First Procedure Start Times in the Catheterization Lab:
A Before and After Study
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Abstract
This study sought to reduce the difference between the scheduled start times and the actual start times of the procedures in the Oklahoma Heart Institute Catheterization Lab (OHICL or Cath Lab). Initially the team tried a change in the holding of patients but no differences were found. This study then used those data as pre data and another method was tried. For the final analysis, differences between start time and scheduled start times were tracked before and after physicians were told that start times would be documented. The hypothesis that the difference would be reduced after the physicians were told seemed to be confirmed by the statistical analysis. Other analyses were conducted on the differences between operating rooms, day of the week, and physicians.

Introduction and Statement of the Problem
This study took place at Oklahoma Heart Institute Cath Lab (OHICL or Cath Lab). Just like many hospitals, OHICL had an issue with starting its first procedures of the day on time. This problem for the lab was a huge source of dissatisfaction among staff, and I hoped this project would help lead to a successful plan for increased efficiency. With 48 employees, and 26 physicians, the company has grown so fast that it was hard to keep all processes within control. I thus chose the biggest improvement area to concentrate on for a project.

Statement of Purpose
The year before the department had conducted an informal study of admitting our patients into our holding area instead of the nursing units to help expedite our start times in the morning. The effectiveness was to be based on the study analysis of our average first case start time before and after the implementation in May and June of 2013. That study did not find a difference in the times (t =-.306, p =.7597). The team did like the new admittance pattern even though it did not seem to decrease the difference in start times. This study purposed to determine possible effectiveness of having the team inform the physicians that they were being recorded. The former data from 2013 were used as the pre-data and then data were collected after the physicians were told their start times were going to be collected, after January of 2014.

Organizational Context
Setting of the problem
I have worked for Oklahoma Heart Institute since 2008. In this time, they have added 26 physicians to the group and the Cath Lab specifically has a total of 15 doctors. In 2008, I became the 16th employee. At this writing there were a total of 48 employees. I am a member of the Cath Lab team. The term “we” in this document refers to my team. I must refer to “we” and “us” because we are a team. We worked as a team to carry out this project.

We have doubled our case load since 2008. With all of the extra cases, we have lots of extra hours to absorb. We wanted to be busy, but knew we could not keep doing what we have been doing. Trying to convince some of the older physicians that we have a problem has been tough. We
have discussed lots of options to help us be more efficient in our daily case load.

Oklahoma Heart Institute (OHI) was developed in 1988 under the direction of Dr. Wayne Leimbach. Over the years, OHI has grown into a successful business. The goal of OHI is to be the leading facility for heart disease and other cardiac diseases. A few years ago, OHI was bought out by Ardent Health System, who also owns Hillcrest Medical Center. OHI now falls under the Hillcrest Medical Center umbrella even though the facilities are in their own buildings. Hillcrest has worked very hard over the last few years to develop a strong reputation within the community. OHI’s main focus has become patient care, and evidence based medicine, which means caring for the patients and doing what is right for them regardless of pay or reimbursement. One chief complaint has been the dissatisfaction from patients and their families for procedures not running on time. This has become a big initiative for the employees of the Cath Lab, because we know how much it affects the families and the patient’s happiness.

History and background

When Ardent bought OHI in 2008, we started to get really busy. At that time is when we doubled the amount of procedures that we did on a daily basis. Instead of our scheduled eight and ten hour shifts, employees were working as long as 24 hours before they would get relieved the next day by the staff coming in to start the day. Everyone was getting miserable. We loved our jobs, but no one wanted to work those kinds of hours. The physicians we just as equally exhausted. Not only were they doing procedures in the Cath Lab, but they were also rounding on the hospital floors and seeing patients in their offices. Their days were just as long as ours if not longer.

Over the years, we have adapted to most of the demands created by having a larger facility and more patients. The one remaining issue for us was the efficiency in which our procedure labs were run.

