analysis.

One of the difficulties in this retrospective chart review is identifying the proper patient population. Logically, the most improved patient population would be patients who were admitted prior to the beginning of the Saturday dedicated orthopaedic trauma OR who were delayed to surgery because this operative time was not available. This group of “cold trauma” patients is interspersed with more emergent cases such as open fractures, compartment syndrome and infectious flexor tenosynovitis. Given the nature of scheduling cases, these emergent procedures were also performed in the Saturday dedicated orthopaedic trauma room where they would have been performed in the shared trauma room prior to the implementation of the policy. Thus the benefit of the dedicated orthopaedic trauma OR may not have been fully captured in this sample as the “cold trauma” cases could be bumped by emergent ones. We attempted to account for this weakness by isolating patients with femur and tibia fractures; however, the most specific subgroup of patients would be very difficult to isolate in a retrospective review given the dynamic and practical nature of case scheduling. Of note, even in a separate sub-analysis (data not shown) of patients in this trauma population who were admitted directly to the orthopaedic service before and after the Saturday dedicated orthopaedic trauma OR, who we had initially thought would benefit the most from this policy change, there was no significant difference in LOS or waiting time to surgery for those patients. Thus this patient population is difficult to capture in this retrospective chart review.

Although there was a significant difference in the racial distribution between the two groups, it is unlikely to have contributed significantly to the primary outcomes of this study and more likely is a random error or change in the patient population seen at Grady.

Finally, the future research projects that could stem from this analysis include the potential for future surveys to obtain and interpret resident and attending satisfaction with this new policy of the Saturday dedicated OR. These subjective survey results should be obtained both at this institution and other centers that transition to the 6 day operative workweek. Although we were unable to acquire the data for this analysis, more specific data on the confidential salaries of the involved staff would be able to show the full cost savings of implementation of this policy.

**Summary:**

In conclusion, this retrospective chart review of operative femur and tibial shaft fractures admitted to Grady Memorial Hospital between November 1, 2009 and October 31, 2011, investigated the effects of the addition of a dedicated Saturday orthopaedic operating room. The LOS overall for patients admitted after this policy change was significantly reduced from a mean of 14.0 days to 11.3 days (p value 0.018). Also, the disproportionally high case distribution on Monday observed prior to the Saturday OR was reduced and a larger percentage of cases were performed on Saturday after the policy change. Furthermore, there was a trend towards shorter waiting time to surgery for patients admitted on a Friday with an average reduction in waiting time of 25.1 hours (48.6 hrs vs 23.5 hrs, p value 0.06). Overall, these findings support the continuation of a dedicated Saturday orthopaedic trauma OR and can provide the foundation for other departments with similar circumstances to negotiate for more operative time on weekends as a potential way to increase efficiency, reduce patient LOS and distribute the caseload more evenly.

**Acknowledgements:** This is a brief section (1 paragraph) that acknowledges any contributions from others, such as reagents or data. State exactly what data was obtained/contributed by persons other than the Discovery student, such as Fellows, Research Associates, etc. Acknowledge any funding sources that contributed to the study.

We would like to acknowledge Patricia Bush for helping obtain approval from the Grady ROC; Baohua Wu the department of orthopaedics statistician for helping perform the statistical analysis; Sherika Kimbrough, Jennifer Wingo and the rest of the nurses who manage the Grady trauma registry and queried the registry for patient information; and Earnestine Spearman at the Grady Medical records department for pulling the paper charts for analysis. No direct funding sources were contributed for this study. There are no conflicts of interest for any of the authors or contributors.

**Literature Cited:** This section lists all references cited in the sections above. This section ***does not count*** toward the page limit. Use a format that includes the title of the cited article.

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Figures: These should be presented one per page and labeled Figure 1, Figure 2, or Table 1, Table 2, etc. Figures/Tables should be presented in the order in which they are presented in Results. Images should be of sufficient size to allow for visualization of relevant structures. Legends may be printed on the same page per above. If you are preparing figures that will be submitted to a professional journal, keep in mind that most journals will not accept figures prepared in Powerpoint. Figures ***do not count*** toward the page limit.

