PROCESS IMPROVEMENT

FOR THE DEPARTMENT OF SURGERY

SIERRA VISTA MEDICAL CENTER

By

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ABSTRACT

This report proposes and analyzes process improvement methods for the Surgical Services Department at Sierra Vista Regional Medical Center. The department currently operates with an average of 25% of elective cases starting on time. This can be attributed to a number of inefficiencies that occur throughout the hospital. The following Industrial Engineering methods were utilized to improve patient flow:

- creation of a data collection system to quantify delays
- use of simulation and facility redesign techniques to determine feasibility and benefits of moving towards a surgical center model
- development of a user interfaced database to record and analyze the occurrences of late surgeon arrivals for first case starts

With the application of proposed recommendations, the surgical department has the potential to save upwards of $60,000 per month while increasing efficiency and quality for the many surgical patients of Sierra Vista.

ACKNOWLEDGEMENTS

Thank you to Laura Gaminde, Christine Feld, and Doris Sawtelle for welcoming me to Sierra Vista and providing me a with a wonderful senior project experience.

Thank you Dr. Tali Freed and Dr. Sema Alptekin for you advice throughout the project. I truly value your experience and guidance.

TABLE OF CONTENTS

TABLE OF FIGURES AND TABLES

INTRODUCTION

Sierra Vista Regional Medical Center has been serving the Central Coast for over 50 years. The center houses 165 beds and is a lead provider of medical services in San Luis Obispo County. Sierra Vista's mission is to "provide the highest quality, most innovative healthcare to the patients we serve, to maintain and enhance cooperative relationships with physicians, payers and employees and to continually improve the health of our County residents." (Sierra Vista 2010) With this mission, Sierra Vista aims to continuously better its processes by increasing quality and efficiency at its facilities.

This report utilizes process improvement techniques to increase the efficiency and quality of surgical services at Sierra Vista Medical Center. Through initial observation and interviews with the staff, the focus of this study was determined to be the inability to quantify delays as they occur, poor communication across floors, and late physician arrivals for first case starts. The following details the steps made to create solutions for these inefficiencies.

BACKGROUND

The surgical department of Sierra Vista offers a wide variety of services for its patients. Services range from dental procedures, to arthroscopic knee surgeries, to surgeries using a Da Vinci surgical system. Registered Nurse First Assistants, Registered Nurses, Operating Room Technologists, and various support personnel consist of the staff of the surgical department. The surgical floor has seven available operating rooms with typically five operating rooms (OR) scheduled in advance. Scheduled surgeries run from Monday through Friday starting from 7:00 am. Staff is on call 24 hours a day/ 7 days a week for emergency cases.

Scheduled surgeries are brought in by surgeons in the county and are scheduled with Surgical Schedulers. A block system is used for surgeons with a high number of surgeries at Sierra Vista. For example, Surgeon 234 has a reserved block from 7:00 am to 2:00 pm in OR 1 every 4th Thursday of the month. Anesthesiologists are brought in externally for each case. With surgeons bringing in patients, Sierra Vista must consider both surgeons and patients as the clients they serve.

When patients arrive at Sierra Vista for surgery, they must first check in and be prepped for surgery. The following outlines the flow of a standard outpatient arriving for surgery.

1. Lobby – First Floor
2. Admitting – First Floor
3. Day Stay – First Floor
4. Pre-Induction Room (PI) – Surgical Floor
    a. If occupied- patient will go to the Patient Anesthesia Care Unit (PACU)
5. Operating Room (1-7) - Surgical Floor

6. PACU - Surgical Floor
7. Day Stay if an outpatient - First Floor
    a. Other departments if patient is staying overnight

From Day Stay to the Pre-Induction room and from the PACU to the first floor, a traveler is used to transport the patient. Distance traveled from Day Stay to Surgical floor is approximately 160 feet.

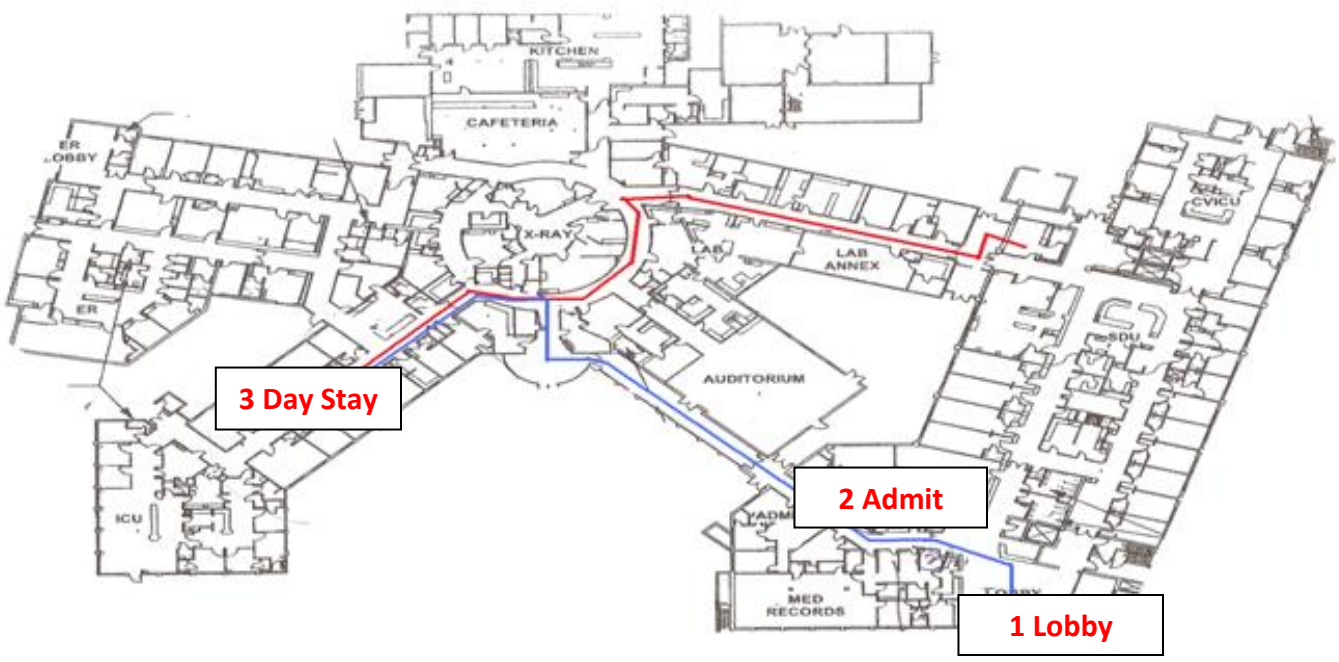


Figure 1: First Floor of Sierra Vista Medical Center

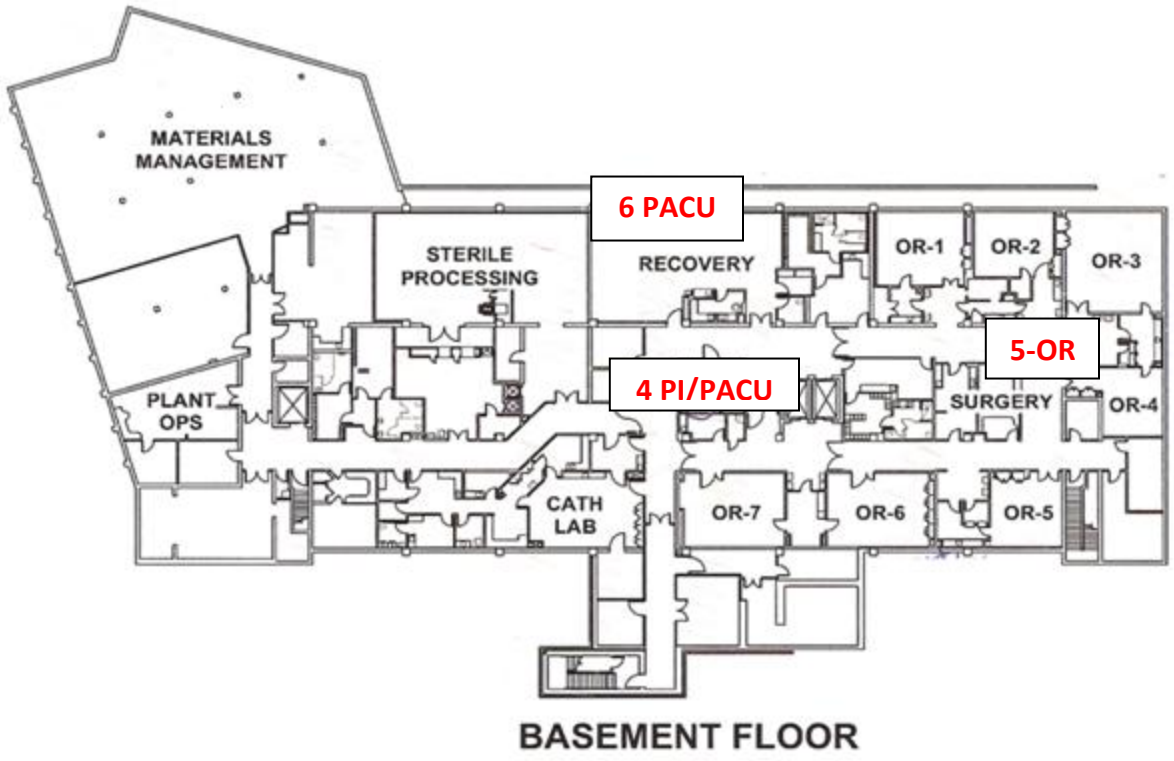


Figure 2: Surgical Floor of Sierra Vista Medical Center - Basement

LITERATURE REVIEW

HEALTHCARE IN THE UNITED STATES

Surgeons, nurses, hospital administrators have the same goal for patients: to provide quality, safe service efficiently and effectively. Though a clear goal, the complexity of the healthcare industry has made this ideal difficult to achieve. In a field where the absence of quality can lead to death, reducing error is of the upmost importance. In 1998 the Committee on Quality of Health Care in America was established and reported that between 44,000 and 98,000 Americans die as a result of medical errors. This is associated with a cost of $17-$29 billion (Kohn 2000). A study performed in 2006 showed modest improvements at a rate of 2.3% per year in overall quality (HSR 2008). The Institute of Medicine had originally recommended a goal of 50% error reduction over a 5-year period (HSR 2008).

Furthermore, in 2000, the World Health Organization published an extensive analysis of the world's health system's ability to meet the goals of healthcare. According the WHO, the goals of healthcare are the improvement of health of the population, increased responsiveness of the health system to the expectations of the population, and fairness in financing the cost of healthcare. This report analyzed a country's ability to meet these goals of healthcare relative to the maximum it could achieve given available resources. Despite spending the highest per capita in the world on healthcare (13.7% of GDP), the United States ranked 37th out of 191 in the study. This is behind Costa Rica at 36th, Canada at 27th, and Japan at 8th (Tandon 2000).

