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Effects of a Patient Progression Coordinator on Hospitalized Patient Progression Times

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Effects of a Patient Progression Coordinator on Hospitalized Patient Progression Times

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Abstract

Background: Since 2005, the Joint Commission required moving patients through the hospital quickly. Previous efforts at our hospital improved Emergency Department throughput but hospital-wide congestion of patients remained.

Objectives: To examine the effects of implementing a patient progression coordinator (PPC) on hospital length of stay (LOS) for patients with ST-elevated myocardial infarction (STEMI), ischemic stroke, knee replacement, and hip replacement.

Methods: We used a separate sample, pre- post- intervention design conducted in a southern California community hospital. The intervention was implementation of a PPC to facilitate movement of patients through the hospital. LOS, from time of admission to discharge, was measured on a random sample of 614 patients admitted with diagnosis of STEMI (n=199), ischemic stroke (n=91), hip replacement (n=198), and knee replacement (n=126) before and after the intervention. Differences were calculated for pre- post LOS using independent t-tests with significance set at 0.05.

Results: Knee replacement patients in the post-intervention group had a significantly shorter LOS (57.22 ± 14.28 hours) compared to those in the pre-intervention group (65.59 ± 16.23 hours; $t=3.85$, $p<.001$). Differences in LOS before and after implementation of a PPC were not significant for STEMI, ischemic stroke, or hip replacement patients.

Conclusions: Our study demonstrated the role of the PPC was effective in reducing LOS for knee replacement patients but not for the other patient groups. It appears that the PPC has the potential to reduce LOS for other populations but further evaluation is needed.

Background

In 2005, The Joint Commission first introduced patient flow standards (Calloway, 2008). These standards set the expectation for hospitals to move patients through the emergency department (ED) quickly, create additional holding spaces for patients when an inpatient bed was not available, and provide adequate resources to care for all patients regardless of location (Joint Commission on Accreditation of Healthcare Organizations, 2005). In 2014, additional standards were added that included reviewing the metrics reflecting success or failure in meeting the standards and the escalation to, and action plan by, leadership when goal metrics were not being met (Joint Commission on Accreditation of Healthcare Organizations, 2013).

The passing of the Affordable Care Act (ACA) in 2014 resulted in an increase in the volume of patients being seen in EDs located in Medicaid expansion states (Nikpay, Freedman, Levy, & Buchmueller, 2017). This expansion resulted in additional overcrowding and delays in the delivery of emergency care. The delays were most often a result of delayed diagnostic tests, delayed consults, and lack of a sufficient number of inpatient beds (Qureshi, et al., 2011; Erenler, et al., 2014). In response to these concerns and highly publicized findings, many hospitals allocated significant resources to improving ED throughput. While quite successful, it was identified that ED throughput was only a part of the problem, requiring efforts to be made for the progression of patients admitted to the hospital (Powell, Khare, Venkatesh, Van Roo, Adams, & Reinhardt, 2012).

Problem Statement

Coordinated efforts in our community hospital resulted in improved ED throughput, however, the hospital-wide congestion of patients continued. Patients admitted to the hospital were unable to move out of the ED because beds were not available on the inpatient care units.

Some patients in the inpatient care units were unable to leave the hospital due to reduced acceptance of new patients at skilled nursing facilities (SNF). While the inpatient charge nurses were knowledgeable of the obstacles affecting patient progression in specific units with geographical boundaries, a lack of ownership of patient flow throughout our institution was identified as a suspected obstacle to improving patient progression.

Purpose

The purpose of our study was to measure the length of stay (LOS) before and after the implementation of a patient progression coordinator (PPC) to determine if there was an improvement in inpatient progress and flow. In April 2017, a PPC was designated at our community hospital to improve patient movement throughout the hospital, from the time of admission to discharge. Our long-term goal was to identify a positive correlation between process ownership and performance outcomes.

Aims

The specific aims of our study were to:

1. Compare the admission time to discharge time for ST-Elevation Myocardial Infarction (STEMI) patients who had a cardiac catheterization and stent placed pre- and post-implementation of a PPC.
2. Compare the admission time to discharge time for hemorrhagic stroke patients pre- and post- implementation of a PPC.
3. Compare the admission time to discharge time for ischemic stroke patients pre- and post-implementation of a PPC.
4. Compare the arrival to Post Anesthesia Care Unit (PACU) to hospital discharge time for knee replacement patients pre- and post- the implementation of a PPC.

5. Compare the arrival to PACU to hospital discharge time for hip replacement patients pre- and post- the implementation of a PPC.

Hypothesis

The following research hypotheses were tested:

1. There will be a difference in hospital admission time to hospital discharge time for STEMI patients who required cardiac catheterization and stent placement before and after the implementation of a PPC.
2. There will be a difference in hospital admission time to hospital discharge time for hemorrhagic stroke patients before and after the implementation of a PPC.
3. There will be a difference in hospital admission time to hospital discharge time for ischemic stroke patients before and after the implementation of a PPC.
4. There will be a difference in the arrival to PACU to hospital discharge time for single knee replacement patients before and after the implementation of a PPC.
5. There will be a difference in the arrival to PACU to hospital discharge time single for hip replacement patients before and after the implementation of a PPC.

Significance

Ownership of inpatient progression throughout the hospital is what makes the role of the PPC unique. The role of a PPC nurse is to monitor patient orders, identify beds that are soon to be vacated, prioritize patients to be admitted from the ED, and follow the progression of physician orders on patients expected either to transfer out of the Intensive Care Unit (ICU), or to discharge from the hospital. While patient movement is also part of the charge nurse role in each patient care unit, the PPC nurse does not have a direct patient care role or other priorities to distract or slow them from prioritizing the movement of patients and the turnover of beds affecting the hospital throughput.

The concept of ownership in nursing is not something that has been explored in nursing literature, although it has been explored in healthcare literature. In their book *Building a Culture of Ownership*, Joe Tye and Bob Dent (2017) demonstrate in a plethora of examples how hospitals with ownership cultures consistently achieve desired performance outcomes in every metric target they attempt to achieve. One could deduce that the required role of a coordinator in accredited programs exists because when one person owns a process, they are invested in the outcomes. Finding that the role of the PPC is able to significantly decrease patient LOS times in the hospital would highlight the value of ownership and provide a new framework for improving processes and outcomes.

Additionally, the concepts of multidisciplinary and collaborative efforts are integral to healthcare and patient outcomes. However, many community hospitals struggle with physicians participating and engaging in quality initiatives (Casalino, November, Berenson, & Pham, 2008). The opportunity to identify an intervention to improve patient throughput that minimizes the need for buy-in from the physicians is an opportunity to improve hospital operations within control of the hospital.

Literature Review

Literature Search

A review of the literature revealed many articles related to patient throughput in the ED, but was less plentiful regarding hospital inpatient throughput. The concept of one person owning the patient progression process is not an intervention that is reflected in the current literature. Recent publications are more theoretical and propose models for patient progression that have not been tested in patient care areas. Of the relevant articles identified, there were several interventions that resulted in improved patient throughput. The most common intervention consisted of focused efforts to discharge patients by a pre-determined time (Patel, Morduchowicz, & Mourad, 2017; Powell, Khare, Venkatesh, Van Roo, Adams, & Reinhardt, 2012; Chaiyachati, Sofair, Schwartz & Chia, 2016). Also identified as a successful intervention was to delineate and enforce patient admission and discharge criteria for certain patient care units within the hospital (Coffey et al., 2018). Chadaga et al. found the intervention of making hospitalists accountable for patient throughput was successful (2012). Lastly, two studies reported that complex, multi-disciplinary, hospital-wide, multifactorial interventions aided in getting patients moved to their next destination, both inside and outside of the hospital quickly (Jweinat, Damore, Morris, D'Aquila, Bacon, & Balcezak, 2013; Resar, Nolan, Kaczynski, & Jensen, 2011).

