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Two costly problems in the operating room (OR) are lengthy turnaround times between surgical cases and the waste of resources and OR time due to high cancellation rates. By reducing turnaround time, staff overtime can be reduced and more cases can be scheduled during the day. Archival data were reviewed on 3727 surgical cases from a U.S. Government medical facility database. This study describes the inefficient use of the current operating room management software system, and identifies strategies to improve operating room efficiency by analyzing the most common causes of delays and cancellations using accurate data and meaningful reports. Personal accountability, teamwork, scheduling, and accurate data are all major factors in improving efficiency.

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Evaluating Operating Room Turnaround Times and Cancellations at

Dwight D. Eisenhower Army Medical Center

Graduate Management Project

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Abstract

Two costly problems in the operating room (OR) are lengthy turnaround times between surgical cases and the waste of resources and OR time due to high cancellation rates. By reducing turnaround time, staff overtime can be reduced and more cases can be scheduled during the day. Archival data were reviewed on 3727 surgical cases from a U.S. Government medical facility database. This study describes the inefficient use of the current operating room management software system, and identifies strategies to improve operating room efficiency by analyzing the most common causes of delays and cancellations, using accurate data, and developing meaningful reports. Personal accountability, teamwork, scheduling, and accurate data are all major factors in improving efficiency.

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Introduction

Overview of Dwight D. Eisenhower Army Medical Center (DDEAMC)

DDEAMC was originally built as the Camp Gordon Station Hospital in 1941 to provide care for World War II casualties (Eisenhower Army Medical Center, 2004). At the peak of the war, DDEAMC was capable of handling 1,600 inpatients. After the war, there was little need for such a large facility and DDEAMC was closed in 1946. The hospital reopened with the threat of the Cold War, and fluctuated in size during the Korean and Viet Nam Wars. During the Korean War, officials realized that the medical facility was in poor repair and needed to be replaced in order to become a viable medical treatment facility to meet the future needs of the Army. A new medical center with research and teaching capabilities in addition to the fundamental patient care mission was planned. Construction began on April 23, 1971. The facility was dedicated on April 24, 1975, but it would not be ready for its first patient until April of the next year (Eisenhower Army Medical Center, 2004).

The mission of DDEAMC is similar to that of most Army medical facilities: supporting the readiness and health care of our active duty forces and providing quality health care to eligible beneficiaries in the Southeastern Region (Eisenhower Army Medical Center, 2004). DDEAMC has a current capacity of 150 inpatient beds and encompasses 28 different specialty clinics

that provide care to a population of over 1,000,000 beneficiaries from eight states and Puerto Rico (Eisenhower Army Medical Center, 2004). The average daily workload consists of 70 inpatients, 43 admissions, 1,164 outpatient visits, 20 surgical procedures, and filling over 3,000 prescriptions (Patient Administration Department, 2002). DDEAMC was the first designated Department of Defense Specialized Treatment Service (STS) Facility for Cardiac Surgery and Interventional Cardiology in 1996. Prior to the STS designation, DDEAMC was performing approximately 180 cardiac cases per year; however, since the designation, the number of cases increased to over 300 per year (Eisenhower Army Medical Center, 2004). The increase in cardiac caseload is essential to the teaching and education mission of the facility.

Approximately 115 residents and interns are currently in training at DDEAMC. The graduate medical education department at DDEAMC includes programs in family practice, internal medicine, general surgery, oral surgery, orthopedic surgery, transitional internship, clinical psychology, surgical podiatry, health care administration, and nurse anesthesia (Graduate Medical Education Office, 2004). DDEAMC is also the training site for several technical specialties for enlisted soldiers, such as the 91W licensed practical nurse program, the physician assistant program, and laboratory and x-ray technologists (Graduate

Medical Education Office, 2004). Students from the Health Professional Scholarship Program and the Uniformed Services University of the Health Sciences also train at DDEAMC.

Conditions that prompted the study

Civilian healthcare facilities, whether for-profit or not-for-profit, are not funded in the same manner as military hospitals. Nevertheless, military hospital commanders are under the same financial pressures as civilian hospital executives. Factors such as increasing demand for services, elevated patient expectations, and high costs for technology-intensive treatments, mean that commanders must ensure that all aspects of hospital services offer value to beneficiaries while keeping the costs to the taxpayers as low as possible (Nicholson, 1997). Surgical services are the second most costly area to operate at the medical center, trailing only pharmacy services, and is thus under constant fiscal scrutiny. The DDEAMC command is always looking for new ways to improve the cost, quality, and access of the military healthcare system, which prompted me to evaluate the details of the surgical services.

Statement of the problem or question

Defining the problem gives a reason for doing the research and work necessary to complete the project and provides a sense

of direction for the evidence gathering action (Bardach, 2000). A well-structured definition of the problem allows for a project that is manageable and is likely to be completed within the time constraints of the project (Bardach, 2000).

DDEAMC's annual operating budget for surgical services is nearly \$18 million. Even with this robust budget, the facility cannot afford to waste money by paying to staff underutilized operating rooms and paying unnecessary overtime. Paying to maintain excess capacity or inefficient usage of surgical resources in one area means that other areas of need go underfunded. Evaluating the turnaround time and efficiency of the surgical services will provide the DDEAMC administration with the information necessary to determine if the surgical service's staffing, and thus labor costs, is at the appropriate level. If excess capacity or correctable inefficiencies exist, then labor costs could be significantly reduced by decreasing the number of operating rooms used daily. In order to determine if this is possible, this study will evaluate OR turnaround times, which are a crucial factor in maintaining efficient OR usage. Efficiency is, simply, maximizing the utilization of available resources. Efficiency can be subdivided into allocative, technical, and productive efficiency. Allocative efficiency pertains to the distribution of limited resources; it is not possible to reallocate resources without taking the

resources from somewhere else (Clewer & Perkins, 1998). Technical efficiency, also called cost efficiency and operational efficiency, is the production of a given quantity of output with the lowest cost combination (Clewer & Perkins, 1998). Productive efficiency means that the output unit is produced with the least possible quantity of input, or equivalently, maximum output with maximum input, which minimizes the amount of waste (Clewer & Perkins, 1998). Productivity measures are considered essential for strategic management because they allow for comparison to benchmarks, history, and competition (Griffith, 1999).

I hypothesize that if DDEAMC could consistently reduce operating room turnaround time to the industry goal of 30 minutes or less, the amount of fully staffed operating rooms could be reduced. Further, I hypothesize that if the current case scheduling system improved, the utilization rate of the operating rooms would also increase, which would also support the objective of closing one of the operating room suites.

