A Novel Perioperative Pathway for Acute Geriatric Hip Fracture Patients

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Submitted to: JMIR Perioperative Medicine
on: August 21, 2025

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Abstract

Background: Morbidity and mortality in geriatric hip fracture patients remains high. Despite advances in medical care, the incidence of medical complications, especially delirium, has remained stable in hip fracture patients. Early surgical repair and optimized perioperative care may improve outcomes.

Objective: To evaluate a multidisciplinary perioperative pathway aimed at reducing delirium, time to surgery, length of stay, and mortality among elderly patients with acute hip fractures. Although individual components of hip fracture pathways have been studied, the components together have not. We designed a pathway to specifically address common medical conditions in elderly patients who experience hip fractures.

Methods: A novel pathway incorporating regional anesthesia, multimodal analgesia, preoperative anemia correction, and guideline-based cardiac evaluation to expedite time to surgery was implemented at a tertiary care academic center. Data from two 18-month periods before and after implementation were compared . A pre-post design was used for this quality improvement study to examine the effects of nerve block utilization on the rates of delirium and carbohydrate drink administration on acute kidney injury , Results were tracked using statistical process control (SPC) charts to assess for special cause variation.

Results: A total of 372 patients met inclusion criteria (183 pre- and 189 post-pathway). Implementation led to significant reductions in cardiology consultation time, length of stay, intra- and postoperative blood transfusions, and time to surgery among delayed cases. There was increased use of nerve blocks and preoperative carbohydrate drinks, with no change in delirium rates or 30-day readmissions. Statistical process control methods were used to detect special cause variation after implementation of selected interventions. There was a significant increase of the use of nerve blocks and carbohydrate drink administration after our educational intervention and addition of these orders to a specific order set in our electronic medical record. We then examined the effect of implementation of nerve blocks on delirium and carbohydrate enriched drinks on acute kidney injury. Although there was an improvement in rates of delirium and acute kidney injury with our interventions, special cause variation was not demonstrated. Mortality remained low at 0.5%.

Conclusions: Hospitalist-led multidisciplinary care pathways can reduce hospital stay, expedite perioperative care, and improve implementation of evidence-based practices in geriatric hip fracture management. Clinical Trial: n/a

(JMIR Preprints 21/08/2025:82798)
DOI: https://doi.org/10.2196/preprints.82798

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A Novel Perioperative Pathway for Acute Geriatric Hip Fracture Patients

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Background: Morbidity and mortality in geriatric hip fracture patients remains high. Despite advances in medical care, the incidence of medical complications, especially delirium, has remained stable in hip fracture patients. Early surgical repair and optimized perioperative care may improve outcomes.
Objective: To evaluate a multidisciplinary perioperative pathway aimed at reducing delirium, time to surgery, length of stay, and mortality among elderly patients with acute hip fractures. Although individual components of hip fracture pathways have been studied, the components together have not. We designed a pathway to specifically address common medical conditions in elderly patients who experience hip fractures.
Methods: A novel pathway incorporating regional anesthesia, multimodal analgesia, preoperative anemia correction, and guideline-based cardiac evaluation to expedite time to surgery was implemented at a tertiary care academic center. Data from two 18-month periods before and after implementation were compared . A pre-post design was used for this quality improvement study to examine the effects of nerve block utilization on the rates of delirium and carbohydrate drink administration on acute kidney injury , Results were tracked using statistical process control (SPC) charts to assess for special cause variation.
Results: A total of 372 patients met inclusion criteria (183 pre- and 189 post-pathway). Implementation led to significant reductions in cardiology consultation time, length of stay, intra- and postoperative blood transfusions, and time to surgery among delayed cases. There was increased use of nerve blocks and preoperative carbohydrate drinks, with no change in delirium rates or 30-day readmissions. Statistical process control methods were used to detect special cause variation after implementation of selected interventions. There was a significant increase of the use of nerve blocks and carbohydrate drink administration after our educational intervention and addition of these orders to a specific order set in our electronic medical record. We then examined the effect of implementation of nerve blocks on delirium and carbohydrate enriched drinks on acute kidney injury. Although there was an improvement in rates of delirium and acute kidney injury with our interventions, special cause variation was not demonstrated. Mortality remained low at 0.5%.
Conclusions: Hospitalist-led multidisciplinary care pathways can reduce hospital stay, expedite perioperative care, and improve implementation of evidence-based practices in geriatric hip fracture management.
Keywords: hip fracture; perioperative care; geriatric; multimodal analgesia; delirium; anemia; hospitalist pathway