Patient Admission Criteria

While no other articles were found identifying an individual given ownership of patient progression, Coffey et al. (2018), referenced a team of "patient flow staff" who were provided with specific admission and discharge criteria for high-acuity and, therefore, higher-resourced units. The patient flow staff were asked to enforce the admission and discharge criteria and escalate concerns to leadership when criteria were not followed. These criteria included pre-determined timeframes after which orders automatically expired for more resource-rich monitoring such as telemetry. Results measured the occupancy of high-resource hospital units such as their intensive care unit, progressive care unit, and telemetry unit to determine if the unit occupancy matched the overall hospital occupancy. This intervention resulted in a decreased amount of time spent in their highest level of overcrowding, known as code black. The intervention did not affect their patient LOS times.

Hospitalists Accountable For Hospital Inpatient Throughput

A literature review of the effect of hospitalists on patient flow results in a wealth of articles focused on the improvement to patient outcomes with patient flow identified as a secondary benefit. The findings published by Chadaga, et al. (2012), were unique in that the only benefit of hospitalists highlighted was decreased LOS for patients throughout different areas of the hospital as a result implementing a hospitalist service. The authors provided evidence of statistically significant improvement to patient LOS in acute care units, surgical units, chest pain units, and short stay units as compared to not having hospitalists. Additional opportunities were identified in palliative care and preoperative areas.

Early Discharge

The concept of 'early discharge' is a highly regarded intervention in the following articles: Patel, Morduchowicz, and Mourad (2017); Powell, Khare, Venkatesh, Van Roo, Adams, and Reinhardt (2012); and Chaiyachati, Sofair, Schwartz and Chia (2016). Each of these articles demonstrated improved throughput measured by unique metrics of hospital crowding by implementing a campaign emphasizing discharging patients earlier in the day. Chaiachati, Sofair, Schwarts, and Chia (2016) focused on coordinating teaching rounds at times that would ensure patient discharge orders were completed by 11am. Powell, Khare, Venkatesh, Van Roo, Adams, and Reinhardt (2012) aimed to enter discharge orders by 12pm for 75% of discharges, with all discharges being complete by 4pm when the ED typically began their higher volumes and admissions for the day. Patel, Morduchowicz, and Mourad (2017) implemented a campaign to discharge patients by noon. This campaign included several elements such as an educational campaign to decrease patients boarding in the ED, holding afternoon physician and case management huddles, and implementing a web-based dashboard able to provide real-time audit data and feedback.

Hospital-wide Campaigns

Two articles described organizational coordinated efforts that were required to successfully improve hospital flow. Resar, Nolan, Kaczynski, and Jensen (2011) detailed a plan termed ‘real time demand capacity management’ that included predicting capacity, predicting demands, developing a plan, and evaluating the plan. This process resulted in a significant decrease in reactive census surge actions when the predictions were greater than 80% correct. The Safe Patient Flow Initiative: A Collaborative Quality Improvement Journey at Yale-New Haven Hospital highlights an initiative to place “the right patient in the right bed at the right time, the first time” that developed goals based on the structure rather than the outcomes (Jweinat, Damore, Morris, D’Aquila, Bacon, & Balcezak, 2013). The foundational principles were grounded in Lean processes, executive sponsorship tied to compensation, physician leadership, and culture change. None of the interventions individually resulted in a successful initiative, but the buy-in and commitment from the entire organization resulted in improved patient throughput times.

Theoretical Framework

Benner’s Novice to Expert Theory

Benner (1982) outlined in the novice to expert theory that as nurses are exposed to processes and experiences, they become more proficient in their practice. The repeated exposure to a situation allows the nurse to act more independently and proficiently in the future. With increased proficiency comes improved prioritization and confidence in their abilities. This intuition allows the nurse to quickly make decisions that will best meet the needs of competing priorities. Benner classified nurses along the continuum as novice, advanced beginner, competent, proficient, and expert (Benner, 1982).

According to Benner (1982), as the nurse has more patient care experience, the novice nurse is able to follow context-free rules to complete a task, but s/he still lacks the ability to determine which tasks are most relevant to the situation. The advanced beginner nurse needs assistance with prioritization and is only beginning to see the meaning in recurrent patterns. The competent nurse begins to see their actions in relation to the long-term goals, though actions are not yet second nature. The proficient nurse views situations as a whole, is able to anticipate unexpected events, and prepares for necessary plan modifications in response to unexpected events. The expert nurse has such a wealth of experience and context that they just know. According to Benner (1982), the leap from competent to proficient is defined not only by time but also by a very different way of viewing problems using the tools and resources to solve problems.

Benner's novice to expert theory guided development of this study by identifying the role that experience and repeated exposure plays in increasing proficiency and excellence in assessing a situation and determining an action (Benner, 1982). Relying on this theory for foundational knowledge, one expects that the role of a designated PPC would allow the individual repeated exposure and context to provide identification of unique resources and alternative solutions. These paradigms by which the PPC views subsequent obstacles would result in a decrease of the time required to navigate a patient through the hospital. As the PCC is able to prioritize patient flow, feel confident escalating concerns, and setting priorities as an expert in patient progression management, we theorized that there would be a decrease in patient LOS times observed after the intervention.

Theory of Constraints

The theory of constraints details the steps necessary to identify bottlenecks and make improvements (Mabin & Balderstone, 2003). In this cycle of identification and elimination of the constraint, the measured outcomes improve. Over a span of many cycles, more constraints can be addressed with the potential to improve results. Using this theory as a framework for identifying opportunities for improvement and making those changes, systems can improve their outcomes.

According to Breen, Burton-Houle, and Aron (2002), the theory of constraint related to healthcare is based on two assumptions. First, organizations are complete and complex systems, resulting in interdependencies that affect each other. Second, a constraint is anything that limits the system from operating at its desired performance level, therefore, constraints are not identified as a negative, but as identified areas to be improved. Based on these two assumptions, the theory of constraints focuses organizations to make improvements by following the five identified steps: identifying the constraint, deciding how to improve it, modifying everything else to support those decisions, identifying investments which may increase performance of the constraint, and then finally identifying the next constraint and following the steps to improve that constraint (Breen, Burton-Houle, & Aron, 2002).

The theory of constraints provided a framework for this study by highlighting an intervention necessary to improve a bottleneck. In a complex organization such as a hospital where many variables are unable to be controlled, the theory of constraints helps to identify where processes can be implemented and improved upon. While individual patients and physicians do not follow strict guidelines, the process for moving patients though the different steps in a hospital stay can be controlled and improved upon. This study evaluated whether the implementation of a PPC was able to address and remove constraints, resulting in decreased patient LOS times.

Variables

Appendix A outlines the theoretical and operational definitions of the study. The independent variable in this study was the implementation of a PCC to facilitate patient flow. Dependent variables included patient LOS times including the time a patient arrived in the PACU after surgery to the time of hospital discharge for patients with knee and hip replacements, and the time of hospital admission to the time of hospital discharge for STEMI, hemorrhagic stroke, and ischemic stroke patients. Additionally, demographic variables included age, gender, race, ethnicity, marital status, and employment status. Lastly, clinical variables were included such as patient diagnosis, admitting unit, discharge to location, use of tobacco, use of alcohol, presence of diabetes, presence of hypertension, and body mass index (BMI).

Methods

Design

The design of our study was a separate sample, pre- post- intervention study. The nature of the intervention allowed retrospective data analysis to adequately capture differences in sample group variables and patient length of stay (using discrete fields in the electronic health record (EHR). Additionally, the sample did not require recruitment. Lastly, this design allowed the researcher to complete the study in the defined period of time.

Sample

A random sample of all patients admitted to the hospital for STEMI, stroke, total hip replacement, or total knee replacement who met inclusion/exclusion criteria were included in the study. These sample categories were identified due to the high volume of admitted patients with these diagnoses, and the predictable and consistent nature of their interventions and hospital LOS times.