Literature review

The volatile combination of rising costs, declining reimbursements, uncertain economy, and an increasing demand for healthcare services poses a remarkable challenge for healthcare professionals. The way that hospitals generate profit has

changed dramatically over the past three decades. In the 1970s and 1980s, most of a hospital's revenue was derived from inpatient stays. There was little incentive to improve efficiency; longer hospital stays meant larger profits. This has changed--profits previously generated from inpatient diagnostic procedures are diminishing, because these procedures are now done on an outpatient basis with costly, sophisticated equipment such as MRIs and CT scanners (Jackson, 2002). Additionally, with enhancements in surgical technology, procedures that would have previously required a lengthy hospital stay are now done through minimally invasive techniques that enable quicker patient recovery and shorter hospital stays (Jackson, 2002).

General accounting practice classifies the OR as a cost center that is typically responsible for 20-40% of a hospital's costs. Conversely, it has mistakenly been assumed that the OR contributes roughly the same percentage of revenue back to the hospital (Jackson, 2002). A survey of more than 200 hospital executives revealed that 60% of executives thought that the 20-40% cost/profit margin was accurate (Jackson, 2002). However, the Towers Perrin actuarial firm reports 68% of hospital revenues are surgery related, and this figure does not include ancillary services such as lab and radiology procedures, which are often generated by surgical procedures (Jackson, 2002).

According to E.C. Murphy, the typical healthcare organization is 2,000% more complex than the average business and has five times as much regulatory oversight (Mailhot, 1996). The typical operating room serves the needs of dozens of surgeons, thousands of patients, and has interactions with almost every department in the hospital--all while under the scrutiny of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), the Occupational Safety and Health Administration (OSHA), the Food and Drug Administration (FDA), the Centers for Disease Control and Prevention (CDC), the state, and other regulatory bodies (Mailhot, 1996). With the tremendous amount of oversight, changes in technology, changes in practice, and changes in reimbursement, managing surgical services is a complex, multifactorial task.

Running the OR is much more complex than the sum of the individual variables that make up the parts. In addition to quality care, the goal of any surgical services manager is to ensure efficiency and proper utilization of the ORs. OR efficiency is maximized by reducing the amount of time that an OR is not being used for revenue-generation, that is, surgical time (Dexter, Macario, 2004). Efficiency is achieved through managing the many variables, such as having instrument sets ready and lowering room turnover times, that affect the number of cases completed in the allotted time.

Utilization of the OR is determined by comparing the difference between the time an OR is available for use and total time (including turnover time) it is used for cases. For example, if an OR is staffed for eight hours, and the last case of the day ends after six hours, there are two hours of under-utilization. This is a utilization rate of 75% (Dexter, 2003). Extensive research has been done with the intent of increasing OR utilization and therefore increase profits.

OR managers must focus on cost control and cost reduction by finding ways to control supply inventory, standardize equipment, and decrease practice variation (Mailhot, 1996). Many variables must be considered when trying to improve OR utilization: OR efficiency, unused OR time, overused OR time, turnover time, staffing, supply sets, scheduled or block time, bed availability, scheduling staff, scheduling patients, missing paperwork, missing equipment, and cancellations are just a few of the variables.

One of the most prevalent means of increasing OR utilization is implementing the use of information management (IM) and information technology (IT) systems. Operating room data from the surgical IM system at Yale-New Haven Children's Hospital indicated that only 26% of their scheduled first cases start on time (Caramico, Kain, Gaal, Rimar, 1998), while the best in practice boasts a 76% rate (Healthcare Financial

Management, 2002). The reasons cited for the late cases were late arrivals of the patient, nurse, surgeon, or anesthesiologist. More details within each category were recorded, such as premedication needed, no consent, equipment delays, etc. The data were then posted near the recovery room for the staff to view. After two months, 286 first cases were analyzed, and the data from these cases showed a significant increase in the number of first cases that started on time ($p=0.001$) (Caramico, Kain, Gaal, Rimar, 1998). Perioperative managers at Yale-New Haven Children's Hospital used the introduction of this daily data feedback to increase the efficiency of the operating room by getting the operating rooms to start on time, merely by raising group consciousness. OR management software is a very useful tool that can use historical data as a baseline for measuring improvement and competitive benchmarking.

Benchmarking has recently crossed industry lines to identify breakthroughs in thinking. Benchmarking is typically thought of as a comparison of some measure of quality or performance factor among similar facilities. However, the concept of benchmarking has evolved into four generations (Marco & Hart, 2001). The first generation is referred to as reverse engineering. This is done when a competitor's product is analyzed and the desired attributes are copied (Marco & Hart,

2001). Second generation benchmarking is done by making comparisons of processes with competitors (Marco & Hart, 2001). Third-generation benchmarking is also a comparison of process, but the comparison is made to non-competitors outside one's own industry, such as comparing scheduling operating rooms to scheduling airline flights (Marco & Hart, 2001). The fourth generation is strategic benchmarking, which entails developing a systematic process for process evaluation and performance improvement (Marco & Hart, 2001). Similar economic decisions are made across industries to allow the process of third-generation benchmarking. For example, with an average operating margin of 10%, the airline industry cannot afford to keep extra airplanes around in case a plane has mechanical problems. Likewise, with margins even lower than the airline industry, most hospitals cannot afford to maintain fully staffed operating rooms, which means excess capacity, because of inefficiencies in scheduling and turnover (Marco & Hart, 2001).

Although OR practices have greatly improved in recent years, approximately 50% of second cases do not start on time because of preceding procedure overruns (Lebowitz, 2003). This can be improved-- an effective use of IT systems is implementing a computerized scheduling system that tracks historical data about a specific surgeon and procedure combination to approximate case duration. An accurate time estimate of each

procedure will reduce the amount of procedure-overrun time (Lebowitz, 2003). One of the limitations with relying on historical data is the insufficient amount of data on infrequently performed surgeries or uncommon surgeon/surgery combinations might be inadequate to provide reliable estimates. In these cases, Lebowitz suggests using surrogate data: either an average of all surgical times at the hospital for that procedure or national data (2003). However, even with near-perfect procedure estimates, variability in surgical procedures is inevitable and on-time procedures should not be promised to anyone. Uncertainty of procedure times is compounded as the variability of each case is transmitted to each subsequent procedure. Hence, the procedures that start later in the day have less reliable start times than those scheduled earlier in the day (Lovejoy & Li, 2002). This is the primary reason surgeons prefer earlier start times and have an aversion to later start times (Lovejoy & Li, 2002). Furthermore, practice improvements must be addressed in many areas in order to improve efficiency enough to increase overall OR utilization. One important area that is often scrutinized, and is the focus of this paper, is turnaround time or turnover time.