Scope of the problem

One of the biggest opportunities for us is our first procedure case start times in the morning. Our goal is 8:00a.m. and at the beginning point we were closer to averaging around 8:30a.m. This study was going to see if we could improve our first procedure start times. The year before this study we had tried implementing a new process of admitting our first patients of the day in our holding room instead of in a room on one of our nursing units. When a patient was admitted on one of these floors, it required transport of the patient to the Cath Lab when they had been prepped and ready. These data became our pre-data, as the procedure did not work to reduce times at all. We had wanted to decrease how many minutes late we ran per case each day. It quickly became apparent that our method was not working. We would have loved for the present study to show a significant amount of improvement without having to implement a complicated secondary protocol to help our times. When the first effort did not show to be significant, we thought initially that there really might be no other way to improve without having the help of the physician’s arrival time. Before trying another change in how patients were handled, we decided to inform the physicians that we were recording their start times and then tried to determine if simply informing them would make a difference, the focus of the present study.

This study was conducted only at the Cath Lab at Oklahoma Heart Institute. The study measured how well our start times improved by using our newly implemented
admitting process (pre data) informing the physicians of the recordings, and then keeping track of the start times (post data). We had already started the new admit process, and I gathered the data for our start times both during that process and then after we informed the physicians.

**Significance of the Project**

I feel like this study would be important to our organization because cardiology is a top money maker for the hospital so it would benefit from any increased efficiency. For more selfish reasons, these findings will also benefit our work hours and hopefully allow staff to leave at a more reasonable time in the day. This will help with staff satisfaction, and get them more time to spend with their families. The most important reason, however, is this will be a significant help in our patient satisfaction. Without our patients being happy, OHI could not make it in this market.

In conclusion, improving our start times would help with the overall feeling of the lab. The team arrives to work at 7:00 a.m., so not starting a case until after 8:30 a.m., really puts a damper on the day. It can be very hard to recover. This study was to improve the overall satisfaction for the staff, doctors, and patients by reducing the differences between scheduled start times and actual start times.

**Definition of Terms**

OHI- Oklahoma Heart Institute
Cath Lab- Cardiac Catheterization

**Review of literature**

In order to understand the importance of this study, the importance of starting operating procedures on time need to be reviewed. By getting the importance, a better understanding can be had of the current problems hospitals are facing. There are 3.7 million heart caths done per year in Cath Labs across the nation (Wysocki, 2006). I examined literature to see what obstacles, advantages, and disadvantages were similar to my own facility.

Review of the literature was to determine if the implementation of our new holding procedure would be enough on its own to make a significant change in our first procedure start times or if other facilities had tried other approaches. I wanted to see what other facilities and personnel had faced, and what they did to deal with late start times. I looked at the obstacles, customer service, expectations and physician motivators, advantages, and disadvantages.

**Obstacles**

Cardiac catheterization labs are typically stressful places to work. Days can be hectic and unpredictable, staff must constantly juggle schedules in order to slot emergent and urgent cases between scheduled ones, and cases are often bumped or delayed (Siegrist, 2009). This leaves patients hungry, anxious, and impatient. Cardiologists dislike the unpredictability and length of their days spent in the Cath Lab, while hospital administrators often are concerned about overtime caused by process inefficiencies, such as beginning first procedures of the day late (Bharadway, 1999).

**Customer Service**

Even though Cath Labs across the nation are incredibly busy, the main focus of customer satisfactions still remains (Wysocki, 2006). It is hard to find that perfect juggle every day when the staff is trying to keep the patients happy as well as keeping the physicians happy. Staff just
wants to be able to run the most efficiently as possible, but they have all of these other factors to consider as well. Patients want to have their procedures done at their scheduled procedure time. The patients have to go without food after midnight the night before their procedure. If they have an afternoon procedure scheduled, and it gets delayed for whatever reason, they could end up going several hours without food or drink. This is a huge source of patient dissatisfaction. Also, when there are delays in starting the procedure, patients and their families automatically assume the worst (Bharadway, 1999). They most often believe that it is because the Cath Lab staff is not prepared for them, or something bad has happened to the patient before them. Patient delays cause more anxiety than any other cause. Hospitals across the nation are currently focusing on what they can do to help expedite their cases to help patients feel more valued (Vogel, 2012). Some of the main focuses hospitals use for patient satisfaction are respect and compassion, never contradict patients, and keep your promises. Our focus now is to keep our promises.