The STEMI patients included patients admitted to the hospital through the ED. Once there was certainty of ST segment elevation on electrocardiogram (ECG), these patients were identified as a ‘Code STEMI’ and the cardiologist and cardiac catheterization lab staff were alerted to the arrival of the patient. Patients included in this study received a stent in the cardiac catheterization lab, but did not undergo a subsequent open-heart procedure.

The hemorrhagic and ischemic stroke patients were both initially identified in the ED by tell-tale symptoms and identified as a ‘Code Stroke.’ A hemorrhagic stroke was identified as an area of bleeding in the brain, whereas an ischemic stroke was characterized by an area of the brain not receiving oxygen due to a blockage of blood flow caused by a blood clot in an artery in the brain. Patients included in this study were identified based on the diagnosis made by the radiologist as demonstrated on a computed tomography scan (CT).

Patients who underwent a knee or hip replacement were similar in presentation and goals of treatment, but had different expected courses of treatment thereby requiring they be split into two different sample categories. Total knee replacement patients and total hip replacement patients were those patients admitted to the hospital for elective total joint replacement surgery. Patients typically chose to undergo replacement surgery because they were in severe and constant pain secondary to arthritis that interfered with their ability to enjoy life.

Study Sample and Size

The PPC nurse role facilitating inpatient progression was initiated in April 2017. The timeframe for pre-intervention data review was April 1, 2016 to March 31, 2017. The timeframe for post-intervention data review was June 1, 2017 to May 31, 2018. Based on Cohen’s power analysis for a two-tailed t-test study, for a medium effect size to be significant in this study, with a Cohen's d of 0.50, a power of 80%, with an alpha of 0.05 calculated a minimum of 64 patient charts needed review for each pre-post group for a minimum total of 128 patient charts. Typically, 75-100 patients were admitted each year in each of the five patient categories (i.e., patients with a diagnosis of STEMI, hemorrhagic stroke, ischemic stroke, knee replacements, and hip replacements). In order to maximize clinical buy-in to the study's results, a random sample of patients meeting inclusion and exclusion criteria was included for 100 patients in each of the five patient categories for a total of 500 patients pre-intervention and for 100 patients in each of the five patient categories for a total of 500 patients post-intervention (for a total of 1,000 pre-post patients). Patients meeting the inclusion criteria were included in this study regardless of age, gender, race, ethnicity, religious beliefs, or sexual orientation.

Inclusion criteria. Patients identified as having a STEMI with subsequent stent placement in the cardiac catheterization lab were included in the study. Patients identified as having a hemorrhagic or ischemic stroke and entering the hospital through the ED were included in the study. Patients admitted to the hospital for electively scheduled single knee replacement or single hip replacement surgery were included in the study.

Exclusion criteria. Patients were excluded from both the pre- and post- intervention group if they met any of the following criteria:

- Meeting the American Heart Association's eligibility criteria for requiring cardiopulmonary resuscitation within the 24 hours prior to being admitted to the hospital or during their hospital admission
- Age less than 18 years or greater than 85 years

- STEMI patients requiring open-heart surgery during the hospital admission as defined as requiring a sternotomy or thoracotomy incision
- Any patient who was transferred to another hospital during the identified hospital admission
- Any patient who expired during the identified hospital admission
- Any patient with adverse events occurring during hospitalization to include development of an infection, hemorrhage requiring blood transfusion, fall with injury, or development of deep vein thrombosis, pulmonary embolus, acute organ failure, or hospital-acquired pressure injury
- Patients with psychiatric diagnosis or suicide ideations requiring extra resources to ensure patient safety during hospital admission

Setting

Our study was conducted in a 111-bed community hospital in southern California. This hospital is a licensed regional STEMI receiving center, a certified chest pain center, a Joint Commission accredited primary stroke center, a cancer center, and is actively pursuing joint center accreditation. Average daily hospital census in 2017 was 85 patients (with 106 licensed beds at the time) and an average LOS for all patients (excluding healthy newborns) of 3.5 days. The 23-bed ED averaged 136 patients per day in 2017 for a total of 25,056 ED visits. Outpatient procedures are conducted in our gastrointestinal procedure suite, the interventional radiology suite, the cardiac catheterization suite, and our five room surgical suite.

The inpatient hospital bed count consists of a 12-bed Intensive Care Unit (ICU), a 9-bed Cardiac Progressive Care Unit, and three different medical/surgical units for a total of 71 medical/surgical beds, all with the capability of remote telemetry. Additionally, there are perinatal services and a six-bed Level 2 Neonatal ICU. Patients included in this study were admitted through the ED, or patient registration, and may have been admitted to the ICU, the Medical/Surgical Unit, or the Cardiac Progressive Care Unit.

Intervention

The intervention in our study was the designation of a PPC who worked from 10:30am to 7:00pm on weekdays. The PPC role consists of being aware of all physician orders for patients to an assigned patient unit within the hospital, and identification of available beds and facilitation of patient movement to those beds. Patients needing beds may include scheduled surgery patients requiring admission to an inpatient bed post-operatively, patients requesting transfer from other hospitals, patients transferring to other hospitals, patients requiring admission to an inpatient bed from the ED, patients awaiting downgrade from the ICU to an Acute Care Unit, and patients awaiting discharge orders from an Acute Care Unit.

The PCC is a Registered Nurse (RN) responsible for four primary duties affecting patient progression. First, upon being notified of the need for an inpatient bed, the PPC evaluates the medical necessity and acuity for admission request. Using admission and discharge criteria for each inpatient unit, the PPC assesses the needs of the patient and selects the best location for admission based on the anticipated monitoring and intervention requirements of the patient, as well as the current status of the entire hospital. Next, the PPC communicates and coordinates with physician and nursing leadership to ensure the selected inpatient bed is an appropriate match for the patient. While doing this, the PPC maintains an objective hospital-wide perspective to manage and facilitate the flow of patients through the inpatient hospital process. Lastly, the PPC is the primary contact for other hospitals and physicians wishing to transfer patients into our hospital, or coordinating the transfer of patients out of our hospital who need a higher level of care.

The qualifying requirements for a PPC include: having an RN license, Bachelors of Science in Nursing degree preferred, three years of hospital nursing experience, with one year of critical care experience and one year of nursing leadership preferred. In addition to managing patient flow, the PPC must maintain a high commitment to customer service, both internally and externally. The PPC is the first person with whom most physicians and other hospitals would communicate, making their communication skills important.

Prior to the implementation of the PPC in April 2017, patient flow through the hospital was managed at the hospital unit level. The charge nurses for each unit were provided with patient information from either a physician wishing to admit a patient, or from the charge nurse in other hospital units needing to move patients out of their areas. Obstacles to patient flow in this model included slow facilitation times by the charge nurse or poor communication of delays, due to the single-unit focus and the priority placed on supporting and being available to assist with patient care on their individual hospital units.

Instrument and Data Collection

A list of patients meeting the inclusion criteria for each of the five categories of patients selected for this study were obtained from the relevant program coordinator. The STEMI coordinator provided a list of patients who received stents in the cardiac catheterization lab during the selected time frames. The stroke coordinator provided a list of patients who had a hemorrhagic or ischemic stroke during the selected time frame. The total joint coordinator provided a list of patients who received elective hip and knee replacements during the selected time frame.

During the time frame of our study, our hospital used Cerner as our EHR. Using the list of patients obtained from the relative program coordinator, the EHR was reviewed to identify which patients met inclusion/exclusion criteria, and the data were manually entered into the Excel sheet by the student investigator. Only the student investigator abstracted, collected, and entered data utilizing a standardized process and forms. All data needed for this study were abstracted at one time when accessing the patient's chart and program administrative data. Initially, the Financial Identification Numbers (FIN) were retained to identify the patient and hospital encounter being abstracted. Each patient was assigned a "Patient Identification Number" in the Excel spreadsheet and abstracted data were entered.