Turnaround time is defined as the total time that starts when a surgeon leaves the OR after completing a case and ends when a surgeon arrives in the OR for the next case (Adams,

Warner, Hubbard, & Goulding, 2004). One of the greatest dissatisfiers for the surgeons in the OR is the time they have to wait between cases. Excessive turnaround time also affects patients; they can become more anxious, frightened, and frustrated the longer they have to wait. The nursing staff often find themselves trying to console these irritable, unhappy patients corralled in a holding area where they wait for surgery.

Decreasing turnaround time is often the first objective when trying to improve OR efficiency. Surgeons expect the time from patient-out to patient-in to be kept to a minimum, usually 30 minutes or less. The cost benefits of decreasing the turnaround time are that staff overtime pay can be reduced and more cases can be scheduled during the day. More cases per day mean increased revenue and fewer patients on the wait list. Valley Baptist Medical Center in Harlingen, Texas, realized that decreasing turnaround time is vital to maintaining the hospital's margin. The hospital needed to become more efficient because of the potential loss of surgical procedures to competitive ambulatory surgery centers and other hospitals. (Adams, Warner, Hubbard, & Goulding, 2004). The hospital initiated the Six Sigma quality process. Six Sigma is a highly disciplined process that helps the hospital measure, in statistical terms, how many defects they have in a process and

systematically determine how to eliminate them in order to get as close to zero defects as possible (Adams, et al., 2004). While Six Sigma shares several similarities with other quality improvement initiatives such as Total Quality Management and Continuous Quality Improvement (Adams, et al., 2004), Six Sigma places emphasis on hard data, statistical tools, tracking measures, and sustaining improvements (Adams, et al., 2004).

Valley Baptist also used an operating room scheduling system (ORSOS) database to measure their turnaround data (Adams, et al., 2004). The data during a base period established a mean total turnaround time of 60.9 minutes with a standard deviation of 23.8 minutes. The goal was a total time of 60 minutes with a 20-minute patient-out to patient-in time. Their current patient-out to patient-in time is 22.8 minutes (a surgical center in Chicago boasts a turnaround time of 10 to 15 minutes, allowing one surgeon, using four rooms, to complete 28 cataract surgeries in one day [Crain's Chicago Business, 2004]). Regression analysis was used on three components of overall turnaround time. When using the Six Sigma system, the component that showed the greatest amount of variation would be the first process area to focus on improving.

The results of the initiative revealed statistically significant improvements in several areas. The patient-out to patient-in time decreased 32%, standard deviation decreased 15%,

and the cases outside specification decreased from 49% to 26%. The surgeon-out to surgeon-in time was also reduced 32% (Adams, et al., 2004). The study revealed that factors such as the time of day and the day of the week, which were thought to have an effect on turnaround time, showed no statistical significance (Adams, et al., 2004).

Valley Baptist Medical Center employed several tactics to improve their efficiency. First, they developed a systematic approach to identify and improve one process at a time. Software systems and the Six Sigma processes were then used to track and analyze data. The Six Sigma initiative of continuous communication became a very important part of the management and quality culture (Adams, et al., 2004). The improvements resulting from the process changes should allow an increase of 11 cases per month for General Surgery, the service studied, and a potential of adding 42 cases per month if the process changes can be applied to all surgery areas, for a total of 504 additional cases per year (Adams, et al., 2004). With the average surgical service's contribution margin of \$1225 per case, the potential increase in revenue from the additional cases would be \$617,400 per year, excluding additional revenue from ancillary services (Adams, et al., 2004).

The common frustrations that most medical facilities face such as lack of block time, inefficient scheduling, delays,

cancellations, and poor utilization are very costly and can be difficult to correct. Sometimes facilities need to hire outside consultants to objectively evaluate internal processes. With a 4% decrease in market share, an OR schedule that is nearly impossible to access, and a loss of \$1,800 for every unused OR hour, one Midwest academic medical center called in physician consultants to evaluate their OR turnaround process (Young & Mazzei, 2003). The 750-bed facility's current turnaround time averaged 85 minutes and the nurse turnover rate was 40% (Young & Mazzei, 2003).

The processes that were recommended by the consultant group can be replicated in any surgical setting:

1. Develop a surgical executive committee of executive and medical leaders and key surgical leaders.
2. Appoint an anesthesiologist to direct perioperative services. This person controls the OR schedule and room assignments.
3. Allow the committee to collaborate in creating guidelines for block time utilization. For example, setting the OR utilization rate at 85% will ensure that surgeons use their scheduled time.
4. Measure utilization monthly and provide surgeons with a utilization report that includes OR time

blocks, utilization, total OR time, and cases cancelled.

5. Block time should be adjusted according to the surgeon's utilization rate over a three month period.

The first facility that adopted these recommendations increased their market share 5% in the first 18 months (Young & Mazzei, 2003).

With so much effort committed to increasing the number of scheduled cases, one must not forget to evaluate the reasons for the cancellations of the surgical procedures that were already on the schedule. The United Kingdom Audit Commission estimated almost 78,000 operations in that country were cancelled in one year alone due to equipment repair, operating room refurbishment, and infection control (The Journal of Healthcare Design & Development, 2003).

Staffing is another factor that affects the efficiency of the OR that should be considered in process improvement. Staffing, usually the second largest OR expense, after supplies, is often linked to case volume. Experienced OR nurses and support staff are expensive, and important parts of the flow in the OR. An unpredictable OR schedule can lead to unnecessary overtime. OR managers must know how much it costs to operate a room per hour during normal work hours as well as after normal

hours. After-hours salaries are much higher. Therefore, over-utilization of the OR must be watched very closely. Managers cannot afford to pay excessive overtime to add a low revenue-producing elective case at the end of the day. Knowing the baseline revenue that will be generated for each type of procedure is valuable to the OR manager faced with making a decision to proceed with a late elective case, a decision that can be interpreted in terms of increased cost versus decreased patient satisfaction. However, in a military facility, revenue will not likely be produced for a late running case. Therefore, it is imperative that the military OR manager know how much the operating cost per hour is for after hour cases.