Introduction

Geriatric hip fractures represent a significant clinical challenge due to the high risk of perioperative complications and poor postoperative outcomes.
Hip fractures remain one of the most common causes for urgent surgery in the elderly [1,2]. The burden of care for acute hip fracture persists beyond the perioperative period as many patients are discharged to long-term care facilities [2,3]. Despite advancements in early surgical intervention and perioperative management, morbidity and mortality remain substantial in this population. Delirium can occur in up to 60% of patients and is associated with significant morbidity and mortality, including inability to return to community life [4,5,6].
Numerous studies have examined individual components of perioperative care, including the type of anesthesia [7,8], co-management on a geriatrics or hospitalist service [9], [10-12], use of peripheral nerve blocks [13], and appropriateness of preoperative testing [14]. However, there is a paucity of evidence on the effect of combining these components in a real-world pathway. There a number of pathways focusing on overall operations and process maps with care coordination but few studies have implemented specific measures to address medical complications unique to the geriatric hip fracture population [15]
Delirium is frequently exacerbated by opioid use and is a common complication that prolongs

hospitalization. There is evidence supporting regional anesthesia and multimodal analgesia in reducing postoperative pain and delirium. A meta-analysis found that peripheral nerve blocks were associated with lower rates of delirium in patients without baseline cognitive dysfunction [16]. Multimodal analgesia, regional anesthesia, enhanced recovery pathways including use of oral rehydration, and delirium precautions are paramount in optimizing outcomes [17].

Unnecessary preoperative cardiac testing can delay surgical repair. Operative repair of hip fractures within 24 to 48 hours of admission is recommended for improved outcomes [17]. Expedited medical evaluation prior to surgery may reduce delirium [18]. Excessive testing leads to surgical delays, which increase morbidity and mortality without demonstrable benefits [19]. Appropriately applying cardiac testing guidelines can help minimize costs.

Anemia is a common comorbidity found preoperatively due to frailty that worsens in the postoperative period. Anemia and acute kidney injury (AKI) are significant complications in patients with hip fractures, often occurring together and independently increasing morbidity and mortality. Anemia, frequently present at the time of injury due to blood loss from the fracture, can be exacerbated by surgery and blood transfusions. AKI, a sudden decrease in kidney function, is common after hip fracture surgery and is associated with prolonged hospital stays, increased mortality, and higher healthcare costs. [20-25]

Our objective is to assess the effectiveness of a hip fracture pathway on several important outcomes. Educational initiatives aimed at the hospitalist group began in 2018 and focused on appropriate cardiac testing and consultation according to ACC/AHA guidelines, use of regional nerve blocks, and opioid-sparing pain management in the elderly to avoid delirium [26]. In efforts to address a patient population with increasing comorbidities after an increased number of intrahospital transfers, starting in July 2021, we describe efforts to address specific medical complications in the hip fracture population using a pathway aimed at addressing common comorbidities in geriatric hip fracture patients. Collaboration with the cardiology department to reduce waiting times for consultation also occurred at the same time.

The objective was to improve the care of our hip fracture patients by targeting the individual contributors to morbidity and mortality.

Methods

Setting

This pathway was implemented at Thomas Jefferson University Hospital, which is a tertiary care academic medical center in Philadelphia, PA. It serves a diverse population of insured and uninsured patients and is the main hub and referral center in a regional enterprise health system consisting of 18 hospitals.

Hip Fracture Pathway Components

We implemented a novel multidisciplinary preoperative pathway in 2018 to provide comprehensive hip fracture care to reduce delirium and length of stay while also expediting surgery within 24 hours. The institutional review board of Thomas Jefferson University approved this study on 12/2021 (Control ##21E.1180) with waiver of requirement for patient consent. The electronic medical record (EMR; Epic; Verona, WI) was queried for records of patients with a diagnosis of acute hip fracture on admission using ICD-10 codes and ICD-10 Procedure Codes during two time periods: from 1 July 2021 to 31 Dec 2022 and 1 Jan 2023 to 1 Jul 2024 An acute hip fracture was defined by the presence of one of the following fracture types: intertrochanteric, subtrochanteric, or femoral neck. Additional inclusion criteria included having been admitted to the hospital medicine service and having undergone surgical fixation for the fracture during hospitalization. Patients with a pathologic fracture, injury occurring greater than 2 weeks before presentation, or previous arthroplasty or surgical fixation of the fractured hip were excluded. Acute kidney injury was identified according to

ICD-10 codes.