All patient data were abstracted from discreet fields in the EHR. Demographic data were contained on the patient demographic section. Clinical variables were obtained in the patient history and physical, and patient admission database. Time stamps for admission time, arrival to PACU time, and discharge time were obtained from the patient results flowsheet. A formula was created in excel to calculate the LOS based on times entered. The formula was validated with 20% of the patients to ensure accuracy of LOS calculation.

Data Analysis Plan

Ten percent of the sample was reviewed for accuracy in data entry by the quality and patient safety specialist at our facility who also had administrative access to the data in the EHR before data analysis. Seventeen of the 1,497 data points reviewed were questioned for accuracy. These data were reviewed with the quality and safety specialist and the student investigator. Of the 17 data points questioned as inaccurate, six were modified from the original data set based on consensus agreement.

Once data were checked for accuracy and cleaning completed, the data from the Excel spreadsheet were inputted into the statistical software analysis program (IBM SPSS 24) for analysis. Descriptive and inferential statistics were performed. Frequency and percentage of the pre-post group was generated for demographic and clinical variables. Patient demographic characteristics included age, gender, race, ethnicity, marital status, and employment status. Clinical variables included patient type (STEMI, hemorrhagic stroke, ischemic stroke, knee replacement, and hip replacement), admitting unit, discharge to location, use of tobacco, use of alcohol, presence of diabetes, presence of hypertension, and BMI.

A chi-square (x^2) cross tabulation of demographic and clinical variables before and after the implementation of a PPC was calculated to assess differences in the pre- post-intervention sample groups. Mean and standard deviation were reported for times from admission to hospital discharge for STEMI, hemorrhagic stroke, and ischemic stroke patients; and from arrival to PACU to hospital discharge for knee and hip replacement patients. Differences in LOS for all hypotheses were analyzed using independent t-tests. The level of significance was set at 0.05.

Ethical Considerations

Our study was approved as an expedited review by the institutional review boards (IRB) at the local data collection university and George Washington University. The research team in this study assured that ethical principles such as principles of beneficence, nonmaleficence, and justice, as well as regulations of biomedical ethics and protection of research subjects were respected. The treatment fidelity was assured including only participants that received all elements of the intervention. The participants' identity was protected by removing all possible links between the data and the individual patient. After all data abstraction was complete, the FIN numbers were deleted, and the student investigator did not retain any list with patient identifiers to eliminate any possibility of linking the data and the subject's identity. Measures to prevent breach of secure data from occurring included limitations for those with access to data (student investigator, quality and patient safety specialist, and director of nursing research at our facility) and storing data on a password protected computer with a secure hard drive with access allowed only to the student investigator. There were no anticipated risks to physical or mental well-being as data were retrospective.

Results

A total of 614 patients were included in analysis. Included were 199 STEMI patients, 91 ischemic stroke patients, 198 knee replacement patients, and 126 hip replacement patients. While it was our intention to include both ischemic and hemorrhagic stroke patients in the data analysis, we identified that most of our hemorrhagic stroke patients were transferred out of our hospital to another facility with a higher level of care. In our study, we excluded any patient who was transferred to another hospital during the identified hospital admission. We were only able to collect LOS data for one pre-intervention and 10 post-intervention hemorrhagic stroke patients and, therefore, hemorrhagic stroke patient results, addressed by hypothesis 2, were not reported in this study.

STEMI Sample Group

Demographic and clinical characteristics. Of the 199 STEMI patients in the total group, 50% (n=99) were in the pre- and 50% (n=100) were in the post-intervention group. Of the total group, a majority were 18-60.9 (n=82, 41.2%) or 61-74.9 years old (n=80, 40.2%), male (n=146, 73.4%), white (n=160, 87.9%), non-Hispanic (n=138, 78%), married (n=103, 58.5%), and many were retired (n=63, 45%; Table 1). Most patients were admitted to the ICU (n=124, 62.3%) and then discharged home (n=169, 85.4%). Reviewing clinical characteristics for the

STEMI group demonstrated a majority did not use tobacco (n=120, 64.5%), did not regularly consume alcohol (n=98, 64.9%), did not have diabetes (n=135, 68.9%), but did have hypertension (n=118, 59.9%) and many had a BMI ≥30 (n=74, 45.4%).

Several significant differences in demographic and clinical characteristics existed before and after the implementation of the PPC. The pre-intervention group had significantly more white than non-white patients (p=.03) and significantly more patients who did not consume alcohol than who regularly consume alcohol (p=.007) compared to the post-intervention group. The post-intervention group had significantly more non-Hispanic than Hispanic patients (p=.05) more male than female patients (p=.01), and more married than unmarried patients (p=.02) compared to the pre-intervention group. There were no additional significant differences in demographic and clinical variables in the pre-intervention and the post-intervention STEMI group based on Table 1.

STEMI outcomes. To evaluate hypotheses 1, we measured the LOS (in hours) from admission to discharge for STEMI patients before and after the implementation of a PPC. Mean LOS was 69.87 ± 55.77 hours for the pre-intervention group and 57.81 ± 34.17 hours for the post-intervention group. No statistically significant difference was found in LOS for STEMI patients before versus after the intervention (t=1.82, p=.07; Table 2).

Ischemic Stroke Sample Group

Demographic and clinical characteristics. Of the 91 ischemic stroke patients in the total group, 31.9% (n=29) were in the pre- and 68.1% (n=62) were in the post-intervention group. Of the total group, a majority were 61-74.9 (n=36, 39.6%) or 75-85 years old (n=37, 40.7%), male (n=49, 53.8%), white (n=81, 89%), non-Hispanic (n=72, 79.1%), married (n=59, 65.6%), and retired (n=38, 52.8%; Table 3). Most patients were admitted to non-ICU units (n=54, 60%) and then discharged home (n=45, 50%). Reviewing clinical characteristics for the ischemic stroke group demonstrated a majority did not use tobacco (n=76, 84.4%), did not regularly consume alcohol (n=55, 70.5%), did not have diabetes (n=64, 70.3%), but did have hypertension (n=61, 67%) and many had a BMI 25-29.9 (n=35, 39.8%) or ≥30 (n=31, 35.2%).

The only significant difference in demographic and clinical characteristics existing before and after the implementation of the PPC for patients with ischemic stroke was the shift in age. The post-intervention group had significantly more patients age 75-85 years than patients age 18-60.9 years or 61-74.9 years (p=.03) compared to the post-intervention group. There were no additional significant differences in demographic and clinical variables in the pre-intervention and the post-intervention group based on Table 3.

Ischemic stroke outcomes. To evaluate hypotheses 3, we measured LOS (in hours) from admission to discharge for ischemic stroke patients before and after the implementation of a PPC. Mean LOS was 57.59 ± 47.50 hours for the pre-intervention group and 72.91 ± 47.60 hours for the post-intervention group. No significant difference was found in LOS for ischemic stroke patients before versus after the intervention (t=-1.41, p=.16; Table 2).

Knee Replacement Sample Group

Demographic and clinical characteristics. Of the 198 knee replacement patients in the total group, 49.5% (n=98) were in the pre- and 50.5% (n=100) were in the post-intervention group. Of the total group, a majority were 61-74.9 years old (n=104, 52.5%), female (n=115, 58.1%), white (n=177, 89.4%), non-Hispanic (n=166, 83.8%), married (n=134, 67.7%), and retired (n=126, 71.2%; Table 4). All patients were admitted to non-ICU units (n=198, 100%) and then a majority were discharged home with home health care (n=154, 77.8%). Reviewing clinical characteristics for the knee replacement group demonstrated a majority did not use tobacco (n=176, 88.9%), did not regularly consume alcohol (n=101, 51.5%), did not have diabetes (n=165, 83.3%), but did have hypertension (n=130, 65.7%), and a BMI ≥30 (n=113, 57.7%).