Recent evidence that better care can come at a lower cost has been driving force for many new changes in healthcare efficiency in the United States (Schmidek 2005). Hospitals have begun to take second looks at their current processes and have succeeded in improving

quality while reducing cost. Changes in the current economic environment have also contributed to the mounting pressure for healthcare to become more efficient (Martin 2009).

INEFFICIENCY IN SURGICAL SERVICES

Operating rooms produce an estimated 42% of hospital's revenues. However, data has suggested that this value has the potential to be much greater (HMFA 2005). High inefficiency in surgical services can be contributed to low on time starts (average OR starts on time 27% of the time), long OR turnovers (average 31.5 minutes), and a high degree of manual processes (HMFA 2005). Many organizational studies have revealed that surgical departments have substantial holes in organizational data, lack of constant standards for resource utilization, and poor use of staff (HMFA 2005).

Different viewpoints, particularly on how to increase efficiency without compromising patient safety, has often created tension between the multiple, diverse professions that contribute to the operations of a surgical department (Rosen 2009). Issues on communication, resource and time management, and use of technology have both contributed to the success and failure of quality service and efficient surgical flow (Bozzelli 2009).

For example, conflicts in how nursing staff and surgeons operate together have caused dissatisfaction for both professions. In one article, nurses expressed their discontent with surgeons who pressured them to hurry through their job (Riley & Manias 2006). For instance, a nurse participating in an ethnographic study expressed that he felt he could not adequately serve his patient with the strong pressure from a surgeon to begin a surgery and rush preparation. On the surgeon side, a surgeon commented on the inability of some nurses to

successfully decide on the order of urgency of his surgeries. This discontent led to frustration in working with a particular hospital (Mazzei 1999).

In another hospital, technology was utilized when communication could not be depended on. In the University of Iowa Carver College of Medicine, the implementation of revolutionary technology has lead to solutions for communication issues in a surgical department, ultimately leading to optimizing surgical quality and efficiency. Managers at Iowa now use an automatic medical data analysis program to generate estimates on the amount of time remaining for an ongoing surgery. Normally, the only option of obtaining this number was to ask a nurse or surgeon in the operating room. This new system at Iowa prevents surgeons from being interrupted during a surgery by combining information about the surgeon, procedure, and patient vital signs to generate estimates on time needed. This information is fundamental for a surgery scheduler and is now obtained without distracting a surgeon from his surgery (Page 2009).

Furthermore, the implementation of operations research theories and techniques that have proved relevant in the food service industry or in a manufacturing plant has proved relevant in health care industry as well. Dr. Eugene Litvak focuses on the unique and similar aspects of utilizing operations research to minimize patient variability and increase patient flow (Litvak 2005). Litvak comments on the myths of improved patient flow: high unit or hospital occupancy rates, high utilization rates in different units, and reduction in the time of patient transfers between units to, in itself, improves hospital flow. While these metrics may offer short solutions to efficiency issues, they are not necessarily directly correlated to increase of patient throughput. Patient throughout put can be defined as number of patients moved

through a hospital over a certain time period. Increase of patient throughput is directly related to increasing access of care (Litvak 2005).

In St. John's Regional Health Center, the use of Litvak's ideas has lead to increases in both satisfaction and efficiency in their surgical department as a result of a simple change in resource management (McGlinchey 2006). Although counterintuitive, the case study and St. John's Regional Health Center showed that elective surgical admissions (non-emergent) were as variable, or even more variable, than emergency admissions. This fact has proven accurate at many hospitals across the nation. This is due to surgeons wanting flexibility in their schedule. For example, some surgeons prefer performing their procedures during the middle of the week, resulting in a high level procedures on Wednesday. The two types of patients (emergent and elective) competing for available operating rooms had resulted in many delays or cancellations in elective procedures. With operating rooms scheduled to max capacity, emergent procedures led to many disturbances in flow with numerous surgeries lasting late into the night. Christy Dempsey, the Vice President for Perioperative and Emergency Services, led the implementation of efficiency projects with the goal of increasing surgical.

With a 30-day trial program, Dempsey implemented the idea of an add-on operating room, where elective surgeries would not be scheduled (Crute 2005). The room would remain available for emergent surgeries only. With a room available to accept emergent surgeries, the amount of variability occurring drastically decreased. Emergent surgeries were "planned" as part of the daily operations of the department. This lead to an increased adherence to the schedule of procedures, 5% increase in surgical volume, 45% decrease in surgeries performed after 3PM, and 4.6% increase in revenue. In addition to these increases, surveys showed that

surgeons, staffs, and patients had an increase in overall satisfaction with their surgical experience at St. Johns (McGlinchey 2006). This method of scheduling has been utilized at Sierra Vista with high success.

Positive results from hospitals such as University of Iowa Carver College of Medicine and St. John's Regional Health Center serve as strong motivation for improvements to the efficiency and quality of hospitals across the nation. These successes in improvement of OR efficiencies can almost always have been a result of data driven initiatives (HMFA 2005). Without accurate data, the areas where reform needs to be made cannot be determined and shared with the multiple professions involved in surgical services. Successes with data driven initiatives have resulted ORs with an impressive 76% on time case record and 15 minute turnovers (HMFA 2005). Actions to increase efficiency have included establishing and measuring indicators of process performance, reducing variation with the process using clinical pathways, and reducing clinical staff time focused on non-clinical activities. For example, Mass General implemented an OR facility re-design where the patient stays in the same room throughout the entire procedure. All equipment necessary is available and prevents the patient from moving from bed to bed, increasing both patient safety and efficiency (HMFA 2005). Successful implementation of improvement projects nationwide can lead to decreased costs and increased quality, making access to health care more possible for all.

Data Collection of Causes for Delays

Design

A data collection system was designed to determine why a patient did not begin surgery when scheduled. Only 25% of elective cases (non-emergency) began on time during March 2010. This study aimed to indentify and quantify the causes of delays. The collection system was first proposed to the directors of the departments involving surgery patients including Lobby, Admitting, Day Stay, and Surgical Floor (See Appendix A). Concerns were raised about the multiple volunteers at the lobby being able to fill out the data collection card correctly. To address this issue, an instruction flyer was created for all volunteers (See Appendix B). The tracking card was designed for ease of use with the input of directors.

Figure 3: Surgical Patient Tracking Card

Surgical Patient Tracking Card

Date: _____ Scheduled Time of Surgery:_____
Time OR Desk Calls for Patient:_____ Actual Time of Surgery:_____

Location	Time In	Time Out	Delay (Y/N)	Delay Code/ Reason (if any)
Lobby				
Admitting				
Day Stay				
PI Room				
OR ____				
PACU				

Delay Codes

1- Admitting
2- Anesthesiologist
3- Consent Issues
4- History and Physical
5- Labs
6- OR
7- Patient
8- Surgeon
9- Other

METHODS

Upon arrival at the Lobby, patients were given a tracking card. As patients moved from location to location staff wrote the time entered and time exited. If a delay occurred in patient flow, the delay would be recorded on the tracking card. Detailed instructions were placed on the back of the card (See Appendix C). Data collection lasted for 11 business days from April 1-15th. Cards were picked up on a nightly basis and analyzed. The percent of cases that arrived on time were calculated with the following metrics:

- % of cases started on time = % Start OT
- % of cases started within 10 minutes of start time = % Start w/in 10
- % in OR within 10 minutes of start time = % In OR w/in 10
- % in OR on time = % In OR OT

The data collection system also involved a suggestion submittal area where staff could write suggestions for improvement (See Appendix D).

RESULTS

47 completed cards were used to analyze results over the collection period. The most common causes of delays recorded were late arrivals of surgeons, paperwork issues, poor communication, and patients unable to meet requirements for surgery (missing labs, EKG, unable to undergo anesthesia, etc). See Figure 5. Delays occurred most often on the surgical floor while the patient was in the Pre Induction Room. The following shows averages of the 11 days of data collection. See Appendix E for overall daily reports.