PERIOD 1 of PATHWAY:
The initial phase focused on an educational initiative for the hospitalists on appropriate cardiology consultation and evidence-based use of cardiac testing . The goal was to expedite the time to surgery and reduce the number of unnecessary cardiac tests
The intervention was initiated on July 1 2018 and consisted of a series of meetings by a multidisciplinary group consisting of hospitalists, anesthesiologists, and cardiologists, during which institutional guidelines for appropriate cardiology consultation and cardiac testing were developed. The guidelines emphasized the need for prompt surgical intervention and reserving testing (stress testing and transthoracic echocardiography)only for cardiac conditions that increase the risk for intraoperative death or are potentially modifiable prior to surgery. The guidelines were developed in accordance with the American College of Cardiology/American Heart Association and Canadian Cardiovascular Society recommendations [26]. Cardiologists aimed to complete consults within 12 hours of notification. Prior to the initiative, a review of internal data revealed a high rate of unnecessary cardiac tests as well as a high rate of delirium. A hospitalist disseminated the changes to the other faculty members through a one-hour lecture.
Another part of the educational initiative focused on reduction in delirium. . This also included an initiative to educate hospitalists on the use of regional anesthesia and multimodal analgesia combined with opioid reduction education reduced opioid use and delirium. During the first time period, there was a one-hour lecture on cardiology and a one-hour lecture on pain management. All pre- and postoperative orders were built into an order set in the EMR specifically designed for hip fracture patients.

Delirium management/pain management
Options for multimodal analgesia and recommended opioid doses were added to an electronic order set. This included pre-populated options for acetaminophen, celecoxib, ibuprofen, ketorolac, and tramadol. In addition, the order set included an acute pain service consultation and request for placement of a femoral nerve block (continuous catheter or single shot) by the anesthesiology team within 2 hours of notification. For patients who received a continuous catheter, the catheter was typically removed on postoperative day 2. The pathway included an opioid-minimizing strategy with regional anesthesia, multimodal non-opioid analgesics, reduced standard opioid doses, switching from morphine to hydromorphone as the default opioid, and a femoral nerve block performed within 2 hours of admission. Standard dosing for opioids was also added to the pathway and order set and included oral oxycodone 2.5 to 5 mg every 4 to 6 hours as needed for moderate pain, intravenous hydromorphone 0.25 mg every 2 hours as needed for severe pain. Prior to the intervention the opioid administration was at the discretion of individual hospitalists. Further efforts to reduce delirium included nursing and provider education on patient ambulation and removal of urinary catheters were attempted on postoperative day 1 before and after the intervention. A dedicated physical therapy pathway was built for hip fracture patients.

Secondary outcomes included length of stay, readmissions, time to operative repair and the first physical therapy (PT) session, and the proportion of patients discharged to home.

PERIOD 2 of PATHWAY

Medical Complications
In efforts to address a patient population with increasing comorbidities due to increased number of intrahospital transfers, starting on July 1 2023, we describe efforts to address specific medical

complications in the hip fracture population using a pathway aimed at each of these issues. We focused on blood utilization, increased availability of nerve block with placement of nerve block within 2 hours of admission and after hours availability, expansion of an enterprise-wide order set, and robust hospitalist education and cardiology collaboration. Our educational initiatives included an expanded series of lectures by cardiology (two additional lectures) on appropriate use criteria according to ACC/AHA guidelines for cardiovascular testing, education on evidence-based management of pain in the elderly. During the second time period there were two additional cardiology lectures, one hour each, on evidence-based application of the AHA/ACC guidelines [26]. To reduce delirium there was an additional lecture on multimodal analgesia, increased availability of nerve blocks with all call-taking anesthesiologists agreeing to perform nerve blocks in the emergency department, removed gabapentinoids and tramadol from order sets, and changed the default opioid from morphine to hydromorphone. We also expanded the use of carbohydrate clear drinks with a partnership with the clinical nutrition team to reduce the discomfort of thirst and hunger, alleviate postoperative nausea and vomiting, and avoid the depletion of glycogen stores to help reduce hypoglycemia-related morbidity and thus help reduce delirium in the perioperative period [28].