The only significant difference in demographic and clinical characteristics existing before and after the implementation of the PPC for patients with knee replacement was the location to which the patient was discharged. The post-intervention group had significantly more patients discharged home with home health care versus home alone or to a SNF (p=.02) than the pre-intervention group. There were no additional significant differences in demographic and clinical variables in the pre-intervention and the post-intervention group based on Table 4.

Knee replacement outcomes. To evaluate hypotheses 4, we measured the LOS from the length of time (in hours) from arrival to PACU to hospital discharge for knee replacement patients before and after the implementation of a PPC. Mean LOS was 65.59 ± 16.23 hours for the pre-intervention group and 57.22 ± 14.28 hours for the post-intervention group. Knee replacement patients in the post-intervention group had a significantly shorter LOS compared to those in the pre-intervention group (t=3.85, p<.001; Table 5).

Hip Replacement Sample Group

Demographic and clinical characteristics. Of the 126 hip replacement patients in the total group, 55.6% (n=70) were in the pre- and 44.4% (n=56) were in the post-intervention group. Of the total group, a majority were 61-74.9 (n=64, 50.8%) years old, female (n=75, 59.5%), white (n=119, 94.4%), non-Hispanic (n=122, 96.8%), married (n=73, 57.9%), and retired (n=75, 67.6%; Table 6). All patients were admitted to non-ICU units (n=126, 100%) and then a majority were discharged home with home health care (n=73, 57.9%). Reviewing clinical characteristics for the hip replacement group demonstrated a majority did not use tobacco (n=106, 84.1%), did regularly consume alcohol (n=72, 57.1%), did not have diabetes (n=119, 94.4%), but did have hypertension (n=76, 60.3%) and many had a BMI ≥30 (n=57, 45.6%).

Several significant differences in demographic and clinical characteristics existed before and after the implementation of the PPC. The post-intervention group had significantly more patients discharged home with home health care than home alone or to a skilled nursing facility (p=.01) and significantly more female than male patients (p=.04) compared to the pre-intervention group. The pre-intervention group had significantly more patients who regularly consumed alcohol than those who did not (p=.03) compared to the post-intervention group. There were no additional significant differences in demographic and clinical variables in the pre-intervention and the post-intervention group based on Table 6.

Hip replacement outcomes. To evaluate hypotheses 5, we measured the LOS based on length of time (in hours) from arrival to PACU to hospital discharge for hip replacement patients before and after the implementation of a PPC. Mean LOS was 69.71 ± 37.27 hours for the pre-intervention group and 64.34 ± 22.30 hours for the post-intervention group. No significant difference was found in LOS for hip replacement patients before versus after the intervention (t=0.95, p=.34; Table 5).

Discussion

The purpose of our study was to determine if the implementation of a PPC decreased the LOS for five different sample groups: STEMI patients, hemorrhagic stroke patients, ischemic stroke patients, knee replacement patients, and hip replacement patients. After removing the hemorrhagic stroke sample group due to inadequate sample size because a majority of hemorrhagic stroke patients admitted to our hospital were transferred to another facility for a higher level of care, our study did identify a significant improvement in patient throughput times for knee replacement patients. The implementation of a PPC at our institution, however, did not significantly decrease LOS for STEMI patients, ischemic stroke patients, or hip replacement patients.

Although the PPC intervention did not produce a statistically significant decrease in the LOS for the STEMI sample group, our hospital leadership may find results to be clinically significant in improving inpatient progress and flow. Clinically, our results demonstrated a reduction in mean LOS by approximately 12 hours after the intervention compared to before. While not statistically significant, 12 hours accounts for a 17% reduction in LOS. If a patient is occupying a hospital bed for 12 hours less, that half-day reduction would allow a patient who is waiting in the ED or the PACU to move into an inpatient room 12 hours sooner and would improve inpatient flow. Additionally, we speculate that a 12-hour reduction in nursing labor cost for the nurse providing care for the patient would reduce patient expenses.

Additionally, factors unrelated to the intervention of the PPC may have contributed to the lack of a statistically significant decreased LOS for the STEMI sample group. The post-intervention group had significantly more males and significantly more married patients compared to the pre-intervention group. According to the Agency for Healthcare Research and Quality (AHRQ), LOS tends to be longer in male patients than females, which may have contributed to a longer LOS in the post-intervention group (AHRQ, 2014). However, according to Shulan and Gao (2015), married patients have a 22% shorter LOS than unmarried patients, which should have contributed to a shorter LOS in the post-intervention group even though the pre-post differences were not significant. Lastly, Claeys et al. (2013) found that LOS for STEMI patients among 22 hospitals varied due to different hospital discharge policies rather than the acuity and complexity of illness of the patients.

Although the PPC intervention did not produce a statistically significant difference in the LOS for the ischemic stroke sample group, our hospital leadership may find results to be clinically significant. Clinically, our results demonstrated an increase in mean LOS by approximately 15 hours after the intervention compared to before. While not statistically significant, 15 hours accounts for a 26% increase in LOS. This increase in LOS would result in another patient who may be waiting in the ED or PACU to wait for an inpatient bed for an additional 15 hours. Additionally, we speculate that increased LOS would result in additional nursing labor costs for the nurse caring for this patient for an additional 15 hours and increase hospital expenses.

While additional factors may have contributed to the increase in LOS for the post-intervention ischemic stroke sample group compared to the pre-intervention group ischemic stroke group, additional investigation into factors affecting this sample group during this timeframe is recommended. We speculate that factors may include a difference in discharging practices, physician practices, or the acuity of the patients in the sample group. The only significant finding in the data collected for this study was that the post-intervention group had significantly more patients age 75-85 years than the pre-intervention group. Polanczyk et al. (2001), found a significant increase the LOS for patients over age 80 years old. While over age 80 years is a different age grouping than used in our study, these findings could have contributed to a longer LOS in the post-intervention ischemic stroke patients.

The intervention of a PPC was effective in decreasing the LOS for the knee replacement patients. Clinically, our results demonstrated a reduction in mean LOS by approximately 8 hours after the intervention compared to before. To hospital leadership, 8 hours accounts for a 13% reduction in LOS, and would allow additional patients waiting for a bed to move out of the ED or PACU 8 hours sooner. The only variable with a significant difference between the pre- and post- intervention group was the discharge to location. The pre-intervention group had significantly more patients discharged to a SNF than the post-intervention group. We speculate that the discharge arrangements necessary to ensure safe transfer to a SNF may have increased the LOS for those patients in the pre-intervention group. Having significantly fewer patients discharged to a SNF in the post-intervention group may have decreased LOS in the post-intervention sample group. We speculate that the fewer number of patients discharged to a SNF in the post-intervention group may have been due to a change in discharging practices or physician preference compared to the pre-intervention group.

The intervention of a PPC did not significantly decrease the LOS for the hip replacement sample group. However, hospital leadership may find results to be clinically significant. Clinically, our results demonstrated a reduction in mean LOS by approximately 5.5 hours, which accounts for an 8% reduction in LOS. If a patient is occupying a hospital bed for 5.5 hours less, that would allow a patient who is waiting in the ED or the PACU to move into an inpatient room 5.5 hours sooner and would improve inpatient flow. Additionally, we speculate that a 5.5-hour reduction in nursing labor cost for the nurse providing nursing care for the patient would reduce patient expenses.

Additionally, factors unrelated to the intervention of the PPC may have contributed to the lack of a statistically significant decreased LOS for the hip replacement sample group. Significant differences in the before and after group included gender, discharge to location, and alcohol consumption. The post-intervention group had significantly more females than male patients compared to the pre-intervention group. As identified by AHRQ (2014), the larger proportion of females in the post-intervention group may have contributed to a shorter LOS in the post-intervention group. Additionally, we speculate that the larger proportion of patients who were discharged to home with home healthcare in the post-intervention group, versus home alone or to a SNF in the pre-intervention group, may have contributed to an increase in LOS in the post-intervention group as there may have been a delay in discharge while setting up home health care arrangements. Lastly, the larger proportion of patients who regularly consumed alcohol in the pre-intervention group compared to the post-intervention group may have affected the LOS. We speculate the patients who did not regularly consume alcohol may have had fewer comorbidities, although additional comorbidities were not measured or captured in our study.