**Table 1**

| *Character* | *Overall (n=455)* | *Pre (n=239)* | *Post (n=216)* | *p value* |
| --- | --- | --- | --- | --- |
| **Age** |  |  |  |  |
| Mean ± SD (N) | 38.3 ± 15.4(455) | 37.8 ± 15.5(239) | 38.8 ± 15.2(216) | 0.32 |
| **Race** |  |  |  | <0.0001\* |
| Asian | 21/453(4.6%) | 8/239(3.3%) | 13/214(6.1%) |  |
| Hispanic | 19/453(4.2%) | 17/239(7.1%) | 2/214(0.9%) |  |
| African-American | 285/453(62.9%) | 132/239(55.2%) | 153/214(71.5%) |  |
| Caucasian | 128/453(28.3%) | 82/239(34.3%) | 46/214(21.5%) |  |
| **ISS** |  |  |  |  |
| Mean ± SD (N) | 11.4 ± 7.4(455) | 12.1 ± 7.7(239) | 10.6 ± 7.0(216) | 0.022\* |
| **Mechanism** |  |  |  | 0.24 |
| Sports | 3/455(0.7%) | 0/239(0.0%) | 3/216(1.4%) |  |
| Animal | 2/455(0.4%) | 1/239(0.4%) | 1/216(0.5%) |  |
| ATV | 3/455(0.7%) | 2/239(0.8%) | 1/216(0.5%) |  |
| Bicycle | 5/455(1.1%) | 3/239(1.3%) | 2/216(0.9%) |  |
| Struck NOS | 4/455(0.9%) | 3/239(1.3%) | 1/216(0.5%) |  |
| Motorcycle Crash | 55/455(12.1%) | 33/239(13.8%) | 22/216(10.2%) |  |
| Pedestrian | 64/455(14.1%) | 34/239(14.2%) | 30/216(13.9%) |  |
| Accident | 10/455(2.2%) | 5/239(2.1%) | 5/216(2.3%) |  |
| Motor Vehicle Crash | 123/455(27.0%) | 73/239(30.5%) | 50/216(23.1%) |  |
| Assault | 14/455(3.1%) | 8/239(3.3%) | 6/216(2.8%) |  |
| GSW | 76/455(16.7%) | 38/239(15.9%) | 38/216(17.6%) |  |
| Fall | 96/455(21.1%) | 39/239(16.3%) | 57/216(26.4%) |  |

Table 1. Demographic data. There was no significant difference in the age of patients or mechanism of injury between the groups (p value 0.32 and 0.24 respectively). There was a significant difference in the race between the groups (p value <0.0001). There was a significant difference in the injury severity scores between the pre and post policy groups (p value 0.022)

**Table 2**

| *Character* | *Overall (n=455)* | *Pre (n=239)* | *Post (n=216)* | *p value* |
| --- | --- | --- | --- | --- |
| **Day of the week** |  |  |  | 0.090\* |
| Sunday | 66/455(14.5%) | 30/239(12.6%) | 36/216(16.7%) | 0.232 |
| Monday | 77/455(16.9%) | 48/239(20.1%) | 29/216(13.4%) | 0.062\* |
| Tuesday | 65/455(14.3%) | 34/239(14.2%) | 31/216(14.4%) | 1 |
| Wednesday | 73/455(16.0%) | 44/239(18.4%) | 29/216(13.4%) | 0.161 |
| Thursday | 52/455(11.4%) | 30/239(12.6%) | 22/216(10.2%) | 0.463 |
| Friday | 61/455(13.4%) | 28/239(11.7%) | 33/216(15.3%) | 0.274 |
| Saturday | 61/455(13.4%) | 25/239(10.5%) | 36/216(16.7%) | 0.055\* |

Table 2. Shows the number of lower extremity fracture cases done on each day of the week both pre and post policy change. Overall the data trended towards a difference in the distribution of the case load between days of the week (p value 0.090). When comparing individual case load on Monday and Saturday, there was a trend towards a difference between groups with p values of 0.062 and 0.055 respectively.