**Expectations and Physician Motivation**

There is a fine line of getting things right when multiple parties are involved. Maintaining expectations is important, but always being able to deliver can be difficult (Sun, 2013). In this topic, there are three different parties that all have high expectations for the way the day will start. The patients, the physicians, and the staff members all want the day to run smoothly.

This is why it is so important to have a good working system. The team wanted to create a plan where all parties involved could be satisfied with the way things were running. When a procedure is scheduled at 8:00a.m., the expectations are that that procedure will start on time (Donahue, 2008). We just had to get a plan in place to make this happen more frequently and so research on what motivates physicians was examined.

There was evidence that physicians use feedback to make changes in their practice procedures (Lockyer, 2011). According to Wyszewianski and Green (2000), providing feedback to physicians in accordance with individual physicians’ characteristics might be best. However, they did report that factual information could be effective for both the “receptive clinicians and the traditionalists” (p. 463). Further, presenting the facts might be more effective than educational interventions. After examining 3702 citations and honing down to 90, Veloski, Boex, Grasberger, Evans, and Wolfson (2006) concluded that feedback by itself was effective in changing physician behavior. The team decided that it would simply let the physicians know their start times on a consistent basis and this information would become feedback to them.

**Advantages**

When first procedures of the day are started on time, it sets a trend for the rest of the day to follow. The staff members typically work harder and faster to get procedures turned over when they start there day out strong without sitting and waiting around. This allows for scheduled procedures to finish sooner so that in-patients might get their procedures done at a more reasonable time (Richard Siegrist, 2009).

Another advantage is that the team can use less overtime hours. When hospitals start their days out an hour behind, it can cause the lag of the day to add up and cause lots of extra time to be put in in the
evenings. If the team can save time by being more efficient, the hospital can then make more money (LeBlanc, McLaughlin, Freedman, Sager, & Weissman, 2004). There are a lot of hospitals that are running inefficiently, and would love to implement new procedures to help curb some of that lost time. The satisfaction rates have been shown to increase when putting these procedures into place (Bharadway, 1999).

**Disadvantages**

When trying to be efficient, it needs to be done the correct way. There are several needs that need to be taken into account. Patients are the ultimate priority. We want to make sure that we are taking great care of them, and they do not just feel like a number. Our patients need to feel like we have their best interests in mind at all times (Jeffs, Lyons, Merkely, & Bell, 2013).

Another need that is to be considered is the physicians. Sometimes with increasingly long days, while starting early is a priority, mornings are the only times they are able to see their families. With the thought in mind that everyone needs to come out ahead, this needs to be taken in consideration. It is okay to expect physicians to start their scheduled cases on time, but when encouraging them to do so, the communication needs to be respectful and our simple feedback was respectful. Many times their day starts and continues way beyond the procedure room staff.

**Conclusion**

Increasing efficiency seems to be a trend in many hospitals across the country. Everyone wants to run as smoothly and efficiently as possible all while delivering the best care possible. And while many facilities have implemented studies to figure out how to improve, the results will be different in every case. Every facility is different in its needs, and it just takes searching to see what works best for them.

**Methods**

**Hypothesis**

The purpose of this study was to address the late first case start times in the Cardiac Catheterization Lab at Oklahoma Heart Institute. Every morning, we have anywhere from four to seven eight o’clock cases scheduled in the lab. Our goal is to have the first patients of the day on the procedure table and ready to start by eight o’clock. Over the last few years, our start times had continued to get worse and worse. Once we started tracking it, it did not take long to decide that the biggest contributing factor was the physician’s arrival time. Everyone felt like this was a huge detriment to our lab and the staff. We have a rotating staff that has to stay until the end of the last procedure of the day. This can make anywhere from an eight to twenty-four hour day, so starting on time truly means a lot to staff. It also means a lot to our patient’s families to start on time, and when we were starting our first case late, it caused every scheduled case after that to also start behind. We felt that if we could make the physicians aware that we were tracking the start times, and would be issuing reports on their average start times to them and their superior, we would start getting better results. Because I had to complete a project for my degree, I volunteered to be the one to collect, analyze, and write up conclusions. My article was shared with the team at the end.