Reviewing the literature and the theories utilized in the design of this study, it is appreciated that none focused on the ability of a single role to improve outcomes. All of the literature referenced defined a team and one or more processes. The Donabedian model highlights that improving health care performance outcome metrics, in this case LOS, cannot happen in a silo and requires attention to structure and process to be included as well (Donabedian, 1966). The theory of constraints recognizes that healthcare organizations are complex with interdependencies that affect other things. Constraints are not negative, but are something that limits desired performance and can be improved (Breen, Burton-Houle, & Aron, 2002). Thus, the role of the PPC provides opportunity to assess and improve upon the constraints affecting the effectiveness of the PPC role, thereby potentially improving LOS for additional patient populations.

Organizational behavior literature suggests that the engagement and achievement of desired performance metrics is reflective of the culture of the organization. In *How the Growth Outliers Do It* (2012), Rita Gunther McGrath links excellent corporate performance with focused management on corporate values and culture. Tim Porter-O'Grady best describes the correlation in the book *Building a Culture of Ownership in Healthcare* (2017)*: "*It can easily be said that without the convergence and congruence among structure, culture, values, and ownership, these outcomes can neither be achieved nor sustained" (pg. 250). As demonstrated in multiple examples in *Building a Culture of Ownership* (2017), healthcare performance outcomes follow an organizational culture of ownership. Tye and Dent (2017) outline the "invisible architecture" of ownership as tangible core values, an organizational culture of self-empowerment, and positive workplace attitude.

However, the positive correlation between organizational culture and performance outcomes is recognized not only in healthcare, but across various industries. According to research conducted by Markos and Sridevi (2010), employee engagement is an essential prerequisite for better performance outcomes. A study, published in the Journal of Organizational Behavior, analyzed the performance of 95 franchise car dealerships over six years to determine what comes first, organizational culture, or performance (Boyce, Nieminen, Gillespie, Ryan, & Denison, 2015). It was shown in this study that a higher culture of involvement, consistency, adaptability and mission resulted in higher performance as evidenced by customer satisfaction and vehicle sales.

Study Limitations

Many limitations were identified in the study design, data collection, and data analysis of this study. Initially, several opportunities existed to improve the design of this study. The retrospective nature of this study limited our knowledge of each case to only that information which was contained in the EHR. However, the due to the retrospective nature of our study design, it should have been recognized that most hemorrhagic stroke patients were transferred to another facility with a higher level of care, and the study plan should not have included a hemorrhagic stroke sample group. The timing of the post-intervention period may also have been a limitation of the study. As the PPC was a new role in our hospital in 2017, the nurse filling the role was a novice regarding the expectations of the role. The timing of the post-intervention period beginning June 1, 2017 likely did not allow the PPC to advance from novice to competent or proficient in the role before we began measuring the effectiveness of the position (Benner, 1982).

The small sample size in this study may have limited the opportunity to identify significance as highlighted by the pre- post- LOS p value that came close to significance (p =.07) in the STEMI group. A larger sample size may have identified a significant decrease in LOS for the post- intervention STEMI group compared to the pre-intervention STEMI group. Additionally, the sample size for the pre- and post- intervention ischemic stroke groups and the post- intervention hip replacement group did not achieve the 64 patients we desired as estimated by Cohen's power analysis to reach significance.

There were several limitations associated with data collection in this study. The lack of measuring additional process metrics along with the implementation of a PPC was identified as a limitation in this study. Helpful process metrics may have included the amount of time in LOS that was affected by external processes not managed by the PPC. Processes not managed by the PPC could have included the length of time the patient was ready for a bed but a bed was unavailable, or the length of time the patient was ready for discharge but discharge arrangements were not yet completed. Also helpful process measures may have been performance metrics assuring that the PPC was accomplishing designated process tasks such as length of time from a bed available to alerting nurses on the receiving unit that patient was assigned to an available bed. Lastly, as the PPC is only present at the hospital 40 hours per week, the lack of specific data collection on patient LOS when the PPC was present and facilitating patient movement compared to when the PPC was not present was identified as a limitation of the study.

Implications/Recommendations for Practice, Policy, and Research

The results of our study offer implications for our facility and organization to examine opportunities for improvement in all aspects of the patient flow experience. Opportunities to improve the role of the PPC and set hospital-wide targets for patient flow times have the potential to further decrease patient LOS. Additional enhancements in organizational culture offer the opportunity to amend hospital-wide outcome metrics, enhance employee experience, and perfect the patient experience. Recommendations based on our findings will be shared with key stakeholders within our organization and healthcare system.

The role of the PPC did reduce LOS for knee replacement patients and appears to have the potential to reduce LOS for other populations. We recommend following the five steps to improve constraints to identify and test several opportunities that enhance the effectiveness of the PPC: identifying the constraint, deciding how to improve it, modifying everything else to support those decisions, identifying investments that may increase performance of the constraint, and then finally identifying the next constraint and following the steps to improve that constraint (Breen, Burton-Houle, & Aron, 2002). We speculate, based on interviews with the PPC and a review of identified study findings and limitations, that a performance improvement taskforce could be established to identify and eliminate process and structure challenges affecting the PPC role based on the recommendations below.

First, setting clear time targets for processes impacting hospital patient flow may increase the effectiveness of the PPC role. Possible time targets may include the time it takes environmental services staff to clean a room and the time allowed for an accepting nurse to receive report on a new patient into an unoccupied and available room. Measuring adherence to these time targets and providing hospital-wide transparency to target achievement rates may increase awareness and further decrease patient LOS.

Additionally, piloting modifications to the PPC role may improve effectiveness to the role. Staffing the PPC role 12pm to 12am, 7 days per week during peak movement times may improve efficiency by allowing an individual to own the entire movement process for the day. Based on our hospital's patient progression data, a majority of admission orders occur between 4pm and 10pm, peak times for physician downgrade orders occur between 9am and 11am, most patients are discharge out of the hospital between 3pm and 6pm, and a majority of all patient movement occurs between 1:00pm and 11:30 pm.

Based on the findings of this study and a lack of improvement in patient LOS for STEMI patients, ischemic stroke patients, and hip replacement patients, we recommend a thorough assessment and diligent gap analysis of hospital culture be conducted and deliberate attention and strategy be implemented in building tangible positive values and a hospital culture of ownership. Recommendations for future research include removing constraints from the role of the PPC such as expanding the hours and days of the week the PPC works, setting time targets for the processes required to move a patient into a bed in order to improve effectiveness of the PPC role, and testing LOS with the revised PPC role in other populations. Future research is recommended to study the qualitative effects of the PPC role such as perceived value added for other hospital staff and physicians.

Sustainability

Our study found the role of the PPC did reduce LOS for knee replacement patients and appears to have the potential to reduce LOS for other populations. We speculate that consistent and ongoing improvement efforts to identify and remove additional constraints that currently limit the effectiveness of the PPC role will improve LOS for additional patient populations. With continued improvement in LOS for patients throughout the hospital, we anticipate that hospital leadership will value the impact the PPC role has on hospital patient throughput.

Conclusions

As the demands and regulations placed on hospitals to improve patient satisfaction and serve growing numbers of patients increases, hospitals must find effective and efficient means to ensure the movement of patients through their hospital and safely decrease patient LOS. Our study found the role of the PPC did reduce LOS for knee replacement patients and appears to have the potential to reduce LOS for other populations.