**Table 3**

***Length of Stay (day)***

| *Characteristic* | *Overall* | *Pre* | *Post* | *p value* |
| --- | --- | --- | --- | --- |
| **Any day of the week** |  |  |  |  |
| Mean ± SD (N) | 12.7 ± 18.4(455) | 14.0 ± 20.9(239) | 11.3 ± 15.0(216) | 0.018\* |
| **Monday** |  |  |  |  |
| Mean ± SD (N) | 17.0 ± 29.5(77) | 20.5 ± 34.1(48) | 11.3 ± 18.8(29) | 0.011\* |
| **Tuesday** |  |  |  |  |
| Mean ± SD (N) | 12.1 ± 14.7(65) | 11.5 ± 15.7(34) | 12.7 ± 13.7(31) | 0.46 |
| **Wednesday** |  |  |  |  |
| Mean ± SD (N) | 11.9 ± 13.8(73) | 13.7 ± 15.8(44) | 9.2 ± 9.5(29) | 0.088\* |
| **Thursday** |  |  |  |  |
| Mean ± SD (N) | 9.9 ± 12.3(52) | 7.5 ± 4.7(30) | 13.1 ± 17.9(22) | 0.92 |
| **Friday** |  |  |  |  |
| Mean ± SD (N) | 10.6 ± 12.9(61) | 11.4 ± 12.4(28) | 10.0 ± 13.5(33) | 0.21 |
| **Saturday** |  |  |  |  |
| Mean ± SD (N) | 11.2 ± 16.2(61) | 11.4 ± 13.5(25) | 11.1 ± 18.0(36) | 0.84 |
| **Sunday** |  |  |  |  |
| Mean ± SD (N) | 14.8 ± 19.0(66) | 17.9 ± 24.1(30) | 12.2 ± 13.1(36) | 0.26 |

Table 3. There was a significant difference in the overall length of stay between the pre and post policy groups (p value 0.018) with a reduced mean LOS from 14.0 days to 11.3 days. This reduced length of stay was most prominent in patients admitted on Monday or Wednesday (p values 0.011 and 0.088 respectively).

**Table 4**

***Waiting Time to Surgery (hrs)***

| *Characteristic* | *Overall* | *Pre* | *Post* | *p value* |
| --- | --- | --- | --- | --- |
| **Any day of the week** |  |  |  |  |
| Mean ± SD (N) | 33.3 ± 57.7(455) | 32.5 ± 53.0(239) | 34.1 ± 62.6(216) | 0.70 |
| **Monday** |  |  |  |  |
| Mean ± SD (N) | 32.9 ± 70.8(77) | 32.6 ± 66.5(48) | 33.3 ± 78.7(29) | 0.44 |
| **Tuesday** |  |  |  |  |
| Mean ± SD (N) | 38.4 ± 63.3(65) | 32.5 ± 42.2(34) | 44.9 ± 80.6(31) | 0.43 |
| **Wednesday** |  |  |  |  |
| Mean ± SD (N) | 30.3 ± 64.2(73) | 26.2 ± 27.3(44) | 36.4 ± 96.8(29) | 0.43 |
| **Thursday** |  |  |  |  |
| Mean ± SD (N) | 28.9 ± 30.2(52) | 32.8 ± 37.4(30) | 23.7 ± 15.3(22) | 0.78 |
| **Friday** |  |  |  |  |
| Mean ± SD (N) | 35.0 ± 69.1(61) | 48.6 ± 93.1(28) | 23.5 ± 36.8(33) | 0.060\* |
| **Saturday** |  |  |  |  |
| Mean ± SD (N) | 28.2 ± 27.6(61) | 25.1 ± 29.9(25) | 30.3 ± 26.2(36) | 0.24 |
| **Sunday** |  |  |  |  |
| Mean ± SD (N) | 38.6 ± 54.0(66) | 32.6 ± 46.6(30) | 43.6 ± 59.6(36) | 0.18 |

Table 4. There was not a significant difference in the overall waiting time to surgery between the groups. However, there was a prominent trend towards a shorter waiting time in the subset of patients admitted on Friday with a reduced mean waiting time from 48.6hrs to 23.5hrs (p value 0.060).