Table 1: Percent of Cases during April 1-15

% Start OT	% Start w/in 10	% In OR OT	% In OR w/in 10
22%	31%	37%	49%

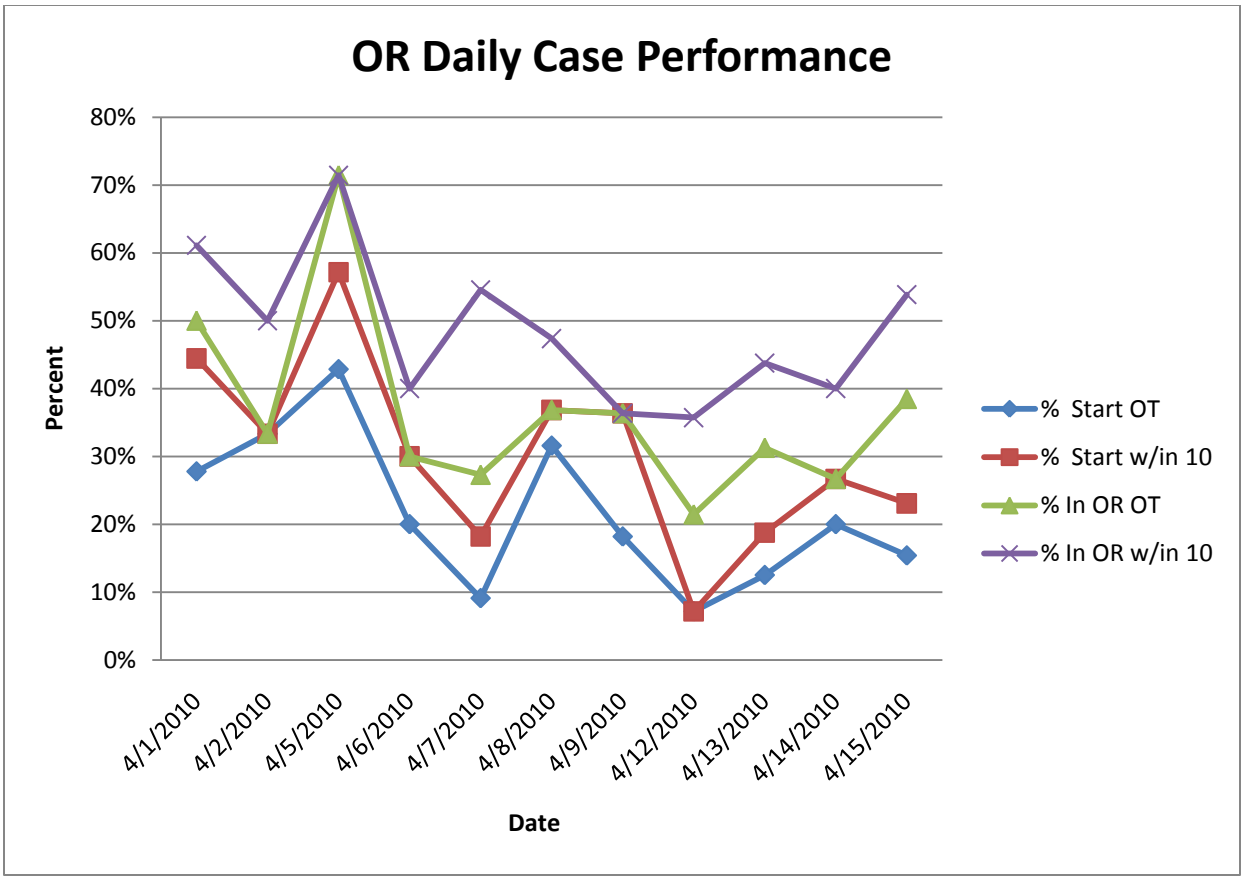


Figure 4: Data Tracking Results

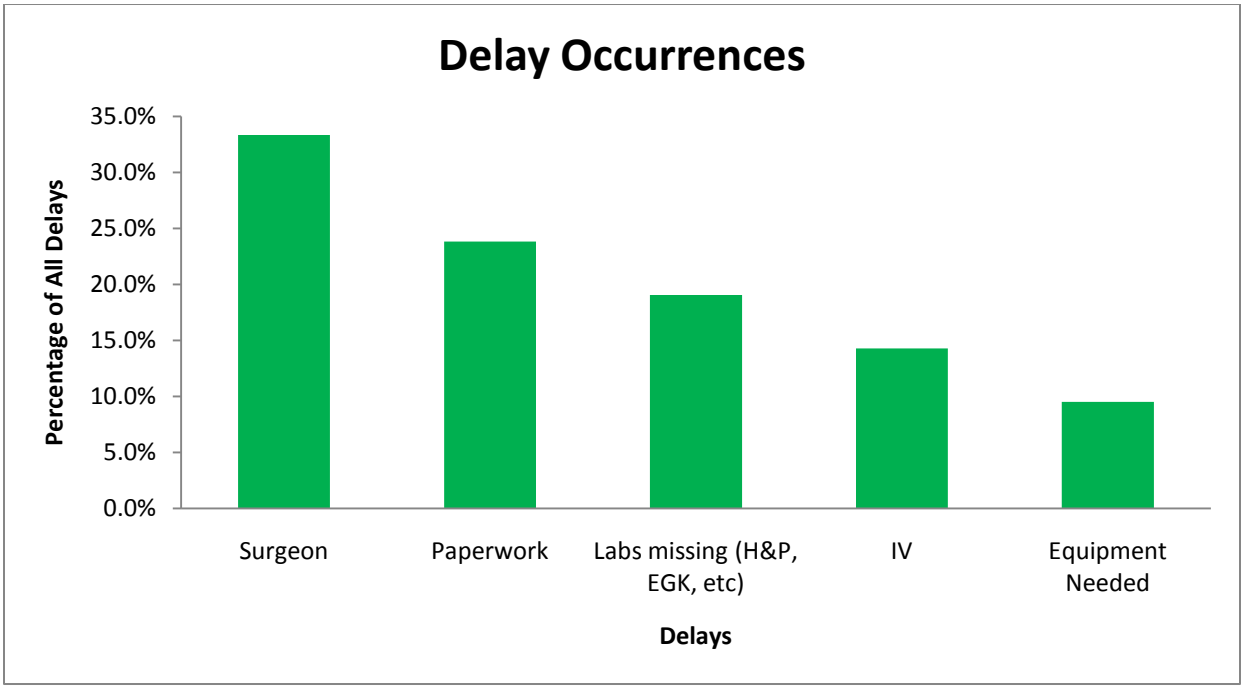


Figure 5: Pareto Chart- Delays

Facility Usage Redesign – Moving towards a Surgical Center Model

Design

A surgical center does not have all the traditional departments of a hospital and therefore limits the movement of patients and staff to a centralized location. With the potential to operate with the efficiency of a surgical center while offering the resources of a medical center, Sierra Vista can hold a competitive edge in serving its patients. The following studies the feasibility and benefits of moving towards a surgical center model at Sierra Vista.

Alternative 1: Patients move from Day Stay to Surgical Floor as soon as possible

This alternative recommends that patients who are ready for surgery be moved down to the surgical floor as soon as they are prepared for surgery. Currently, approximately thirty minutes before a surgery is to begin the surgical front desk makes a call for a patient to be moved down to the surgical floor. A traveler then goes to pick up the patient from upstairs and brings the patient to the surgical floor. This has caused issues when a surgery finishes sooner than expected. For example, during a day where ESWL procedures are scheduled back-to-back the obstruction in a patient currently in the OR was not found. The procedure ended within 5 minutes leaving the room being unutilized for 24 minutes while the next patient was brought to the surgical floor. This model would assist in ensuring patients are ready for surgery as soon as the OR is available.

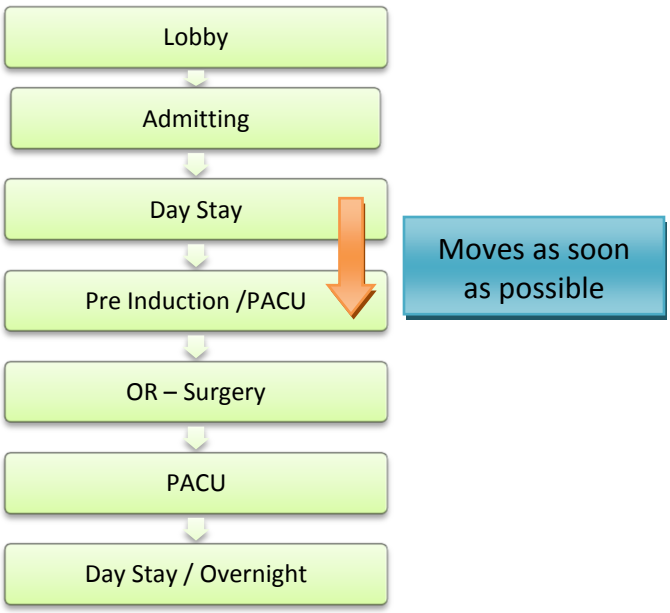


Figure 6: Alternative 1 Patient Flow Chart

Alternative 2: Patients move Directly from Check-In to Surgical Floor

This alternative recommends that patients move from checking in at the lobby and admitting directly to the surgical floor. This alternative would provide the same benefits as Alternative 1 and increase the available capacity of Day Stay for other departments or for possible future hospital growth. The distance required for patients traveling on a patient bed would also be decreased by approximately 160 feet. The recommendation of this alternative had been made by anesthesiologists and had been proposed in the past; however feasibility of the project had not been determined.

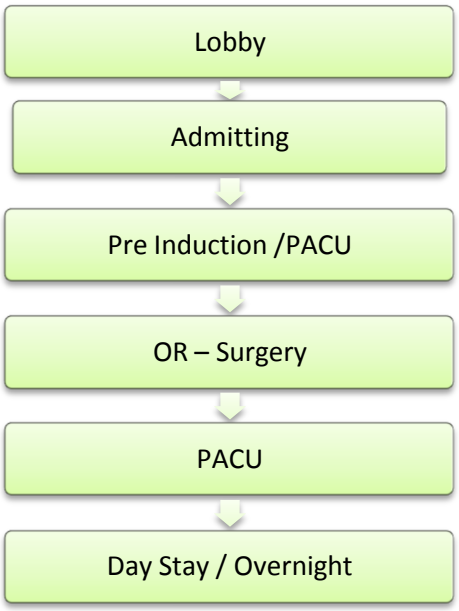


Figure 7: Alternative 2 Patient Flow Chart

Alternative 3: Patients move Directly from Lobby/Admitting to Surgical Floor and stay in Surgical Floor until discharge

This alternative would pertain to out-patients only and would require the same considerations as Alternative 2. Outpatients would no longer move to the Day Stay area of the hospital. The department would operate as independently as possible in the hospital. This model would also create the highest utilization of the surgical floor rooms (Pre-Induction and PACU).

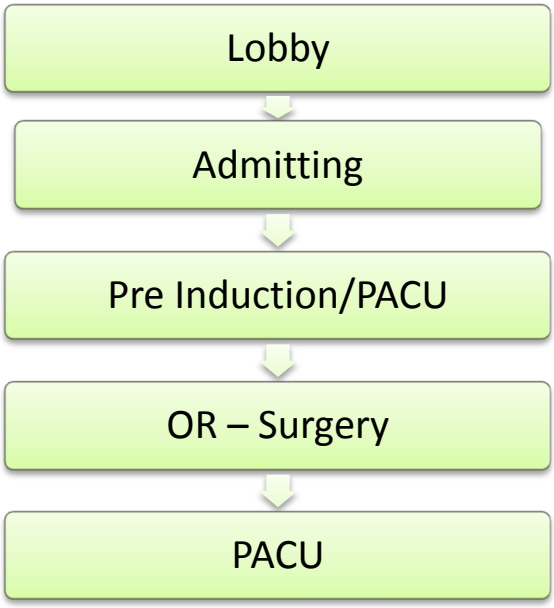


Figure 8: Alternative 3 Patient Flow Chart

METHODS

The capacity requirements (number of patient beds required) for the proposed alternatives are determined through simulation models of current patient flow along with simulations for each of the 3 possible alternatives. The methodology behind the simulation is described in this section.

A redesign of the PACU layout is also created to maximize capacity. A Microsoft Visio design of the current state and possible future state of the PACU was developed.

Simulation of Current Flow

Defining Requirements

Using MedModel, a simulation was created to model current patient flow throughout the hospital. All patients are assumed to arrive from outside the hospital (i.e. patients already in the hospital still undergo check-in at the lobby). Results from data collection were utilized along with data provided from hospital Cerner reports to create time distributions. Patients are entities with the following attributes:

1. enterORTime – Time patient enters assigned OR
2. patientNum – Patient number from 1 to n. n= number of cases for day
3. ORassignment – OR patient has surgery in: 1-7
4. apptTime – Time patient was scheduled to have surgery
5. MinsInOr- Minutes patient is in OR. Time rolled out of room – time rolled into room.

Arrival time of patients are determined by apptTime - N(140,10). Arrivals and attributes of each entity are imported from an excel document (See Appendix F).

The simulation has the following global variables:

1. Turnover – minutes between availability of OR after patient exits OR, user is prompted for value at the beginning of simulation
2. Census- counts number of patients in the hospital, displayed and updated while simulation is running
3. dayStay- counts number of patients in Day Stay, displayed and updated while simulation is running

4. PACU- counts number of patients in PACU, displayed and updated while simulation is running
5. Operating- counts number of patients currently in an operating room, displayed and updated while simulation is running
6. surgeonDelay- average minutes surgeons arrive late for day, user is prompted for value at the beginning of simulation
7. StartCaseDelay - average minutes cases start after scheduled for day, user is prompted for value at the beginning of simulation

Entity Processing

Patients are processed throughout the following locations.