Based on our study results and identified limitations, our first recommendation to organizational stakeholders is to develop a performance improvement taskforce to identify and eliminate process and structure barriers that impact effectiveness of the PPC role. Proposed improvements to the PPC role include changes to the hours and days of the week the PPC works and setting time targets for hospital processes that affect patient movement. Additionally, our second recommendation to organizational stakeholders is to conduct a thorough and diligent assessment of hospital culture and organizational values. Based on the findings from that assessment, we recommend a strategic and thoughtful implementation of a culture of ownership consistently demonstrating positive values.

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Table 1. Differences in demographic and clinical characteristics before versus after the intervention for STEMI patients

Variable	Total Group n (%)	Pre-intervention n (%)	Post-intervention n (%)	χ^2	p value
STEMI	199 (100)	99 (50)	100 (50)		
Age in years				0.91	.63
• 18-60.9	82 (41.2)	38 (38.4)	44 (44)		
• 61-74.9	80 (40.2)	43 (43.4)	37 (37)		
• 75-85	37 (18.6)	18 (18.2)	19 (19)		
Gender				5.99	.01
• Male	146 (73.4)	65 (65.7)	81 (81)		
• Female	53 (26.6)	34 (34.3)	19 (19)		
Race				5.04	.03
• White	160 (87.9)	77 (93.9)	83 (83)		
• Non-white	22 (12.1)	5 (6.1)	17 (17)		
Ethnicity				3.83	.05
• Hispanic	39 (22)	23 (28.7)	16 (16.5)		
• Non-Hispanic	138 (78)	57 (71.3)	81 (83.5)		
Marital Status				5.17	.02
• Married	103 (58.5)	40 (49.4)	63 (66.3)		
• Not Married	73 (41.5)	41 (50.6)	32 (33.7)		
Employment status				1.93	.38
• Employed	31 (22.1)	13 (17.8)	18 (26.9)		
• Not employed	46 (32.9)	24 (32.9)	22 (32.8)		
• Retired	63 (45)	36 (49.3)	27 (40.3)		
Admitting Unit				0.15	.70
• ICU	124 (62.3)	63 (63.6)	61 (61)		
• Non-ICU	75 (37.7)	36 (36.4)	39 (39)		
Discharging Location				1.19	.55
• Home	169 (85.4)	82 (82.8)	87 (87.9)		
• Skilled Nursing Facility	11 (5.6)	7 (7.1)	4 (4)		
• Home with Home Health Care	18 (9.1)	10 (10.1)	8 (8.1)		
Tobacco Use				0.81	.37
• No	120 (64.5)	61 (67.8)	59 (61.5)		
• Yes	66 (35.5)	29 (32.2)	37 (38.5)		
Alcohol				7.32	.007
• No alcohol	98 (64.9)	54 (76.1)	44 (55)		

• Regular consumption of alcohol	53 (35.1)	17 (23.9)	36 (45)		
Diabetes				0.46	.50
• No	135 (68.9)	69 (71.1)	66 (66.7)		
• Yes	61 (31.1)	28 (28.9)	33 (33.3)		
Hypertension				0.24	.62
• No	79 (40.1)	41 (41.8)	38 (38.4)		
• Yes	118 (59.9)	57 (58.2)	51 (61.6)		
BMI					
• BMI <25	38 (23.3)	24 (27.6)	14 (18.4)	4.36	.11
• BMI 25-29.9	51 (31.3)	30 (34.5)	21 (27.6)		
• BMI ≥30	74 (45.4)	33 (37.9)	41 (53.9)		

Table 2. Time from admission to discharge (hours) for STEMI and ischemic stroke patients

	Pre-intervention Length of Stay Mean (SD)	Post-intervention Length of Stay Mean (SD)	t-test	p value
STEMI	69.87 (55.77)	57.81 (34.17)	1.82	.07
Ischemic Stroke	57.59 (47.50)	72.91 (47.60)	-1.41	.16

Table 3. Differences in demographic and clinical characteristics before versus after the intervention for ischemic stroke patients

Variable	Total Group n (%)	Pre-intervention n (%)	Post-intervention n (%)	χ^2	p value
Ischemic Stroke	91 (100)	29 (31.9)	62 (68.1)		
Age in years				6.91	.03
• 18-60.9	18 (19.8)	5 (17.2)	13 (21)		
• 61-74.9	36 (39.6)	17 (58.6)	19 (30.6)		
• 75-85	37 (40.7)	7 (24.1)	30 (48.4)		
Gender				0.08	.78
• Male	49 (53.8)	15 (51.7)	34 (54.8)		
• Female	42 (46.2)	14 (48.3)	28 (45.2)		
Race				1.70	.28
• White	81 (89)	24 (82.8)	57 (91.9)		
• Non-white	10 (11)	5 (17.2)	5 (8.1)		
Ethnicity				1.29	.20
• Hispanic	19 (20.9)	4 (13.8)	15 (24.2)		
• Non-Hispanic	72 (79.1)	25 (86.2)	47 (75.8)		
Marital Status				2.01	.16
• Married	59 (65.6)	22 (75.9)	37 (60.7)		
• Not Married	31 (34.4)	7 (24.1)	24 (39.3)		
Employment status				0.08	.96
• Employed	14 (19.4)	5 (17.9)	9 (20.5)		
• Not employed	20 (27.8)	8 (28.6)	12 (27.3)		
• Retired	38 (52.8)	15 (53.6)	23 (52.3)		
Admitting Unit				0.14	.71
• ICU	36 (40)	12 (42.9)	24 (38.7)		
• Non-ICU	54 (60)	16 (57.1)	38 (61.3)		
Discharging Location				0.85	.66
• Home	45 (50)	16 (57.1)	29 (46.8)		
• Skilled Nursing Facility	27 (30)	7 (25)	20 (32.3)		
• Home with Home Health Care	18 (20)	5 (17.9)	13 (21)		
Tobacco Use				0.88	.54
• No	76 (84.4)	26 (89.7)	50 (82)		
• Yes	14 (15.6)	3 (10.3)	11 (18)		
Alcohol				0.25	.62
• No alcohol	55 (70.5)	20 (74.1)	35 (68.6)		

• Regular consumption of alcohol	23 (29.5)	7 (25.9)	16 (31.4)		
Diabetes				1.39	.24
• No	64 (70.3)	18 (62.1)	46 (74.2)		
• Yes	27 (29.7)	11 (37.9)	16 (25.8)		
Hypertension				0.04	.83
• No	30 (33)	10 (34.5)	20 (32.3)		
• Yes	61 (67)	19 (65.5)	42 (67.7)		
BMI					
• BMI <25	22 (25)	6 (20.7)	16 (27.1)	3.24	.20
• BMI 25-29.9	35 (39.8)	9 (31)	26 (44.1)		
• BMI ≥30	31 (35.2)	14 (48.3)	17 (28.8)		

Table 4. Differences in demographic and clinical characteristics before versus after the intervention for knee replacement patients

Variable	Total Group n (%)	Pre-intervention n (%)	Post-intervention n (%)	χ^2	p value
Knee Replacement	198 (100)	98 (49.5)	100 (50.5)		
Age in years				2.69	.26
• 18-60.9	42 (21.2)	22 (22.4)	20 (20)		
• 61-74.9	104 (52.5)	46 (46.9)	58 (58)		
• 75-85	52 (26.3)	30 (30.6)	22 (22)		
Gender				0.71	.40
• Male	83 (41.9)	44 (44.9)	39 (39)		
• Female	115 (58.1)	54 (55.1)	61 (61)		
Race				1.22	.27
• White	177 (89.4)	90 (91.8)	87 (83)		
• Non-white	21 (10.6)	8 (8.2)	13 (17)		
Ethnicity				0.70	.40
• Hispanic	32 (16.2)	18 (18.4)	14 (14)		
• Non-Hispanic	166 (83.8)	80 (81.6)	86 (86)		
Marital Status				1.25	.26
• Married	134 (67.7)	70 (71.4)	64 (64)		
• Not Married	64 (32.3)	28 (28.6)	36 (36)		
Employment status				1.13	.57
• Employed	26 (14.7)	13 (13.4)	13 (16.3)		
• Not employed	25 (14.1)	16 (16.5)	9 (11.3)		
• Retired	126 (71.2)	68 (70.1)	58 (72.5)		
Admitting Unit					
• ICU	0 (0)	0 (0)	0 (0)		
• Non-ICU	198 (100)	98 (100)	100 (100)		
Discharging Location				8.14	.02
• Home	4 (2)	4 (4.1)	0 (0)		
• Skilled Nursing Facility	40 (20.2)	25 (25.5)	15 (15)		
• Home with Home Health Care	154 (77.8)	69 (70.4)	85 (85)		
Tobacco Use				0.16	.69
• No	176 (88.9)	88 (89.8)	88 (88)		
• Yes	22 (11.1)	10 (10.2)	12 (12)		
Alcohol				1.02	.31
• No alcohol	101 (51.5)	53 (55.2)	48 (48)		