**Figure 1**

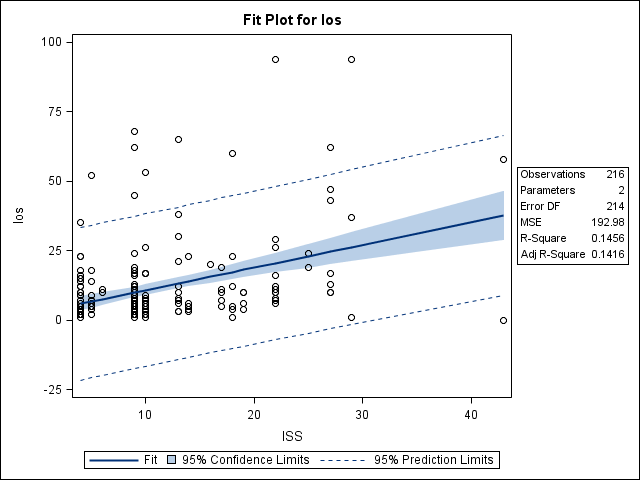
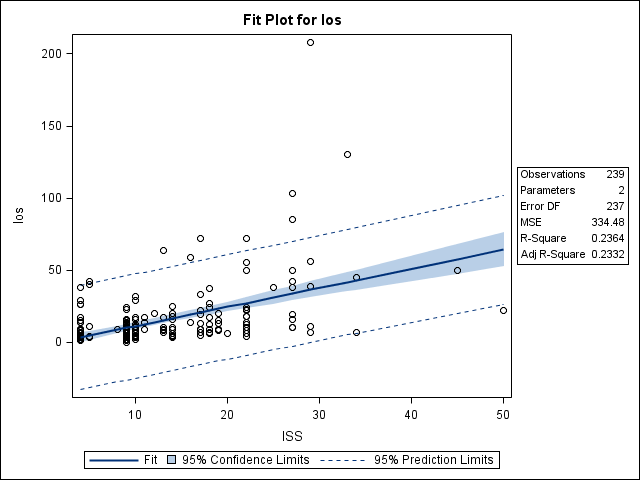


Figure 1. Above is the scatterplot comparing ISS and LOS for patients prior to the implementation of the Saturday dedicated orthopaedic trauma OR. R-square = 0.24 Below is the scatterplot comparing ISS and LOS for patients after to the implementation of the Saturday dedicated orthopaedic trauma OR. R-square = 0.15.

There is a significant difference for ISS and LOS between pre and post, list the value and p value.

For los:

|  |  |  |
| --- | --- | --- |
| Pre=14.0 ± 20.9(239) | Post=11.3 ± 15.0(216) | P=0.018\* |

For ISS:

|  |  |  |
| --- | --- | --- |
| Pre=12.1 ± 7.7(239) | Post=10.6 ± 7.0(216) | p=0.022\* |

We would like to determine whether high ISS will cause longer los. The scatter plot of los vs ISS were given. The R-squares from linear regression were 0.24, which show there is no an obvious linear relationship between ISS and los. The spearman correlation coefficient between ISS and Los was 0.42, and the Hoeffding Dependence Coefficients between ISS and Los was 0.055, both showed los may not depend on ISS. However, there is a significant difference among the quartile of ISS (p<0.001, see table below). For ISS<=6, the mean los is 8.3±9.2, for 7<=ISS <9, the mean los is 7.6±8.6, for 10<=ISS <14, the mean los is 11.9±12.5, for 15<=ISS, the mean los is 26.1±30.4.