1. Lobby
2. AdmittingAndWait
3. Day_Stay
4. Pre_Induction Room
    a. If at capacity, patient goes to PACU
5. OR
    a. Moves to *ORassignment* two minutes before *enterORTime*
    b. Stays in OR for *MinsInOr*
6. PACU
7. EXIT

Scenarios: Low, Medium, High

Three excel documents were created to model a low, medium, and high number of cases in a certain day (See Appendix F).

1. Low- modeled 4/6/2010 with 10 cases

2. Medium- modeled 4/12/2010 with 14 cases

3. High- modeled 4/8/2010 with 19 cases

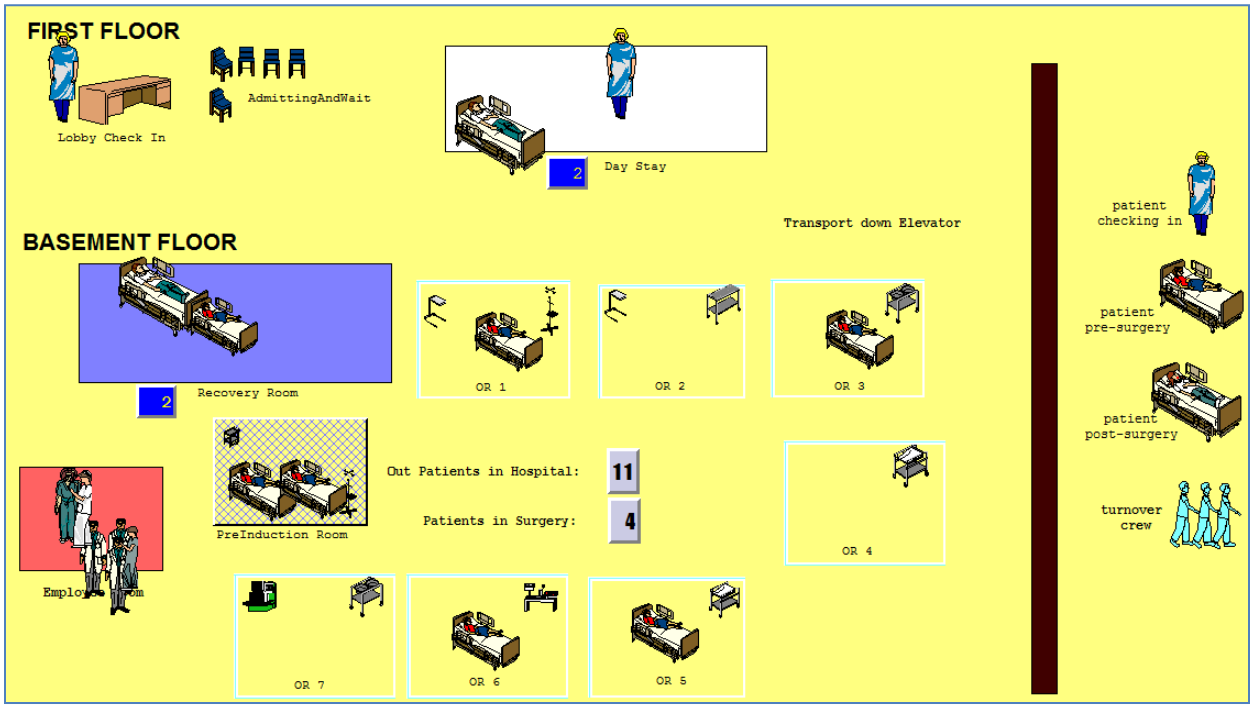


Figure 9: Simulation Model

The simulation was run with the Low, Medium, and High Day scenarios to determine the maximum occupancy, total entries, and % utilization of the PACU. Current state simulation used a maximum capacity of the PACU to be 7 beds to calculate % utilization.

Table 2: Usage of PACU Current State

	LOW	MEDIUM	HIGH
Max Occupancy	4	5	6
Total Entries	13	20	29
% Utilization	10.6%	14%	23.6%

Alternative 1

The following changes were made to the current state simulation to model Alternative 1:

1) Patient was moved from Day Stay to Surgical Floor (Pre-Induction Room or PACU) after an average of 30 minutes in Day Stay.
2) Maximum capacity of the PACU was assumed to be 10 beds.

The following statistics were determined with the simulation model for a low, medium, and high day.

Table 3: Usage of PACU Alternative 1

	LOW	MEDIUM	HIGH
Max Occupancy	5	5	6
Total Entries	13	21	29
% Utilization	7.97%	12.52%	17.7%

Alternative 2

The following changes were made to the current state simulation to model Alternative 2:

1) Patient was moved from Admitting to Surgical Floor (Pre-Induction Room or PACU). Patient did not go through Day Stay.
2) Maximum capacity of the PACU was assumed to be 10 beds.

Maximum occupancy of the Surgical Floor (not including OR) was determined with the simulation model with a low, medium, and high day.

Table 4: Usage of PACU Alternative 2

	LOW	MEDIUM	HIGH
Max Occupancy	5	6	6

Total Entries	14	22	29
% Utilization	8.2%	13.5%	17.2%

For this model to work, patients must have a place to store their clothing and/or belongings. A solution to this problem would be to use a hospital bed with attached an attached storage area. These beds have been used in surgical centers with high success. The chance of misplacing patients items decreases as patients are moved throughout the hospital.

Alternative 3

The following changes were made to the current state simulation to model Alternative 2:

1) Patient was moved from Admitting to Surgical Floor (Pre-Induction Room or PACU). Patient did not go through Day Stay.
2) Patient Stayed in PACU after surgery until exit from hospital. Patients waited in PACU for N(60,5) + L(98,88) minutes.
3) Maximum capacity of the PACU was assumed to be 10 beds.

Maximum occupancy of the Surgical Floor (not including OR) was determined with the simulation model with a low, medium, and high day.

Table 5: Usage of PACU Alternative 3

	LOW	**MEDIUM**	**HIGH**
Max Occupancy	6	8	8
Total Entries	14	22	29
%utilization	13%	21.9%	27.85%

RESULTS

The PACU has currently has enough capacity for patients to implement Alternative 1 and Alternative 2. Alternative 3 would require changes to the floor plan of the PACU to sustain enough capacity for a day with medium or high amount of cases.

Table 6: Maximum Capacity of PACU

	LOW	MEDIUM	HIGH
Current	4	5	6
Alternative 1	5	5	6
Alternative 2	5	6	6
Alternative 3	6	8	8

Travel distances when a patient is in a hospital bed were also estimated for current state and possible alternatives. Traveling on a hospital bed requires a staff member (traveler, nurse, etc) to be present to move the patient. Alternative 2 and Alternative 3 would decrease travel distance by 160 feet and 320 feet, respectively.

Table 7: Distance Traveled on Hospital Bed - Outpatients

	Patient Travel on Hospital Bed (feet)
Current	550 feet
Alternative 1	550 feet
Alternative 2	390 feet
Alternative 3	230 feet

Another benefit of moving towards the alternatives would be better communication. This would prevent the occurrences of delays such missing labs and incorrect administrative procedures. Surgeons and anesthesiologists would also be able to speak to patients without having to travel to the first floor of the hospital.

Current and Future State of PACU

The current usage of the PACU has enough facility space for 7 beds (7 patients). Each patient area is approximately 8 feet by 10 feet and has a cloth curtain separating each patient area.

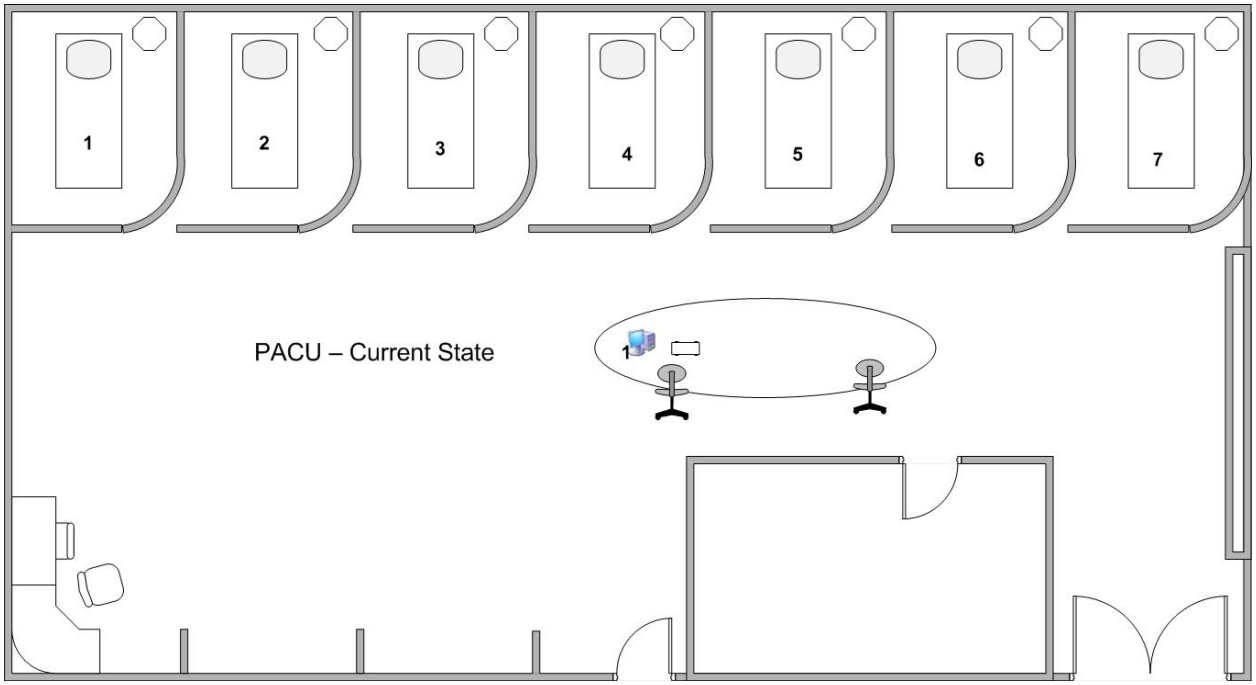


Figure 10: Current State of PACU

A proposed future state of the PACU requires minimal changes. Patient areas 8, 9, 10 already have curtains separating the area; however, the current state uses the area as an office work area.