• Regular consumption of alcohol	95 (48.5)	43 (44.8)	52 (52)		
Diabetes				0.02	.90
• No	165 (83.3)	82 (83.7)	83 (83)		
• Yes	33 (16.7)	16 (16.3)	17 (17)		
Hypertension				1.69	.19
• No	68 (34.3)	38 (38.8)	30 (30)		
• Yes	130 (65.7)	60 (61.2)	70 (70)		
BMI					
• BMI <25	26 (13.3)	12 (12.4)	14 (14.1)	0.79	.67
• BMI 25-29.9	57 (29.1)	26 (26.8)	31 (31.3)		
• BMI ≥30	113 (57.7)	59 (60.8)	54 (54.5)		

Table 5. Time from arrival to PACU to hospital discharge (hours) for knee and hip replacement patients

	Pre-intervention Length of Stay Mean (SD)	Post-intervention Length of Stay Mean (SD)	t-test	p value
Knee replacement	65.59 (16.23)	57.22 (14.28)	3.85	<0.001
Hip replacement	69.71 (37.27)	64.34 (22.30)	.95	.34

Table 6. Differences in demographic and clinical characteristics before versus after the intervention for hip replacement patients

Variable	Total Group n (%)	Pre-intervention n (%)	Post-intervention n (%)	χ^2	p value
Hip Replacement	126 (100)	70 (55.6)	56 (44.4)		
Age in years				0.91	.63
• 18-60.9	33 (26.2)	16 (22.9)	17 (30.4)		
• 61-74.9	64 (50.8)	37 (52.9)	27 (48.2)		
• 75-85	29 (23)	17 (24.3)	12 (21.4)		
Gender				4.28	.04
• Male	51 (40.5)	34 (48.6)	17 (30.4)		
• Female	75 (59.5)	36 (51.4)	39 (69.6)		
Race				0.008	1
• White	119 (94.4)	66 (94.3)	53 (94.6)		
• Non-white	7 (5.6)	4 (5.7)	3 (5.4)		
Ethnicity				0.63	.63
• Hispanic	4 (3.2)	3 (4.3)	1 (1.8)		
• Non-Hispanic	122 (96.8)	67 (95.7)	55 (98.2)		
Marital Status				0.04	.84
• Married	73 (57.9)	40 (57.1)	33 (58.9)		
• Not Married	53 (42.1)	30 (42.9)	23 (41.1)		
Employment status				5.13	.08
• Employed	24 (21.6)	19 (27.1)	5 (12.2)		
• Not employed	12 (10.8)	5 (7.1)	7 (17.1)		
• Retired	75 (67.6)	46 (65.7)	29 (70.7)		
Admitting Unit					
• ICU	0 (0)	0 (0)	0 (0)		
• Non-ICU	126 (100)	70 (100)	56 (100)		
Discharging Location				8.75	.01
• Home	20 (15.9)	17 (24.3)	3 (5.4)		
• Skilled Nursing Facility	33 (26.2)	18 (25.7)	15 (26.8)		
• Home with Home Health Care	73 (57.9)	35 (50)	38 (67.9)		
Tobacco Use				1.07	.30
• No	106 (84.1)	61 (87.1)	45 (80.4)		
• Yes	20 (15.9)	9 (12.9)	11 (19.6)		
Alcohol				4.73	.03
• No alcohol	54 (42.9)	24 (34.3)	30 (53.6)		

• Regular consumption of alcohol	72 (57.1)	46 (65.7)	26 (46.4)		
Diabetes				0.76	.46
• No	119 (94.4)	65 (92.9)	54 (96.4)		
• Yes	7 (5.6)	5 (7.1)	2 (3.6)		
Hypertension				0.007	.94
• No	50 (39.7)	28 (40)	22 (39.3)		
• Yes	76 (60.3)	42 (60)	34 (60.7)		
BMI				0.42	.81
• BMI <25	21 (16.8)	11 (15.7)	10 (18.2)		
• BMI 25-29.9	47 (37.3)	28 (40)	19 (34.5)		
• BMI ≥30	57 (45.6)	31 (44.3)	26 (47.3)		

Appendix A.
Variable Table with Theoretical and Operational Definitions

Variables	Type of Variables	Theoretical Definition	Operational Definition
LOS for STEMI and ischemic stroke patients	Dependent; Interval	Time from admission to discharge from hospital	Time in hours from first set of inpatient vital signs to time hospital discharge summary is printed
LOS for knee and hip replacement patients	Dependent; Interval	Time from arrival in PACU to hospital discharge time	Time in hours from the arrival in PACU documented in EMR to the time hospital discharge summary is printed
Age	Demographic; Nominal	Chronologic age in years	2=18-60.9 3=61-74.9 4=75-85
Gender	Demographic; Nominal	Patient's biological sex	1=Male 2=Female
Race	Demographic; Nominal	Reported self-identification with the person or population group having shared genetic or biological traits	1=White 2=Non-white
Ethnicity	Demographic; Nominal	Reported self-identification with the person or population group having shared genetic or biological traits	1=Hispanic 2=Not Hispanic or Latino
Marital status	Demographic; Nominal	Current relationship status	1=Married 2=Not married
Employment status	Demographic; Nominal	Status of current employment	1=Employed 2=Not employed 4=Retired
Patient Type	Clinical; Nominal	Based on the patient progress note, patient will be identified based on illness and procedure	1=STEMI with stent 3=Ischemic Stroke 4=Knee replacement 5=Hip replacement

Admitting Unit	Clinical; Nominal	Based on the admission note, what patient care hospital unit the patient was first admitted to	1= ICU 2= Telemetry 3= Medical/Surgical 4= Cath Lab 5=Other
Discharge Location	Clinical; Nominal	Based on discharge summary, where was the patient discharged to	1=Home 2=Skilled Nursing Facility 3= Home with home health care
Smoking/tobacco chewing	Clinical; Nominal	Daily use of cigarettes or chewing tobacco	0=No 1=Yes 3= Previous tobacco use
Alcohol	Clinical; Nominal	Alcohol drinking on a regular basis	0=No alcohol 1=Regularly consumes alcohol
Diabetes	Clinical; Nominal	Individual has been diagnosed with diabetes and has been taking medications as noted in hospital History and Physical or coded in problem list.	0=No 1=Yes
Hypertension	Clinical; Nominal	Individual has been diagnosed with hypertension and has been taking medications as noted in hospital History and Physical or coded in problem list.	0=No 1=Yes
Body Mass Index (BMI)	Clinical; Nominal	BMI is defined as the body weight (in kilograms), divided by the square of the height (in meters). The result is expressed as a number - usually between 15 and 70- in units of kilograms per square meter. BMI <25 is	1=BMI <24.9 2=BMI 25-29.9 3=BMI ≥30

		considered normal, BMI 25-29.9 is overweight, and BMI ≥30 is obese	