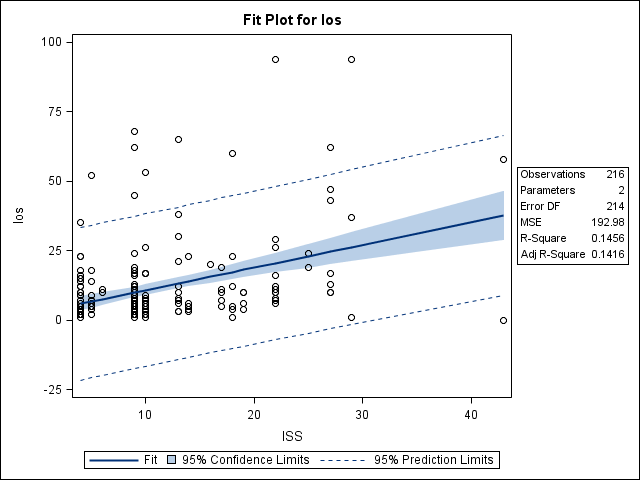
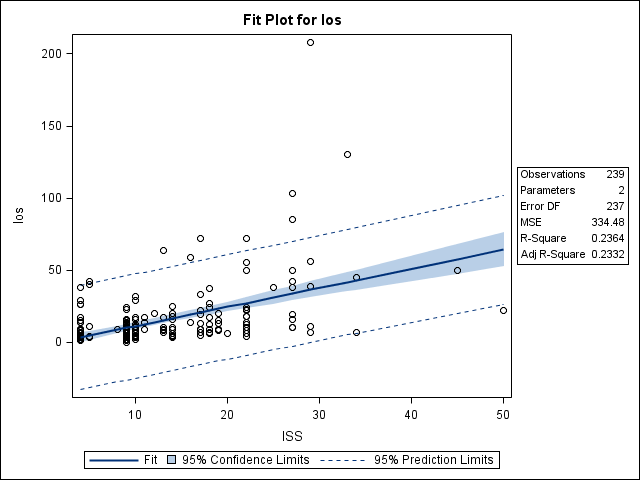
These are the discussions I’ve been having with Baohua but just wanted to keep Drs Moore and Reisman in the loop.

Please see the table below, although the p value<=0.001(Kruskal-Wallis Test) for testing the difference of LOS by quartile of ISS is significant, but there is no obvious linear relationship.

So you could make the conclusion. However, **Hoeffding Dependence Coefficients,**  D=0.06,  doesn’t mean that there is no correlation between ISS and LOS, even it is not linear, it still could be non-linear related.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Analysis Variable : los** | | | | | | | | |
| **ISS** | **N Obs** | **Mean** | **Std Dev** | **Median** | **Lower Quartile** | **Upper Quartile** | **Minimum** | **Maximum** |
| **<=6** | **115** | 8.3 | 9.2 | 5.0 | 3.0 | 9.0 | 1.0 | 52.0 |
| **7-9** | **157** | 7.6 | 8.6 | 5.0 | 3.0 | 9.0 | 0.0 | 68.0 |
| **10-14** | **80** | 11.9 | 12.5 | 7.0 | 4.0 | 16.5 | 1.0 | 65.0 |
| **>=15** | **103** | 26.1 | 30.4 | 14.0 | 9.0 | 37.0 | 0.0 | 208.0 |

Spearman Correlation or **Hoeffding Dependence Coefficients** could be used to test the non-linear correlation between two variables. The straight way to check the relationship between ISS and los is the scatter plot. Please see the attached linear fitting plot. The R-square is only 0.24(pre)/0.15(post). For an acceptable linear relationship, the R-square need to be larger than 0.5 at least. Also the **Hoeffding Dependence Coefficients,**  D=0.06, which means ISS somewhat is not dependent on LOS.  I will suggest you comment your finding not conclusively, but in descriptive way.



Pre Post

The R-square is only 0.24(pre)/0.15(post). For an acceptable linear relationship, the R-square need to be larger than 0.5 at least

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