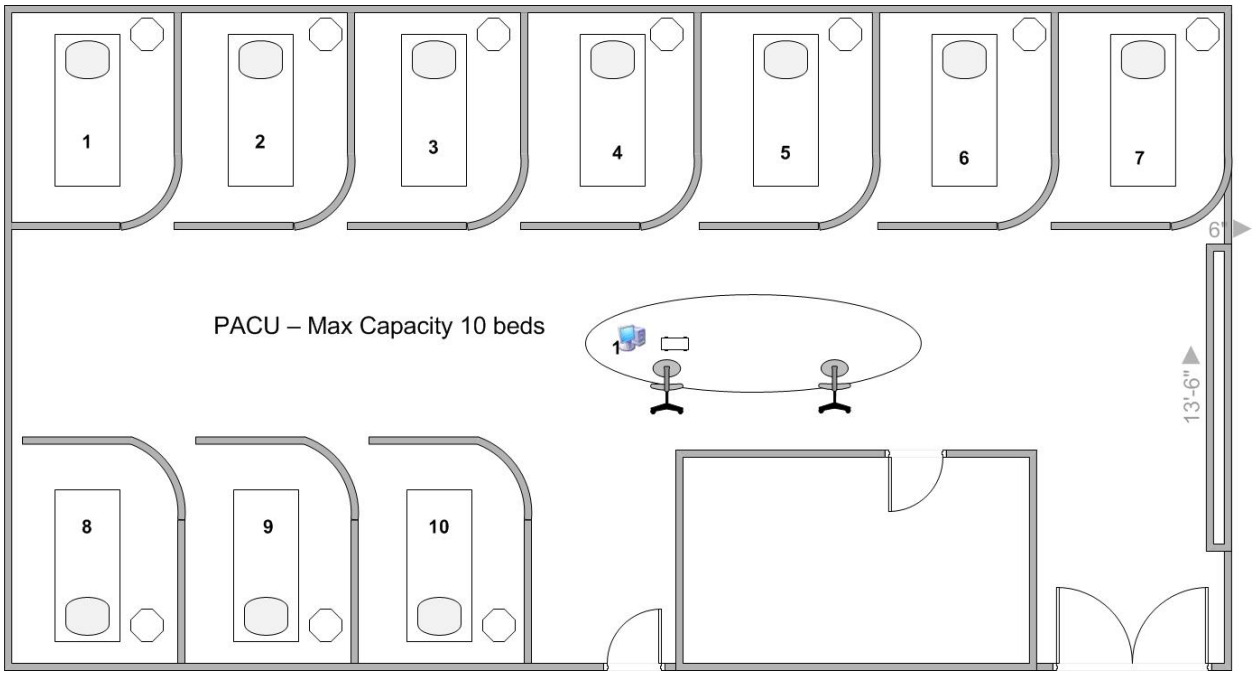


Figure 11: Future State PACU

The future state would require the office area to be moved to different room on the surgical floor. This movement would increase the capacity of the PACU from 7 beds to 10 beds (43% increase). A possible alternative would be to move office area to the Pre Induction Room. This would place all patients before and after surgery in one room and would increase overall patient bed capacity from 9 to 10 beds. Keeping inmate patients in a one private room in Day Stay could increase capacity for other patients as well. Inmate patients require two guards and occupancy of the entire Pre Induction Room.

Cost Analysis

Assuming approximately 300 patients per month and a cost of $40/ OR minute the following estimate the cost benefits of implementing the proposed alternatives. Due to the ability to ensure patients are in a close proximity to the operating rooms when the operating room becomes available, the number of cases that start closer to its scheduled time will increase. If the average case saves 5 minutes of OR time, the estimated savings per month will be 1500 minutes or $60,000. If the average case saves only 2 minutes of OR times, the estimated savings per month will be 600 minutes or $24,000/month.

The cost of implementing the proposed alternatives will be dependent on training staff and preparing the future state PACU for Alternative 3. The following is the estimated time to train and inform staff the changes required for the alternatives. Staff members (42 serving surgical department) are assumed to cost $50/hour to train. The internal rate of return on investment would be greater than 100% for all alternatives.

Table 8: Cost Analysis Alternatives

	Time to Train Staff	Cost of Training Staff	Time Saved Per Case	Cost Savings/ Month
Alternative 1	1 hour	$2100	2 minutes	$24,000
Alternative 2	4 hours	$8400	5 minutes	$60,000
Alternative 3	6 hours	$12600	5 minutes	$60,000

DATABASE OF SURGEON LATE ARRIVALS FOR 1ST CASE START

DESIGN

The late arrival of surgeons at Sierra Vista has contributed to a significant amount of delays in the start of surgeries. Late starts in the first case of each day can ultimately lead to delays in all subsequent cases in an operating room. Currently surgeon late arrivals are recorded on an Excel spreadsheet; however, there is no system to track and analyze late arrivals.

Current Recording System:

Table 9: Current System of Recording Physician Delays

DATE	**Notes (delay and/or cancellation comments)**
02/01/10	Dr. A arrived @ 0715; Dr. B arrived @ 0717
02/02/10	All MDs arrived in a timely manner.
02/03/10	Dr. C arrived @ 0805; Dr. D arrived @ 0816; Dr. E arrived @ 0820
02/04/10	Dr. A arrived @ 0709; Dr. B arrived @ 0710
02/05/10	Dr. C arrived @ 0710; Dr. R arrived @ 0715
02/08/10	Dr. E arrived @ 0712
02/09/10	Dr. F arrived @ 0710
02/10/10	Dr. A arrived @ 0705; Dr. S arrived @ 0705; Dr. R arrived @ 0713

*Surgeon Names have been altered

Defining Requirements

A database would allow for recording of late arrivals and analysis of collected data. This database must have a user-friendly interface for recording surgeon late arrivals as they occur, creating reports for each surgeon, and creating reports on a monthly basis. A unique identification number must also be created for surgeons to allow for public reports. New surgeons added to the database must be assigned a surgeon identification number. Individual reports will be given to surgeons and overall monthly reports will be presented at staff and

surgeon meetings. With these monthly reports, surgeons will be able to track their performance and rankings.

METHODS

Recording New Late Arrival Records

This database will allow records of late arrivals to be added when convenient for the user (daily, weekly, monthly, etc). To enter a new record the user selects the surgeon from a drop down menu (sorted alphabetically), selects the date of the late arrival (calendar appears), enters the number of minutes late for the arrival, and selects record late arrival. The record is then added to a datasheet displayed at the bottom of the page. The user can enter as little as one record to an infinite amount at one sitting. The user can then review the records added and change any errors on the data sheet if any. The user then confirms newly added records and closes the form.

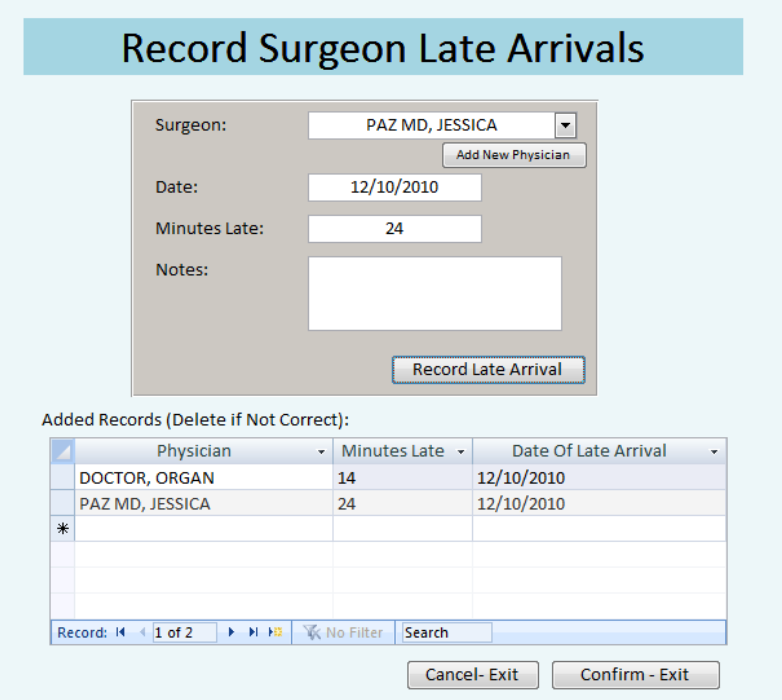


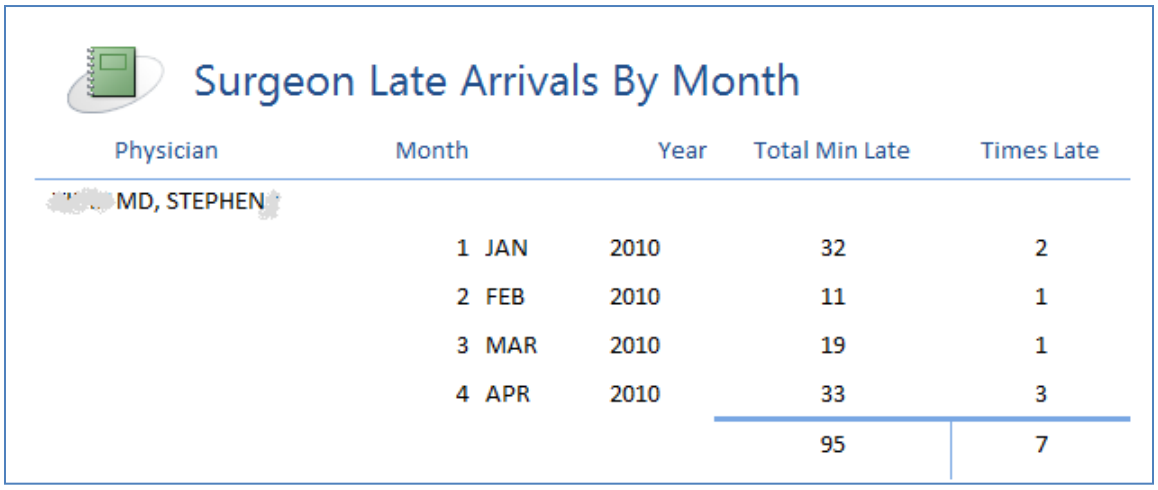
Figure 12: Input Data

If a new surgeon must be added to the database, the user can select "Add New Physician." A text box where the user can enter the new surgeon then appears. After the user enters the surgeon name, they then select "Done." The surgeon record is added to the database and selected as the surgeon to enter a new record.

Figure 13: Adding of a New Physician

Personal Surgeon Reports

Two types of personal surgeon reports were created: Monthly Totals and Complete History. A surgeon name is selected from a drop down menu and the selected type of report can be displayed. Monthly Total report displays total minutes late per month along with occurrences of late arrivals per month.