The operating room has traditionally been a major revenue generator for hospitals. However, a recent industry study indicates that the average OR runs at approximately 68% capacity. With high fixed costs, excess capacity, and expensive labor, the OR represents a significant opportunity for cost control improvement (Healthcare Financial Management, 2002). In a study comparing the clinical productivity of anesthesia groups, private practice groups were shown to generate higher revenue than academic groups because of the longer times per procedure for the academic group (Abouleish, Prough, Whitten, Zornow, Lockhart, Conlay & Abate, 2002). Typically, an academic group has a higher portion of nonpaying or poorly paying

patients and would have to work greater hours to generate the same amount of revenue as the private practice group (Abouleish, et al., 2002). Working longer hours to keep pace with private civilian facilities would not earn a military facility more revenue and could actually be costlier due to overtime labor expenses.

Although these examples are from civilian hospitals, they still have similarities with the dilemmas facing military surgical services managers. This study was conducted in a military hospital with several variables that are unique to the military. Staffing at military hospitals is constantly in flux; high turnover, departures for long term training, changes of duty station, deployments, and employing activated reservists to fill vacancies caused by deployed staff members all result in OR staff constantly changing. A second factor that civilian facilities do not contend with regularly is the fact that all military providers are paid a salary that is not contingent on case volume. A logical assumption would be to infer there is little incentive for military surgeons to maximize the number of cases performed. However, the work ethic of military surgeons can vary from those on active duty only to pay back medical school tuition, to surgeons dedicated to serving their country to the best of their ability regardless of monetary rewards. A third unique variable is that military beneficiaries do not pay

directly for health care. Moreover, it is very difficult to get patients to divulge information about third-party insurance because they fear their premiums may go up, their policy may be cancelled, or they feel that they are entitled to "free" health care and should not have to resort to other insurance. They do not understand that using alternate insurance will potentially increase the benefits and services that they will use in the military healthcare system.

Purpose

The purpose of this paper was to determine if reducing turnover time would improve the efficiency of the operating rooms enough to decrease the number of fully staffed rooms. Increased operating room efficiency will decrease wait list times, increase staff morale, and increase patient satisfaction. Additionally, DDEAMC could save thousands of dollars in annual labor costs by decreasing the amount of full time OR staff.

Methods and Procedures

The events measured in this study were turnaround time, room availability/use, and cancellation rate. Data from DDEAMC's operating room management software system (ORMA) will be compiled in SPSS (Statistical Program for the Social Sciences). Part of any research analysis is to ensure that the tool used to

evaluate the problem is both valid and reliable. Validity refers to the extent to which a test measures what it is actually intended to measure. Reliability has to do with the accuracy and precision of the measurement tool. Reliability is a necessary contributor to validity but alone is not a sufficient condition for validity (Cooper & Schindler, 2003). Archival data from 1 January-31 December, 2004 was used in this study.

Turnaround Time

Turnaround time has typically been defined as the total time from when a surgeon leaves the OR after completing a case to the time the surgeon arrives in the OR for the next case (Adams, Warner, Hubbard, & Goulding, 2004). However, a preliminary examination of the data has revealed that the time the surgeon enters and leaves the operating room was not recorded. Thus, for the purpose of this study turnaround time was measured as the time period between one patient leaving the room and the next one entering. Descriptive ratio datum was calculated for average and standard deviations for turnaround time. A categorical nominal measure was constructed for delayed and on-time procedures. A procedure was considered delayed if the turnaround time exceeded 45 minutes. For the first cases of the day, a delay is defined as any procedure that starts 45 minutes past its scheduled starting time. Multiple regression

was performed to determine which variables significantly contribute to delay. The list of variables which were encoded in the database that were loaded in the model and examined in the analysis is displayed in Table 1. Finally, an ANOVA was performed using the loaded variables.

Table 1.

A List of Variables Examined

Operating Room

Surgeon

Order in the day

First surgery of the day

Last surgery of the day

Number of surgeries in that Operating Room in one day

Month

Day of the week

Priority

If the surgery was delayed

Delay in minutes

Reason for the delay

Turnaround time

Nursing minutes

Variables

The turnaround time is the dependent variable and the independent variables are the factors that delay the operating room turnover time: nursing, anesthesia, surgeon, housekeeping, central medical supply (CMS), laboratory, patient, x-ray, and other.

Data Collection

Data from DDEAMC's operating room management software system (ORMA) was used to determine OR usage and turnover times. All procedures that were performed in the operating rooms at DDEAMC during the 2004 calendar year, a sum of 3722 procedures, were included in the database. Eighteen instances were dropped from the data set due to incomplete recording of data necessary for the statistical analysis. The procedures were classified as follows: 3444 were routine, 182 semi-emergencies, 48 emergencies, and 30 were coded as TSA (time space available). The operating rooms were used for regularly scheduled cases on 241 out of 365 days and used an additional four days for emergency procedures.

Nine separate categories were constructed for possible reasons for delay and were as follows: no reason given, anesthesia, central medical supply (CMS), housekeeping, OR, patient, surgeon, ward, and other. A chi-square was performed with the null hypothesis that the reasons for the delay would be

equally distributed across all conditions. The preliminary results indicated support of the alternative hypothesis, that delays were caused significantly more often by some reasons than others, $p < .01$, (the long version of the statistic, $2(df=8, n=216) = 109.67, p < .01$). However, when the entire data set was examined, no reason was recorded for the delay in over 31% of delayed cases. The omission of data, which will be discussed in the Results section, was a major factor in the outcome of the study.

Results

One of the findings of this study was that DDEAMC's OR turnaround times did not meet the industry standard of 30 minutes. In the course of this study, several problems that need to be addressed to improve the turnaround time and therefore the efficiency of the OR were uncovered. The study was originally intended to focus on several separate steps that combine to make up the total turnaround time. Although the operating room management software that is used in the OR has the data fields necessary to identify the specific areas of the turnaround time that could benefit most from process analysis and improvement, gathering the data turned out to be more complex than running a query and analyzing the data. It turns out that the OR staff does not track of some of the key data needed to measure the specific areas that were originally intended to address. The

inconsistent and inaccurate use of ORMA and incomplete data collection are the first major findings of this study, which will be discussed in depth later in this paper.

In order to determine exactly which part of the turnover process should be analyzed first, the data on the times of four different steps of the turnover process were needed. However, the times needed for analysis were not being entered into the ORMA system. The only time that was recorded was the patient-out to patient-in time. Having data from only one of four periods greatly decreased the utility of the data obtained from ORMA.