The hypothesis stated that our average start times would be earlier after we made the change of our new admit procedure, rather than before we started admitting our patients in holding. The plan was to see that if telling the physicians we
were recording their start times would be enough to reduce the difference between scheduled and actual start times.

**Design**

To test the hypothesis, a quasi-experimental, before and after design was utilized. The dependent variable was the difference in time before and after the change. The independent variable was before and after recording the physicians arrival times. I also used a secondary quasi-experimental design using a factorial ANOVA to see if there were any difference between the operating rooms and the timeframe.

**Data Source**

The participants in this study were the ten Cardiologists practicing at Oklahoma Heart Institute. We tracked all ten Cardiologists individually, as well as the entire group collectively. They were referred to as Physician 1, Physician 2, Physician 3, Physician 4, Physician 5, Physician 6, Physician 7, Physician 8, Physician 9, and Physician 10. Together they were referred to as The Cardiologists. The dependent variable was measured by when the physician actually began the procedure. The scheduled times were subtracted from the actual start times and comprised the dependent variable. The data were collected using our Xper Information Management program that we use to document our procedures. I pulled the data from the program. We have a procedure begin tab that has to be charted when the physician arrives and scrubs into the procedure. When the procedure begin tab is charted is automatically records the time. Xper has a searching tool that was used to pull the procedure begin times. A two month average start time was obtained before the case start times began to be officially tracked. A one month average start time was obtained after the case start times were officially tracked. The score represents the time until starting. The higher the minutes, the later the procedure started. The lower the score, the closer to on-time the procedure started. The reliability of measure was very accurate due to the time keeping of our Xper program being very consistent. (This really was not validity and this article is not about your first study.)

**Procedure**

Over 3 months in 2013 we collected first case start time data to see if our admit procedure could help us get our patients ready quickly, which would inheritably increase our ability to start our first cases on time. The second part of the study was conducted the month of January, 2014 after the physicians were informed their start times would be recorded.

**Data Analysis**

The Xper system accurately tracked each physician’s arrival times to start their first procedures. The data were then analyzed to see if the tracking process was successful in increasing our quantity of on-time starts. Some of the physicians’ times seemed dramatically improved while others seemed to have no improvement. The Null Hypothesis A was that the before start times would not be greater than the after times (Ho: μb ≤ μa). The Ha meant that the numbers after would be less than the numbers from before (Ha: μb > μa). The level of significance was .05. The data were analyzed by using a factorial ANOVA all in one procedure.
Limitations

This original study began to see if admitting our first patients in our holding room would help us to start our first procedures on time. With this study I wanted to see if patient holding (which we continued) with then telling the physicians could improve our start times. One of the limitations was that there was no way to truly track if procedures were delayed due to some other fact other than a late physician arrival. Some cases that showed higher scores had a small probability that something other than late arrival could have happened. Some examples of this were but not limited to emergencies, late patient arrival, or bad lab results that would require pre-procedure care. The reliability was deemed adequately accurate, but could be off one or two minutes due to human error and lack of urgency to select the physician arrived tab. Choosing the Xper system to monitor the start times gave us a high validity of measurement due to the accuracy of the program. The machine would not give a different measure if I queried for the times.

Summary of Results

Descriptive Data Analysis

A measure of the means and standard errors of collected data were found. The data were entered into STATISTICA to create graphs in order to illustrate the findings. The descriptive statistics can be found in Table 1 below. The before and after start times of each of our labs were measured to come up with means and standard errors shown in Table 1.