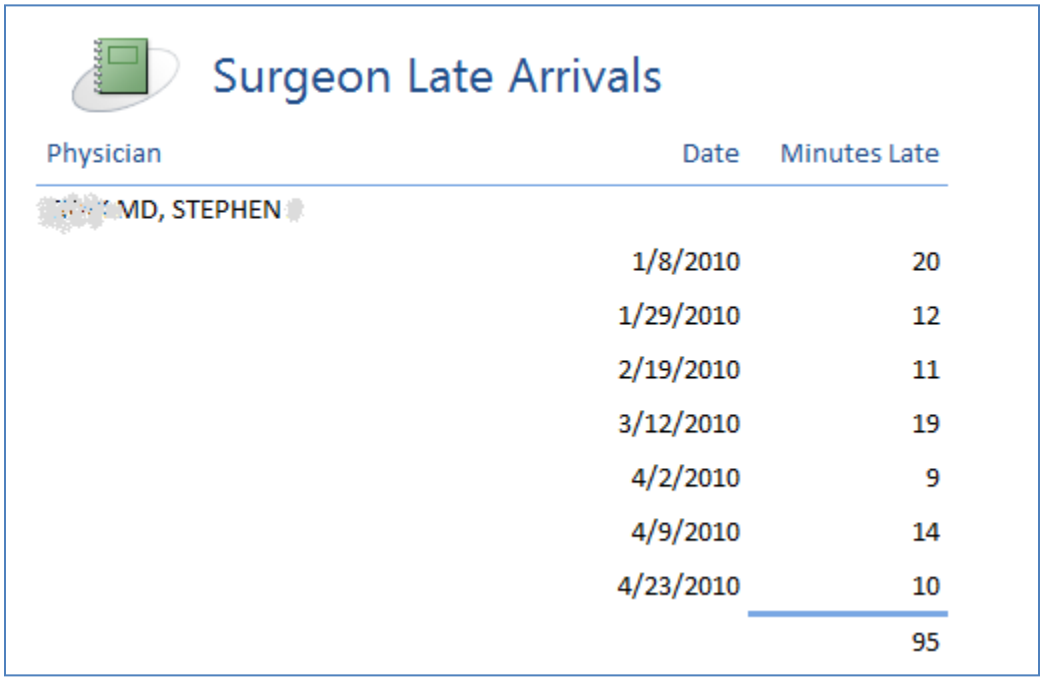


Surgeon Late Arrivals By Month

Physician	Month	Year	Total Min Late	Times Late
[redacted] MD, STEPHEN				
	1 JAN	2010	32	2
	2 FEB	2010	11	1
	3 MAR	2010	19	1
	4 APR	2010	33	3
			95	7

Figure 14: Surgeon Late Arrivals by Month Report

Complete History displays all records of the selected surgeon's late arrivals with minutes late and data of late arrival. Records are displayed in chronological order.



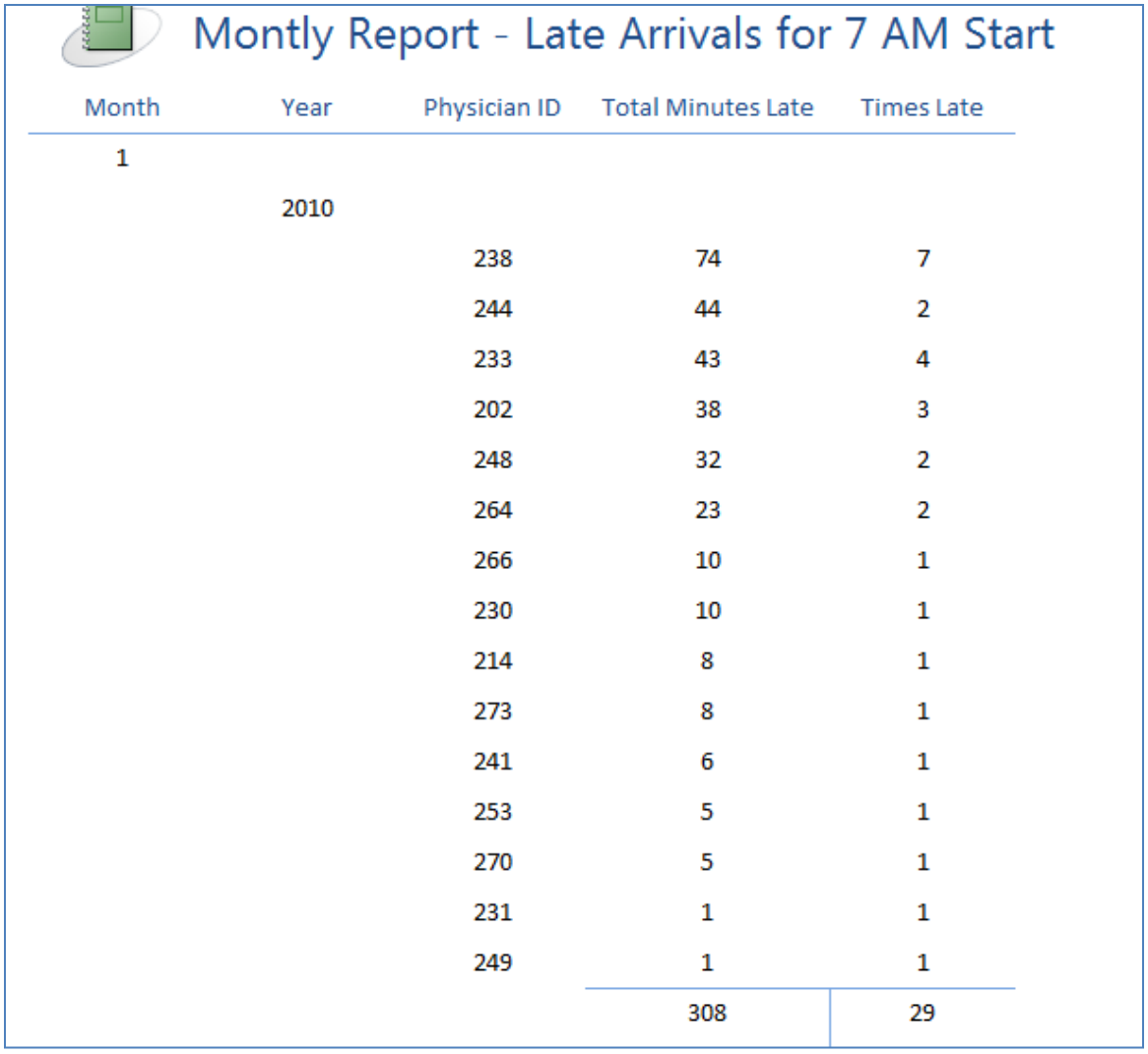
Surgeon Late Arrivals

Physician	Date	Minutes Late
[redacted] MD, STEPHEN		
	1/8/2010	20
	1/29/2010	12
	2/19/2010	11
	3/12/2010	19
	4/2/2010	9
	4/9/2010	14
	4/23/2010	10
		95

Figure 15: Surgeon History Report

Overall Reports - Monthly

Monthly reports are generated using all surgeon late arrivals from a selected period. The report can be displayed with surgeon names or with surgeon ID numbers. The surgeon ID numbers allow for reports to be displayed publicly.



Montly Report - Late Arrivals for 7 AM Start

Month	Year	Physician ID	Total Minutes Late	Times Late
1				
	2010			
		238	74	7
		244	44	2
		233	43	4
		202	38	3
		248	32	2
		264	23	2
		266	10	1
		230	10	1
		214	8	1
		273	8	1
		241	6	1
		253	5	1
		270	5	1
		231	1	1
		249	1	1
			308	29

Figure 16: January 2010 Surgeon Late Arrivals Report

Identification Number Reports

Reports all surgeons and identification numbers. User can also select one surgeon to display his or her unique identification number.

RESULTS

The following shows the total minutes of late surgeon arrivals per month. An estimated cost of an OR at $40/minute was use to calculate cost of late arrivals.

Table 10: Total Minutes Late per Month with Cost

Month	Minutes	Cost ($40/min)
JAN	308	$12,320
FEB	476	$19,040
MAR	330	$13,200
APR	480	$19,200
Avg/month	**398.5**	**$15,940**
JAN- APR total	**1594**	**$63,760**

Appendix G shows graphs analyzing surgeons on a monthly basis.

Cost Analysis

The cost to maintain this database would be dependent on a staff member updating the database and creating monthly reports. With a maximum estimated time of 5 minutes per day to update the database and 30 minutes to create monthly reports, the time required per month is estimated at 150 minutes (2.5 hours) assuming 24 workdays per month. Assuming a cost of labor at $50/hour for a staff member, the costs per month of maintaining the database would be $125/month.

The benefit of these reports would be having surgeons accountable for their late arrivals. Surgeons who have contributed to the most amounts of delays can compare themselves to other physicians. For example, surgeon 238 has contributed to 339 minutes of delay (at a cost of $13,560) from Jan-April. Seeing that he or she alone has contributed to 21% of delays due to late arrivals can hopefully encourage the surgeon to arrive on time. If late arrivals are reduced 50%, a cost savings of approximately $8000/month can be reached. If late arrivals are only reduced 25%, as a result of the monthly reports, a cost savings of approximately $4000/month can still be achieved.

RECOMMENDATIONS AND CONCLUSION

Identification of the causes of delays revealed many sources of inefficiency in the surgical department at Sierra Vista, including communication and late arrivals. Most delays occurred when problems with a case were discovered at the surgical floor. Missed requirements of each surgical case should be detected before a patient arrives for surgery. Pre-operative checklists or calls to patients can be utilized to ensure that every patient is ready to start surgery when scheduled.

Focused data collection in the Pre-Induction room would allow for a more accurate identification of delays that occur and would also require fewer staff to participate. A proposed data collection sheet is shown in Appendix H. The importance of having all staff participate must be emphasized. The collected data should also be shared to staff on a regular basis, at least weekly. A board in the hospital dedicated to sharing information regarding process improvement would also be valuable. For example, highlighting a "Delay of the Week" and current performance graphs. This would allow for accountability and tracking along with areas for staff to focus improvement. Furthermore, having a process improvement focus group made up of a variety of personnel (surgeons, anesthesiologists, nurses, staff, administration etc) to continuously work towards reducing waste and increasing efficiency would provide a strong foundation for future improvement.

The facility flow redesign of patients to a surgical center should be considered as a promising direction for Sierra Vista. The department can begin with Alternative 1, then move to Alternative 2, and gradually move to Alternative 3. Current capacity of the surgical floor is

sufficient for both Alternative 1 and Alternative 2. The movement towards a surgical center model will not only decrease distance travel by patients, staff, and physicians, but will also create a centralized location where the surgical department operates. Ease of communication between staff will increase. Operating similar to a surgical center while having the resources of a hospital can make Sierra Vista the premier location for surgical services in the county. The resistance to the proposed alternatives can be expected to be strong (ex. PACU nurses will not want Day Stay nurses working in the PACU); however, a suggested trial period for a month could decrease resistance to change and provide a good benchmark to measure the effectiveness of the new system.