Operating room use and scheduling

The number of possible days for regularly scheduled surgeries (241) was multiplied by the number of operating rooms (8) to produce a baseline operating room availability of 1928 rooms for the entire year. The data reflects that at least one surgery was scheduled in each room on each of the regularly available rooms 87.75% of the time. Thus, of the 1928 rooms available on regularly scheduled days, a room went unused 240 times. In other words, on average, one room was not used per day. Figure 1 shows the percentage of days that the least frequently used operating room per month was utilized. An average of 2.64 (SD=1.03) procedures were performed in each room per day. Although a room was used on a given day, rooms were not utilized to their full capacity. Approximately 10% of the time

(373 instances), the procedures scheduled in a room were completed by 1230. Furthermore, in 208 instances, procedures in a particular room were completed by 1130, or 86% of the 241 operational days.

Across all months, the average number of days the least-utilized operating room had at least one surgical procedure performed in it was 57.9% of the time, with a standard deviation of 30.58%. The minimum usage occurred in January, when no surgeries were scheduled in one room for the entire month, while March was the highest, with the least-used room being scheduled for at least one surgery 86.9% of the potential days (see Figure 1).

Delays

A total of 859 procedures, or 23.19%, were delayed. An analysis was performed to determine the items relating to delay. One model focused primarily on scheduling factors (order in the day, number of procedures scheduled in the room, etc.) while the other model examined human performance issues (surgeon, priority, reason for the delay, etc.). Of the two models, only the first model, scheduling, accounted for enough variance, 69.87%, to permit further analysis. The failure of the human performance model to account for enough variance may be attributed to incomplete record keeping. For example, of the 859 delayed cases, 274 (31.89%) did not list a reason for the delay.

The number of missing explanations, combined with a similar number of delays listed as "other" under the main categories of delay: anesthesia, surgeon, nursing, OR, and CMS, are the reasons why the human performance model only accounted for 38.74% variance. Additionally, approximately 15% of the delay reasons were ill defined, listing up to five reasons for delay, without recording the most significant reason.

Delays were most strongly associated with the overall busyness of an operating room and the order in the day the procedure occurred. That is, as the number of procedures per room increased, the procedure was more likely to be delayed; and if the procedure occurred later in the day, the procedure was even more likely to be delayed. Regardless of how many procedures were conducted per operating room, the final procedure of the day was also likely to be delayed. Finally, unlike the Valley Baptist study mentioned earlier, delays were more prevalent on the days later in the week and in the beginning months of the year.

Procedures that ran past 1530

A total of 392 procedures (10.58%) of all procedures extended past 1530. An average of 1.63 (SD=0.28) procedures per day lasted past 1530. The percentages of procedures that lasted past 1530, by priority status, are as follows: routine: 82.4%,

semi-emergency: 11.99%, emergency: 3.57%, and TSA: 2.04% (time space available).

For procedures that ran past 1530, those that had nursing start times before 0800 were delayed 13.33% of the time while those that started after 0800 were delayed 54.43% of the time. The average delay for cases starting before 0800 was 38.33 minutes (SD= 19.55) while the average delay for the cases starting after 0800 was 66.82 minutes (SD= 81.00). Figure 2 shows the number of cases that went past 1530 per month.

For procedures that lasted later than 1530, the first procedure of the day was less likely to be delayed than subsequent procedures. While 26% of procedures that lasted past 1530 were the only procedure of the day in that room, they were still delayed 37.3% of the time, also, 91.1% of the procedures that lasted past 1530 were the last procedures of the day and experienced delays 44.3% of the time. Figure 3 shows the number of cases that ran past 1530 relative to the time the patient was in the room (see Figure 3).

A total of 138 procedures (an average of slightly more than one every other day) started after 1330. These cases involved 210 or fewer nursing minutes. Although not all of these procedures could be scheduled in an open operating room earlier in the day, a significant proportion can be rescheduled to improve efficiency and reduce overtime.

Discussion

Incomplete data available

Initially, the factors affecting turnaround time were to be analyzed by dividing turnaround time into four separate periods. However, DDEAMC's staff did not utilize the data collection fields in ORMA that would make this possible. DDEAMC staff only collect data on one of the four time periods, the third period, patient-out to patient-in. Dividing the turnaround time into four periods would allow more precise analysis by associating the many room turnaround processes to the period and order in which they take place. Only measuring the patient-out to patient-in time does not accurately account for any delays that take place before or after the patient enters the room. For example, suppose the patient enters the room at 0800, but the nursing staff consumes a longer than average time with patient preparation and positioning, or that the anesthesiologist has difficulty intubating the patient. Any delays such as these will not be accurately accounted for. The next time that was normally recorded was the procedure start time. If the procedure had a patient-in time of 0800, and a start time of 1000, a 120-minute delay goes unexplained. The current operating room management system software, ORMA, has a data field for delay reasons in the comment section of the patient record, but it only records the

reason for the delay, not the amount of time attributed to each delay and any analysis of delay times would not be possible.

Closer analysis of period three, patient-out to patient-in, will not isolate the time it takes to clean up the room, from the preparation time for the incoming patient; nor does it isolate a delay with the incoming patient after the room is clean. The delay will not be accurately attributed to the incoming patient; furthermore, it could also be assumed there was a long cleanup time from the prior patient. As before, even if a patient delay reason is noted in ORMA, the amount of time lost from the delay will not be accurately captured.

Gaps in ORMA

Other problems exist with ORMA's data collection features. For example, if there is not a follow-on case, a turnover time is not listed. Thus, if there is no follow-on procedure, there is no patient-in time, which ends the turnover period. The ORMA record may reflect that a case was delayed and may state a reason for the delay, but the data are of limited utility for process improvement because the turnover time for all single-case rooms, 12.95% of all cases, was totally omitted. For the 480 single case rooms of 2004, there was no accounting of the setup time, patient prep time, room cleaning time, or delay time; and as revealed earlier, the inaccurate recording of the

reasons for delay reasons makes the data that was collected of dubious validity.

In an effort to get an accurate measurement of turnover time for every case, the time recorded must not depend on the existence of a following case. After all, every case has a set-up time, a patient prep time, and a clean-up time, regardless of what follows. Further analysis of the original four measurement periods reveals that even four periods will not entirely allow case turnover times to be attributed to individual cases. Capturing data on the four turnover periods will allow for more accurate accounting of turnover times, reasons for delays, and the length of those delays. In fact, this could be ideally refined further. A compelling argument could be made to divide turnaround time into as many as five time periods, which will account for the following: Set-up start, Set-up complete, Patient in Room, Prep Start, Prep End, Procedure Start, Procedure End, Patient out of room, and Room Clean (Mowbray, 2003).