Inferential Data Analysis

A factorial ANOVA test was used to test the data. This is an all in one procedure. I used a before and after design that also looked between the operating rooms. This showed the interaction between the operating rooms and before and after. The dependent variable was the difference in time or also seen as timeframe. The timeframe was the independent variable. The categorical predictors were the operating room and timeframe. I tested three different hypotheses for this study by using the factorial ANOVA.

The main hypothesis, or hypothesis A, was if there was a significant difference in before and after start times. The null stated the before numbers would not be greater that the after numbers (Ho: μb ≤ μa). The alternate hypothesis stated that the
before numbers would be larger than the after numbers, which was Hypothesis A (Ha: $\mu_b > \mu_a$). See Figure 1.

**Figure 1.** This graph correlates with Hypothesis A.

The second hypothesis I tested, or Hypothesis B, was to see if there was a difference in the operating rooms regardless of before and after. The null stated that there was no difference in the operating rooms (Ho: $\mu_{cv1} = \mu_{cv2} = \mu_{hybrid} = \mu_{op} = \mu_{sp}$). The alternative hypothesis stated that there would be a difference in operating rooms (Ha: $\mu_{cv1} \neq \mu_{cv2} \neq \mu_{hybrid} \neq \mu_{op} \neq \mu_{sp}$).

**Figure 2.** This graph correlates with Hypothesis B.

The final hypothesis, or hypothesis C, tested whether there was a difference in operating rooms between before and after. The null stated that there was no difference in operating rooms between before and after (Ho: $\mu_{cv1b} = \mu_{cv1a}$; $\mu_{cv2b} = \mu_{cv2a}$; $\mu_{hybridb} = \mu_{hybrida}$; $\mu_{opb} = \mu_{op}$; $\mu_{spb} = \mu_{spa}$). The alternative hypothesis stated there was a difference in operating rooms between before and after (Ha: $\mu_{cv1b} \neq \mu_{cv1a}$; $\mu_{cv2b} \neq \mu_{cv2a}$; $\mu_{hybridb} \neq \mu_{hybrida}$; $\mu_{opb} \neq \mu_{opa}$; $\mu_{spb} \neq \mu_{spa}$).

**Figure 3.** This graph correlates with Hypothesis C. It is useful for interpretation and shows the interaction effect.

For each hypothesis, I was looking for a p value less than .05. The p value for hypothesis A was .00045 so I rejected this null. This suggested that there was significant difference in before and after data. The before times were in fact larger than the after times. The p value for hypothesis B was .129 so I did not reject this null. The p value for hypothesis C was .233 so I did not reject this null.

As one can see, the confidence intervals in Figure 1 do not overlap, showing that the before and after time differences are significant.

While hypothesis B did not prove to be significant, what figure 2 suggests is that the Hybrid room could be the reason that Hypothesis A was significant, as the difference in time for hybrid may have been greater that for OP and SP. The overlap in confidence intervals is not as large.
Figure 3 shows that the reason the before and after times were significantly different was likely because of the Hybrid room. It is the only room that does not have overlapping confidence intervals. However, as one can see, the trend was for most of the times to reduce, except for OP which started out low.

Exploratory Statistical Analyses

After seeing the results for the original hypothesis, it created a desire to dig deeper into creating a solution for the delay in our first procedure start times. In the figures below, you will see some additional patterns that could be further looked into in the future. In this section, I tested further relationships by using a feature selection. This is a predictive analytic technique that reduces variables to see which variables might most predict a target. The target selected in these figures was difference in time. The longer the bar on the graph is, the more it predicts that target. These are things that can be further tested to see if there is an effect. Figure 4 below shows that the operating room is the biggest predictor followed by the day of the week. This figure was done on before data only.

Figure 5 below was also done on before data only. The hybrid room does typically cover the most complicated procedures that the hospital did, so this graph could possibly show that a look into the types of first cases could be a factor into delay.

Figure 5. was created using before data and shows that the hybrid lab currently has the biggest delay.

Figure 6 measured day of the week differences. There is no overlapping on the confidence intervals for Wednesday and Friday. This would suggest that we are the least efficient on Wednesdays and the most efficient on Fridays.