The database of late surgeon arrivals should be used on a continuous basis. Recording the late arrivals will be ineffective unless the recorded information is shared. By keeping surgeons accountable for their late arrivals, surgeons will be able to track their progress and performance. An incentive to arrive on time will also assist in ensuring surgeons know the importance of arriving on time. A physician "scorecard" could be utilized to give physicians feedback and award top performers. In addition, surgeons who continuously arrive late for first case starts may be asked to start their surgeries later in the day.

With the application of these process improvement recommendations, the department of has the potential to save upwards of $60,000 per month while increasing efficiency and quality for the many surgical patients of Sierra Vista Medical Center.

APPENDIX

APPENDIX A: PROPOSAL TO DIRECTORS

MEMORANDUM
To: Sierra Vista Regional Hospital Directors
From: Jessica Paz, Cal Poly Industrial Engineering Senior
Date: March 23, 2010
RE: **Surgical Patient Flow and Delay Data Collection Proposal**

The following proposal outlines a Flow and Delay Data Collection system for surgical patients at Sierra Vista Regional Hospital. In order to implement this program, I would greatly appreciate the help of you and your staff. With your assistance, we can increase both patient, physician, and staff satisfaction by ensuring that cases can start on-time.

Justification:

The operating room currently runs with an average of 25% of elective cases starting on-time. More than 50% of cases start over 20 minutes after the scheduled appointment. At this time, there is no system to accurately determine the cause and occurrences of various delays.

Objectives:

- To identify the main causes of delays
- To develop improvements to streamline the flow of patients throughout the hospital
- To increase patient, physician, and staff satisfaction
- To increase the efficiency of operating rooms

Procedure:

Data Collection

- Patient Tracking Card (example attached) is passed along with patient chart
  - Initial information filled out at lobby (by volunteers when patient arrives at the hospital)
  - No confidential patient information is included on card
- As a patient is moved from location to location- movement and delays are recorded
  - Locations: Lobby, Admitting, Day Stay, PI Room, OR, PACU
- Allows for delays to be recorded from when patient enters the hospital to when patient leaves PACU

Analysis and Reporting

- At the end of each day, I will pick up cards and determine causes of delays for day
- Daily Report
  - % of On-Time cases for Previous Day

    - Top 3 reasons for Delays
    - Displayed on white board for all operating room staff to read
- Weekly Report
    - Tracking and analyzing of overall delay causes and times
    - Determination of Top 3 Delays for the week

Collection of Methods for Improvement

- Encouragement of staff to submit suggestions for improvement on Top 3 Delays
- Recognition for staff suggestions that are used

Duration

- Training of all involved staff March 29-31
- Data Collection - April 1 until April 16, 10 workdays (Possibly extended to a month if necessary)

Benefits

- Identifiable and Measurable Data to present to physicians and staff
- Real-time information reported and analyzed on a daily basis
- Thorough collection of patient flow – from hospital entry to departure from PACU
- Inclusion of staff in improvement process

Requested Support

- Training of staff from various departments on filling out the Tracking Card
- Regular encouragement of staff to submit suggestions for improvement

If you have any questions or comments regarding this proposal, please do not hesitate to contact me.

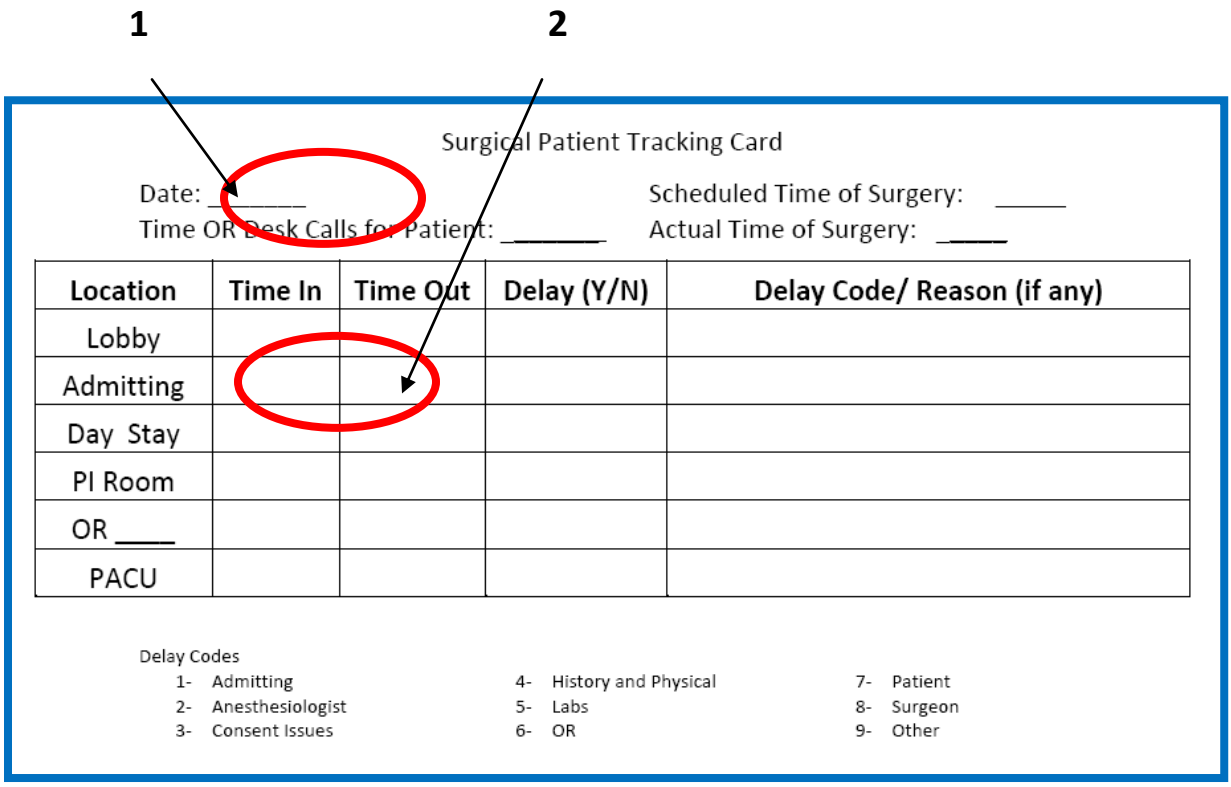
Thank you for your time and I look forward to hearing your ideas on this proposal!

-Jessica Paz
Cal Poly Industrial Engineering Senior Project Student
jepaz@calpoly.edu
909-569-7415

APPENDIX B: TRACKING CARD INSTRUCTIONS

Surgical Patient Tracking Card Instructions

What to do at the Lobby



1) **Fill in Today's Date**
2) **Fill in time Surgical Patients Enter Lobby**
3) **Give patient tracking card and instruct patients to bring card to Admitting**

If you have any suggestions to improve OR efficiency or quality, let us know on the tracking card!

Questions? Feel free to email Jessica at jepaz@calpoly.edu or call (909)569-7415

Thank you for your help and participation!

APPENDIX C: DATA COLLECTION FAQ

TRACKING CARD FAQ

What is the purpose of this card?

- Most staff can name causes of delays, but with these cards we can determine exactly how often and where each delay occurs. This gives us accurate data to show physicians and staff.
    - 44% of outpatients arrived in the OR within 10 minutes of scheduled time in March
    - 25% of outpatient cases started within 10 minutes of scheduled time in March
    - By identifying and quantifying delays, we can begin to reach the goal of cases running 80% on time
- To gather improvement suggestions from the people that know what goes on every day the best – YOU!

What do I do with the tracking card?

- When patient arrives at current location, record time
- If any delays occur, write them down with delay code and explanation
    - **THIS IS THE MOST IMPORTANT ASPECT OF THE CARD**
    - Delay examples
        - At PI – patient needed EGK, office called
        - At OR – surgeon arrived 20 minutes late
        - At OR- OR occupied, previous case running late
    - *If a case is running more than 15 minutes late, a reason for the delay should be listed*
- When patient leaves current location, record time
- If you are at the OR, a few extra things to write
    - OR room number
    - Time OR desk calls for patient

What do I do with the suggestion card part?

- If you think of any ideas that can help reduce delays for the OR, please write them down
- They can be about anything! A process that is redundant, a step that could be done earlier, etc

What is been done with the cards at the end of the day?

- Cards are collected nightly and delays are analyzed
- % of cases that were on time for the day are determined
    - % that patient is in OR within 10 minutes of start time
    - % of cases that start within 10 minutes of start time
- Information will be shared daily to OR staff

Why do I have to write the time in and out for patients? Won't time out at PI be practically the same as time in at OR?

- Yes and No. Most of the time the times will be nearly the same, but by collecting all times we can account for out-of-the-ordinary cases. Such as a patient that arrives at PI but ends up cancelling surgery.
- Writing both times also allows for verification of the data collected

How long will I have to fill out these cards?

- Data collection is scheduled from 4/1 to 4/15 Mon-Fri (If necessary, collection will continue till the end of April)

Any other questions or comments about the cards?

- Please let Jessica Paz know at jepaz@calpoly.edu or write them on the suggestion part of the card
- Thank you for your help and participation!!

APPENDIX D: STAFF SUGGESTIONS

Suggestions for OR Improvement

Name: _____ Issue: _____
Suggestion:_____
_____
_____

Name: _____ Issue: _____
Suggestion:_____
_____
_____

Name: _____ Issue: _____
Suggestion:_____
_____
_____

Thank you for your input! We appreciate your ideas!