The problem of inaccurate turnover time accountability at DDEAMC can be attributed to two factors: the insufficiency of the methodology of recording times and the amount of missing data. During the course of this research, OR staff members were interviewed to determine the cause for the inconsistent documentation. One staff member indicated that he enters delay

reasons if the delay is greater than 15 minutes, but this is not a policy and is not consistently practiced among the staff. Some nurses may use a 20- or 30-minute threshold and, as revealed by the data, some nurses do not list a reason for the delay no matter how long it is.

The ORMA system is plagued with poor and improper utilization in other areas that directly affect the utilization on the operating room. For instance, while investigating the cancellation rate, which is the percent of cases that are cancelled within 24 hours of the scheduled operation date, I discovered that the inaccuracy of the cancellation data, as reported, renders it of little use.

Cancellations

The interest in the cancellation data stemmed from trying to find specific ways to improve efficiency and utilization of the operating room. Knowing the resources consumed in the patient pre-operation process, reducing the number of cancellations would save a tremendous amount of resources. My reasoning behind this is that, while trying to reduce the time involved in the turnover process is achievable, there is an average of two turnovers per room. Thus, it is highly unlikely that enough time will be saved in which to perform an additional operation by reducing turnover time alone. The monthly average cancellation rate for 2004 was 22.41 cases, or 6.05%, for 269

cases annually. This rate also understates the problem, as previously mentioned, this only accounts for cases that are cancelled within 24 hours of the procedure date. The total number of cases cancelled more than 24 hours before the surgery date is unknown.

"Ghost" cases

While researching information about cancellations, I interviewed a medical clerk and made another important discovery. The cancellation data that are captured are inaccurate. By the clerk's own admission, she stated that almost every cancellation that she completes is recorded under the same reason because she picks the first reason on the menu. She also said there are too many reasons on the list to take the time to find the right one. A review of the cancellation data confirms that 90% of the cancellations she entered had the same explanation, abnormal lab/x-ray/EKG. Furthermore, the clerk revealed that many of the cases that are cancelled are "ghost cases" that are never intended to go to the operating room. A "ghost case" is when a doctor submits a patient's name for a surgery to reserve a slot so that it is not released to another service.

Examining the data collected by ORMA system begs the question: what is the utility of the reports that are generated? The ORMA system specialist generates several reports each month:

a report for the monthly Morbidity and Mortality meeting, the cancellation report, a 4-6 week schedule, a transcription report, a list of active duty soldiers waiting for orthopedic surgeries for more than 30 days, and finally a report to record specimens and implants. It does not appear that any of the reports generated are used to improve operating room efficiency. The data that could potentially be useful is flawed: I have explained the inaccuracies of the cancellation report and detailed the scheduling inaccuracies caused by "ghost patients." As it stands, ORMA's utility as an OR process improvement and tracking tool is very limited the way it is currently utilized.

Process improvement

Process improvement (PI) is always an important topic; the DDEAMC operating room was recently directed to look at the turnover times as a process improvement project. However, after the project members looked at the data that is currently being recorded, alternative solutions had to be improvised to track useful data. The staff began collecting baseline data on a new form generated solely for the PI project. Now, the same staff that does not feel they have the time to enter important data in the ORMA system will have to keep track of yet another form and another place to list times. The mere fact that the ORMA data was not useful for a common study of turnover time supports the conclusions, findings, and recommendations of this study. The

data collection for this PI project is ongoing and I suspect that the new and separate form may obscure the results and the utility of the entire project due the "Hawthorne Effect." Recommendations that will enhance PI initiatives are encompassed in the Conclusions and Recommendations section under the Accurate Reports and Data sections of this paper.

Conclusions and Recommendations

Healthcare organizations can be described in terms of six key dimensions: production, boundary spanning, maintenance, adaptation, management, and governance (Katz & Kahn, 1978). The boundary spanning function focuses on the external environment in areas such as technology, reimbursement, and regulation. The adaptation function focuses on the information obtained from boundary spanning, with knowledge of the organizations production and support systems, to anticipate and adjust to needed changes such as modification of existing programs, services, design, or strategy. The adaptation function emphasizes the organization's innovation by creating necessary changes, which is what this study reflects, the need for change (Shortell & Kaluzny, 2000).

The overarching factor that needs to be at the engine of change, one that must be corrected before any attempt is made to improve OR turnover time, utilization, or efficiency, is the

utilization of the ORMA system. The following recommendations are almost entirely related to the utilization of the ORMA system.

Utilizing ORMA

The Chain of Command must insist on the accurate and complete data entry and record keeping. Personnel must understand the importance of the data and realize that it must be complete and accurate, even if there is not a PI project going on. The strategic goals and objectives of the organizational leaders must be clear, concise, and disseminated to the lowest level. Everyone must realize that they are part of a team, thoroughly understand their role, and must help improve the OR work environment.

Accurate Reports

It is vital to generate useful reports based on accurate data. New reports must be generated for operating room process improvement. After all, why track processes if we are not trying to improve them, and how are we going to improve the process if the data are fictitious? Just stating that erroneous and misleading reports, such as the cancellation report, are a waste of valuable resources, does not begin to substantiate the problem. The system needs to be reviewed to determine what data are being collected and how it is used. The staff must do their part to improve the organization. The personnel need to know the

importance of the reports that they generate and how they are used to improve the organization. If the use and importance of the reports are not fully understood, the personnel that play a role generating the reports will not realize the value. If the reports are considered to be of little value, the bits of data that make up the reports will hold even less value and the utility of the reports will continue to be dismal.

Meaningful Data

The data that are collected for the reports need to be as accurate and complete as possible. This means eliminating "ghost" patients, and accurately recording delay and cancellation reasons. Vague and erroneous information has no place in healthcare or the operating room; the data collected must measure what it is intended to measure. The data collection and reports need to be carefully reviewed and improved. The data should be in a form that is accurate, useful, easy to access, and review.

Scheduling Control

The current system allows providers and administrative personnel to schedule cases, among them "ghost" cases. A staff member familiar with the scheduling system suggested implementing a centralized scheduling system that reduces free access. The data reflects that in 241 possible operating days, 208 rooms finished by 11:30, and 373 rooms finished by 12:30.