Figure 6. shows the differences in first case start times based on day of the week.
Physician effects may be seen in Figure 7 below. This would lead one to believe that the physicians have the most effect on our first case start times.

**Figure 7.** is a second feature selection which included after data. This graph shows that the physicians have the biggest effect on after data.

The last selection which was run on the after data were start times based on physicians. According to Figure 8, physician 9 is the least efficient while physician 10 is the most efficient. However, it is important to know that there is a limited amount of after data that could make this not true. It would be important going forward to get an equal amount of data per physician to do an accurate testing.

**Figure 8.** shows start times based on physician for the after data.

**Discussion and Conclusions**

**General Discussion and Conclusions**

The review of the literature was originally to determine if the implementation of our new holding procedure would be enough on its own to make a significant change in our first procedure start times. Then the study became a bit larger and resulted in the present study. Research was conducted to see if admitting our first patients in the holding area would help our first procedures of the day start earlier and then I looked at studies to see how to best motivate physicians. Physicians are scheduled to start at 8 o’clock, and were starting much later than that. My first initiative was to see if adding our new holding-room admit procedure would be enough alone to get the cases started earlier and after realizing the holding room alone was not working, I initiated this study to add telling the physicians we were recording their start times. The holding room idea was one that we liked but did not seem to make a difference. We added telling the physicians and the analysis seemed to show a significant improvement in the mean before to the mean after, overall. While the data showed to be significant overall, further testing, using the factorial ANOVA, showed that the only real significance likely happened in one out of our five procedure rooms.

These results showed that there is an opportunity to implement a new morning procedure in order to start our first cases on time. Further testing and data collection will be imperative to study our opportunities for growth in this area. It would be interesting to see if the improvement maintained and if the difference continued to be only in one operating room, the Hybrid lab.
One interesting fact related to the Hybrid lab is that it does the most complicated procedures. It is interesting to me that even though that room sees the most difficult scheduled procedures, it has made the most growth that enabled my data to prove significant in the before and after category. It also gives me hope, because if we can improve in that case, we should be able to improve in rooms with more simple procedures.

In figure 6, it suggested that we were the most efficient on Friday mornings. In my opinion, my two most timely physicians work on Friday mornings, which could suggest that they are the reason for this representation. Further data collection and tests would need to be run in order to confirm this.

In figure 8, it showed that physician 9 started his cases the latest, but upon further review of the after data, physician 9 was only represented by three cases. This gave an unfair interpretation, and therefore why it would be important to not put stock in these findings. There is clearly not enough data in this area. These should be random samples to be fairly considered, and mine are not.

**Strengths and Weaknesses**

There were a few strengths that helped this study be successful. The first is the amount of before data selected over a six month period. This helped to get a true picture of where we stood, and how much room we had to improve. The second strength was the fact that it showed that there was an actual projected problem. We knew an issue existed, but this gave us the facts. The last main strength was the fact that there so many staff members were willing to participate and help with the study. They wanted to know the results, because depending on the significance, this project could help improve the work environment of starting our cases on time.

Two weaknesses were very evident in this data collection. We did not have near as much post data as we did before data. This potentially changed the amount of significance the data carried. Also, one of the analyses run, pertained to each physician’s individual start times. We had more data on some physicians, and only a few pieces of data on another. This did not give an overall fair representation.

**Recommendations**

The biggest recommendation for this study would be to obtain more data. To be successful and accurate, there needs to be an even representation of data among physicians and procedure rooms. I thought that the before and after data needed to be represented properly by having an equal amounts in both categories as there were more pre data than post data.

**Suggestions for Future Research**

I would make two suggestions for future research. First we need to collect more data, to see if there is more than one room that can make a significant difference in before and after data. The second suggestion would be the implementation of a new study to try to target an opportunity that can make a more significant change, such as physician arrival time. Going forward, I would make sure there was more detail than actually needed. Making sure there were exact dates and days of the week recorded, as well as which physician and which lab they were working for each case would make all of the before and after data uniform.
References


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