APPENDIX E: DATA COLLECTION CASE START RESULTS

Table 11: On Time Starts

Date	Total Num	# Scheduled	# Start OT	# Start w/in 10	# In OR OT	# In OR w/in 10	% Start OT	% Start w/in 10	% In OR OT	% In OR w/in 10
4/1/2010	20	18	5	8	9	11	0.28	0.44	0.50	0.61
4/2/2010	15	12	4	4	4	6	0.33	0.33	0.33	0.50
4/5/2010	14	14	6	8	10	10	0.43	0.57	0.71	0.71
4/6/2010	10	10	2	3	3	4	0.20	0.30	0.30	0.40
4/7/2010	12	11	1	2	3	6	0.09	0.18	0.27	0.55
4/8/2010	19*	19	6	7	7	9	0.32	0.37	0.37	0.47
4/9/2010	11*	11	2	4	4	4	0.18	0.36	0.36	0.36
4/12/2010	15	14	1	1	3	5	0.07	0.07	0.21	0.36
4/13/2010	16*	16	2	3	5	7	0.13	0.19	0.31	0.44
4/14/2010	15*	15	3	4	4	6	0.20	0.27	0.27	0.40
4/15/2010	13*	13	2	3	5	7	0.15	0.23	0.38	0.54
April Total	86	153	34	47	57	75	0.22	0.31	0.37	0.49

*includes add-on cases

APPENDIX F: SIMULATION DAY MODELS

Table 12: April 6, 2010

Time of First Arrival	apptTime	MinsInOr	ORassignment	patientNum	enterORTime
420- N(140,10)	420.00	94	6	1	395
420- N(140,10)	420.00	190	3	2	430
420- N(140,10)	420.00	123	7	3	430
540- N(140,10)	540.00	74	6	4	515
570- N(140,10)	570.00	50	7	5	577
600- N(140,10)	600.00	140	5	6	650
630- N(140,10)	630.00	329	6	7	628
630- N(140,10)	630.00	163	7	8	655
720- N(140,10)	720.00	60	3	9	805
900- N(140,10)	900.00	81	6	10	1035

Table 13: April 12, 2010

Time of First Arrival	apptTime	MinsInOr	ORassignment	patientNum	enterORTime
420- N(140,10)	420	107	7	1	393
420- N(140,10)	420	109	5	2	412
420- N(140,10)	420	83	3	3	429
420- N(140,10)	420	214	6	4	430
420- N(140,10)	420	64	1	5	439
480- N(140,10)	480	62	1	6	534
540- N(140,10)	540	104	1	7	639
600- N(140,10)	600	167	3	8	635
690- N(140,10)	690	250	6	9	695
720- N(140,10)	720	62	1	10	797
720- N(140,10)	720	72	3	11	823
750- N(140,10)	750	87	5	12	740
810- N(140,10)	810	147	3	13	911
960- N(140,10)	960	82	3	14	980

Table 14: April 8, 2010

Time of First Arrival	apptTime	MinsInOr	ORassignment	patientNum	enterORTime
420 - N(140,10)	420.00	332	6	1	393

420 - N(140,10)	420.00	65	5	2	409
420 - N(140,10)	420.00	55	1	3	410
480 - N(140,10)	480.00	57	1	4	473
510 - N(140,10)	510.00	127	5	5	498
600 - N(140,10)	600.00	64	1	6	590
540 - N(140,10)	540.00	45	1	7	540
660 - N(140,10)	660.00	67	1	8	665
420 - N(140,10)	420.00	29	3	9	428
720 - N(140,10)	720.00	54	1	10	740
780 - N(140,10)	780.00	42	1	11	805
960 - N(140,10)	960.00	108	1	12	985
660 - N(140,10)	660.00	88	5	13	685
840 - N(140,10)	840.00	50	1	14	865
900 - N(140,10)	900.00	41	1	15	930
510 - N(140,10)	510.00	81	3	16	527
600 - N(140,10)	600.00	242	3	17	657
1080 - N(140,10)	1080.00	52	1	18	1155
1020 - N(140,10)	1020.00	49	1	19	1100

APPENDIX G: LATE ARRIVALS GRAPHS WITH PHYSICIAN ID NUMBERS

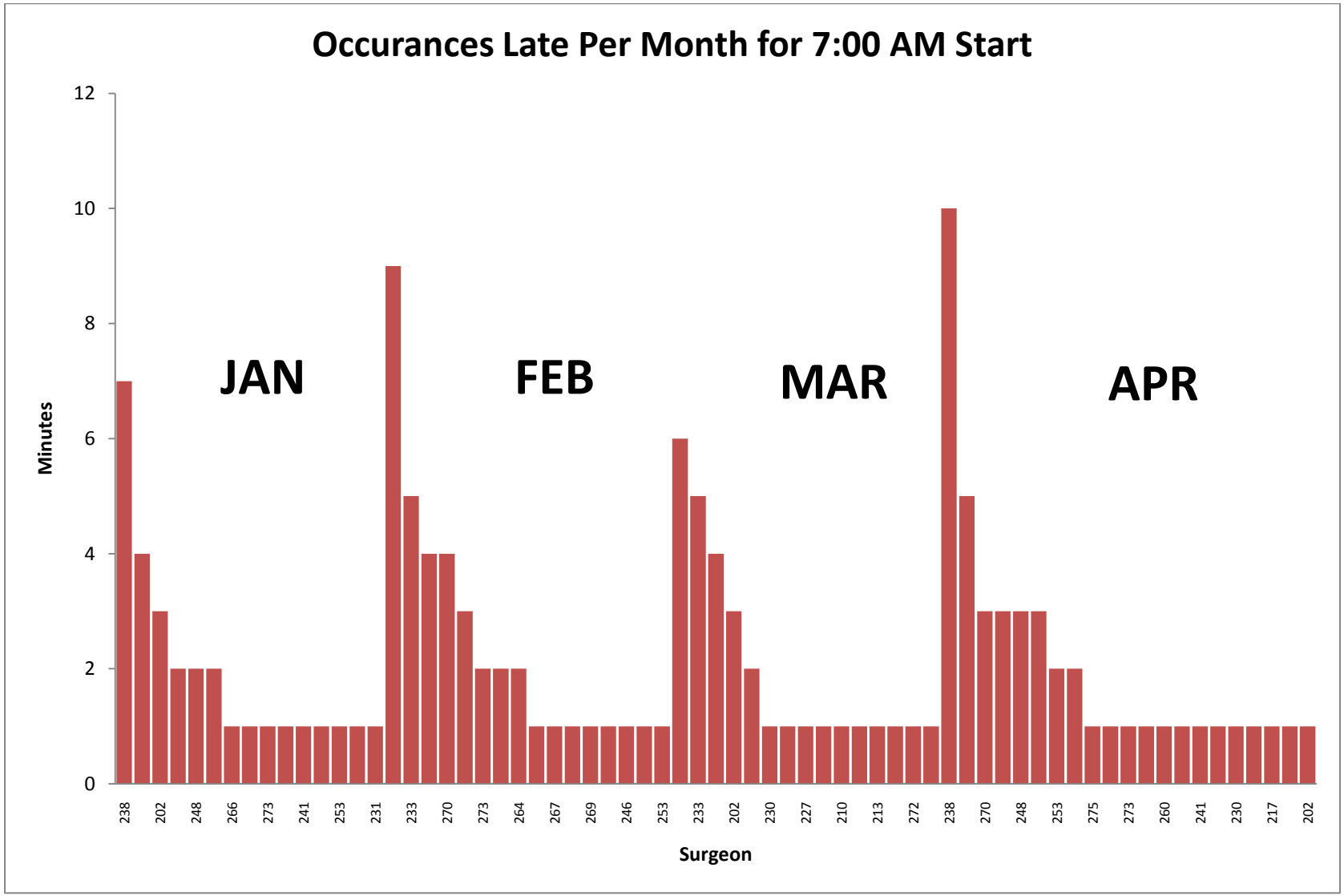


Figure 17: Occurrences Late

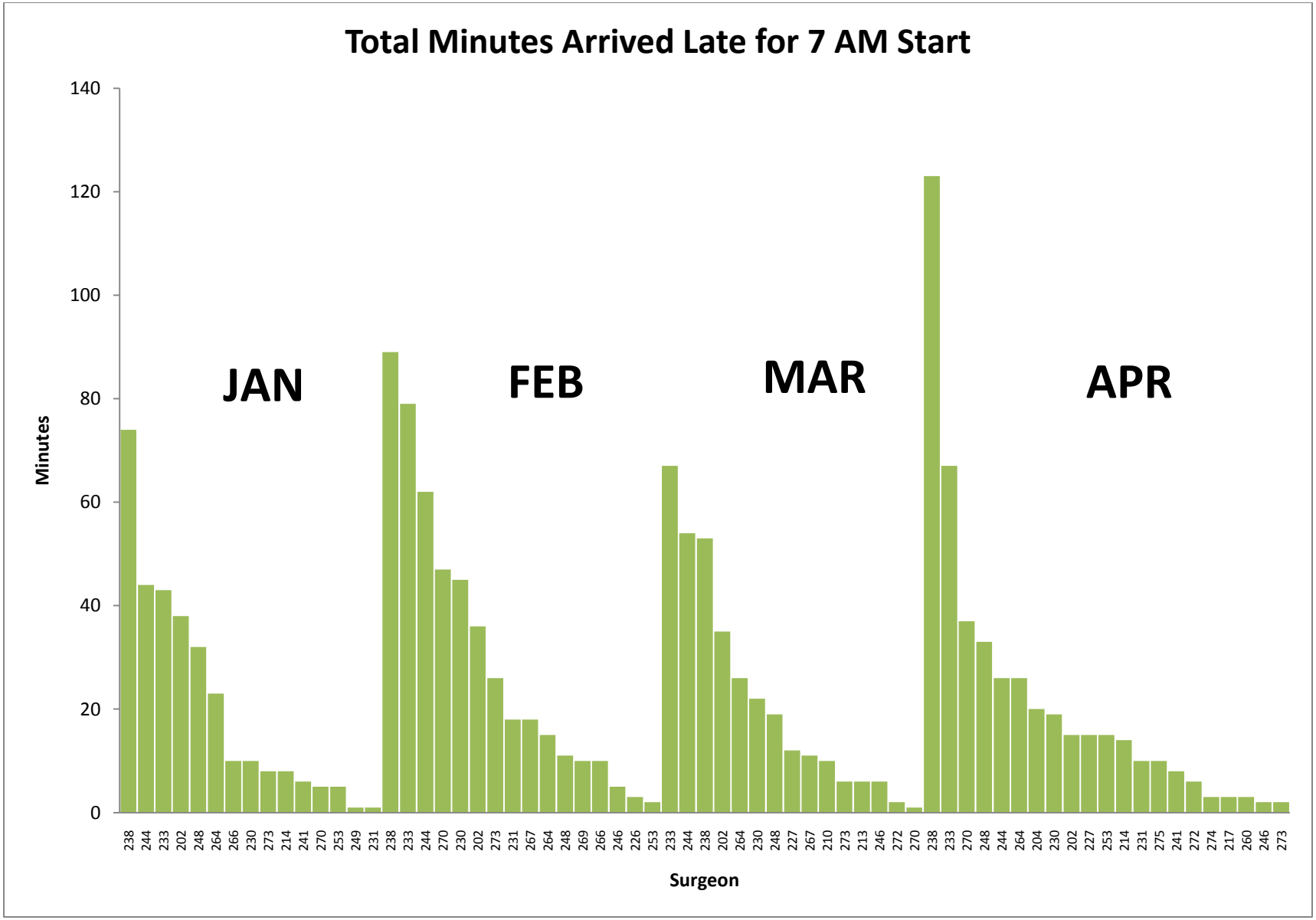


Figure 18: Total Minutes Late

APPENDIX H: PRE SURGERY DELAY LOG

PRE SURGERY DELAY LOG

	Date	Time Entered	Time Left	Delay Reason Code	Notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

Delay Reason Code

1- Admitting	4- History & Physical	7- Patient
2- Anesthesiologist	5- Labs	8 -Surgeon
3- Consent Issues	6- OR	9- Other

Figure 19: Delay Log

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