Thus, there should not be a need to create "ghost" cases as placeholders so another service does not get available rooms. After all, there is a system in place to turn over unused OR time within five days of the surgery date. If a service does not have actual cases booked by then, then the service does not have a backlog problem and should not be causing havoc on the system by scheduling a "ghost" case, canceling it, then scheduling a real case so close to the operation date, causing a preoperative workup rush, and perhaps a real patient cancellation.

Furthermore, DDEAMC has almost 20% of the rooms finished by 1230, which includes the current 66-minute average turnover time and an average of two turnovers per room. If this time is reduced to the standard of 30 minutes the finish times would reflect that 46% of the rooms would be finished by 1300, leaving sufficient OR time for many procedures. However, the average amount of turnovers by 1230 should be less than the overall turnover average, and thus the 46% calculation may be higher than achievable.

Excess OR Capacity

Despite incomplete and occasionally inaccurate data, the fact remains that DDEAMC should be able to utilize the existing ORs more efficiently. The data that were analyzed reflects that there was an empty room nearly every day. A limitation of the data is that it is unknown which days were available. The data

also reveals that there was a room closed for the entire month of January with no decrease in caseload. This indicates that a room can be closed without reducing volume. However, there was a slight increase in overtime cases for January with 37. In 2004, an average of 32.67 cases per month ran past 1530. The amount of overtime cases ranged from 23 in February to 42 in May.

With one room open on 240 days, 10% of rooms finished by 1130, 20% by 1230, a turnover average of 66 minutes, and a room closed for an entire month with no decrease in volume or increase in overtime, being able to close one operating room on a daily basis is definitely accomplishable.

The changes that need to be implemented should not be met with intense resistance, because the study is data driven by the information that the OR staff inputs into ORMA and in the patient's medical record. However, a realistic strategy must represent an accepted consensus about what should be done, incorporating the needs of the customers, providers, and the organization (Griffith, 1999). The strategies suggested need not please everyone, but no group can be so dissatisfied that it will withhold critical support (Griffith, 1999). Any improvements in streamlining the workflow should enhance predictability, increase patient and staff satisfaction, and increase OR utilization.

In summary, the engine of change for making the ORs more efficient needs to be focused on the ORMA system, or any future OR management system. The current system is not being used to its potential. The current reports are not helpful for improving efficiency. The data that is entered into the system is minimal, full of inconsistencies, erroneous, or missing completely. To get the OR on the right track for the future, the tracking methodology in the OR needs refinement, data input needs improvement, and better reports need to be developed. However, for the changes to be effective, the goals and objectives of the OR leaders must be aligned with the strategic goals and objectives of the organizational leaders. The staff that use the ORMA system need to know the importance to their role and how the mission, vision, and values of the organization start with them.

Figures Captions

Figure 1. The percent of possible days the least-used OR was used per month in 2004 (N=241).

Figure 2. The number of cases per month that ran past 1530. The yearly average for 2004 was 32.67 per month (N=3722).

Figure 3. The number of cases that ran past 1530 relative to the time the patient was in the room (N=3722).

Figure 1.

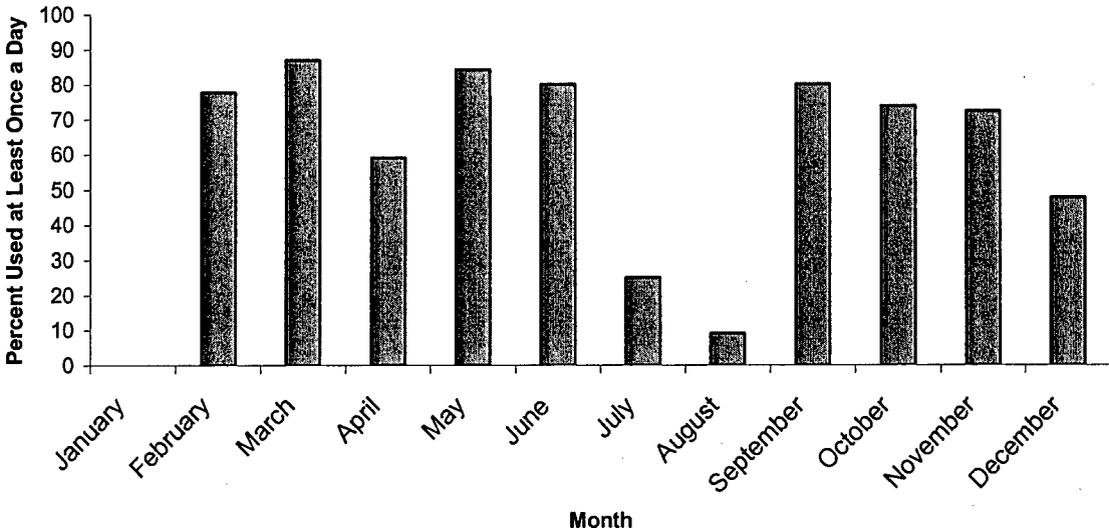


Figure 2.

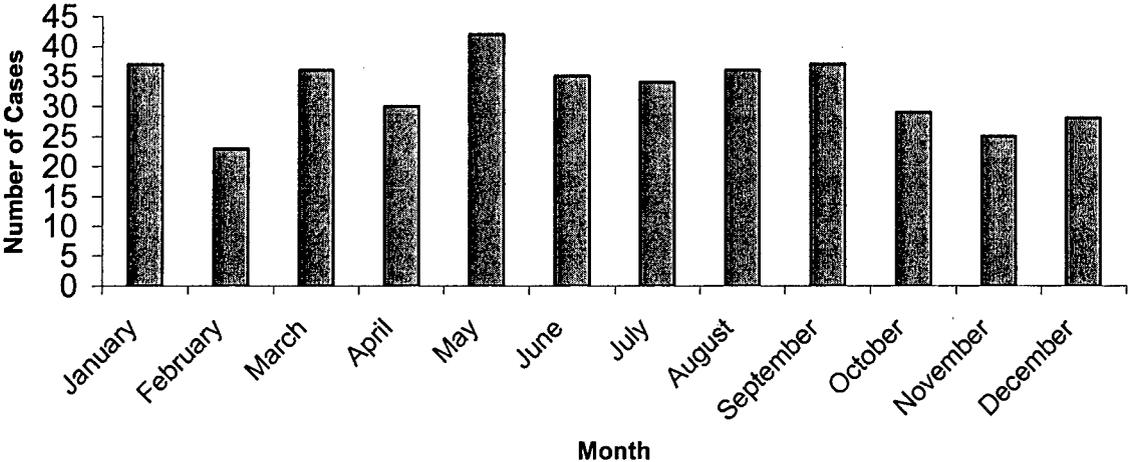


Figure 1.

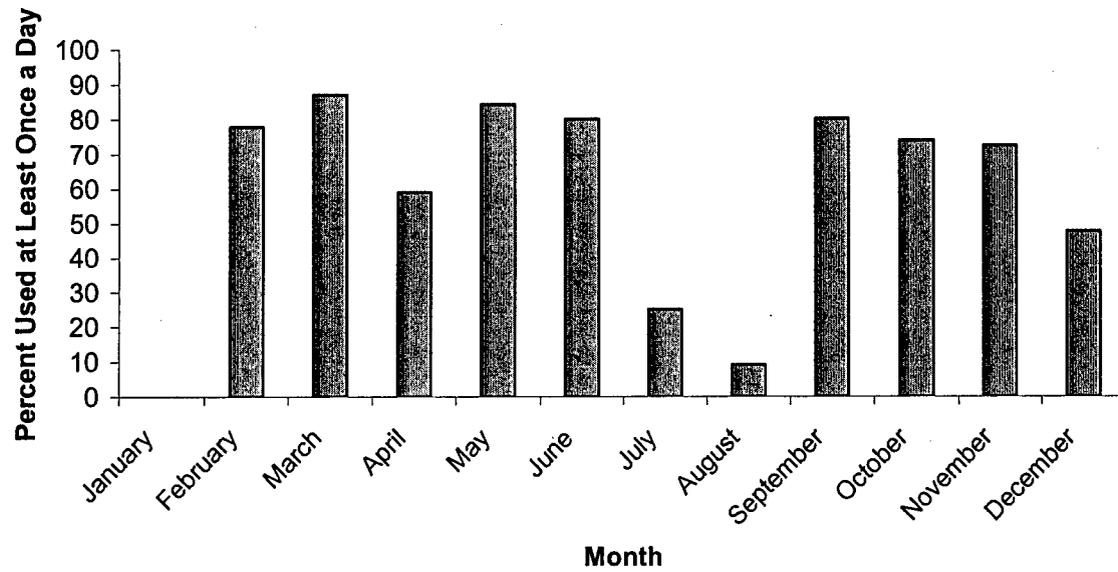


Figure 2.

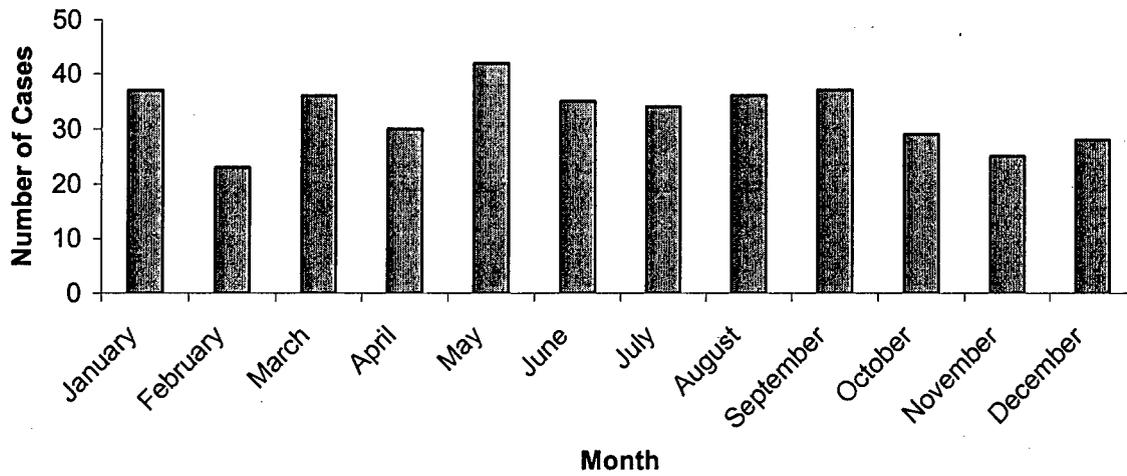
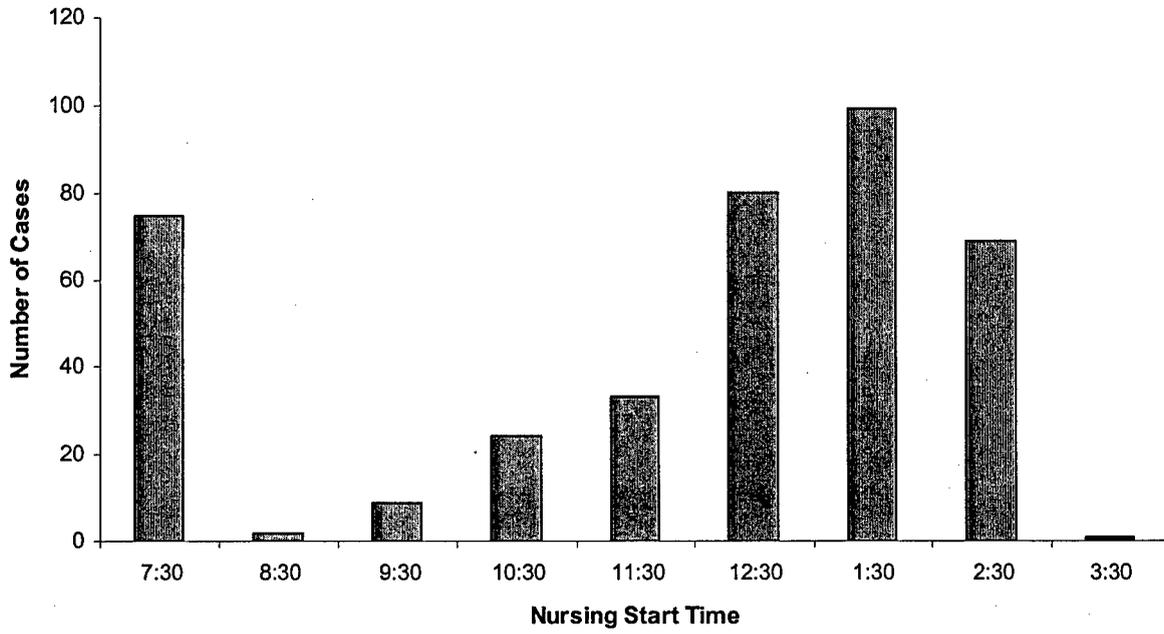


Figure 3.



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