Starting in 2023 we focused on blood utilization education and the addition of iron and epoeitin alpha. Robust education was provided to define transfusion thresholds in conjunction with orthopedic surgery and AABM guidelines [27]. During this time our orthopedic surgery team began to expedite operative repair to a target of less than 24 hours for those on a direct oral anticoagulant (DOAC) without a change in baseline renal function. Expediting operative repair for those on a DOAC was performed to reduce morbidity.

For patients with preoperative anemia, the use of intravenous iron and epoetin alpha was used in select patients with a hgb < 12 g/dL and without complications of recent thrombotic event or hypertension, and teams were educated on appropriate perioperative transfusion goals according to AABM guidelines [27]. In patients with a hemoglobin below 12 g/dL with laboratory evidence of iron deficiency anemia, a dose of 300 mg intravenous iron sucrose and a dose of 40,0000 erythropoetin were given unless contraindicated with 1000 mcg daily of oral B12 and oral folic acid 1 mg daily supplementation. During this time our orthopedic surgery team expedited operative repair within 24 hours for those on a DOAC without a change in baseline renal function.

Further efforts to reduce delirium included an expanded the use of carbohydrate clear drinks with a partnership with the clinical nutrition team to make them available to patients on all units and to include them as part of the EMR as part of an enhanced recovery pathway. All hip fracture patients had a nutrition consult to ensure an timely assessment within 24 hours of admission and consumption of the carbohydrate drinks was recorded. Nursing leadership was educated on timely administration of the carbohydrate drinks in the immediate preoperative period. For all fracture patients, within the EMR a list of those ordered the drinks was generated where preoperative carbohydrate drinks were provided until 2 hours before surgery.

A dedicated physical therapy (PT) team for patients with improved staffing to focus attention on those not on orthopedics floor was initiated in 2023 after the end of the pandemic to expand PT services.

To bridge patients to outpatient bisphosphonate for fracture prevention, baseline laboratory values for osteoporosis were drawn on admission including vit D levels, intact parathyroid hormone levels, calcium and phosphorous levels. All patients were prescribed calcium and vitamin D unless

contraindicated (400 IU vitamin D daily and 1000 mg calcium carbonate daily), and patients were provided outpatient follow up.

Collaborators in this pathway included cardiologists, anesthesiologists, orthopedic surgeons, hematologists, endocrinologists, vascular medicine physicians, physical therapists, dieticians, and emergency medicine physicians (Figure 1).

We evaluated the impact of the interventions by comparing the data from pre- and post-implementation time periods.

Data Collection and Analysis

The institutional review board of Thomas Jefferson University approved this study in December 2021 (IRB protocol #21E.1180) with waiver of requirement for patient consent. The electronic medical record (EMR; Epic; Verona, WI) was queried for records of patients with a diagnosis of acute hip fracture on admission using ICD-10 codes and ICD-10 Procedure Codes during two 18-month time periods: period 1 from July 1 2021- December 31, 2022 and period 2 from January 1, 2023 - July 1, 2024. An acute hip fracture was defined by the presence of one of the following fracture types: intertrochanteric, subtrochanteric, or femoral neck. Additional inclusion criteria included having been admitted to the hospital medicine service and having undergone surgical fixation for the fracture during hospitalization. Patients with a pathologic fracture, injury occurring greater than 2 weeks before presentation, or previous arthroplasty or surgical fixation of the fractured hip were excluded. Delirium was identified through ICD-10 codes.

Data collection was performed through EPIC Chart extraction. To analyze the data, we used the PROC FREQ procedure for each variable in SAS. We used parametric and nonparametric distributions applying the Quantile-Quantile (QQ) plots and the Shapiro-Wilk test to determine normality . For continuous variables we used the Kruskal–Wallis test and for categorical variables we used the Chi-squared, Mantel-Haenszel, and Fisher tests . Normally distributed continuous data were presented as means with standard deviation (SD) while non-normally distributed and categorical data were presented as means with the 95% confidence interval (CI). All analyses were performed using the SAS system (SAS Institute Inc., Cary, North Carolina). A p value of <0.05 defined statistical significance. We used the Vizient Clinical Data Base to compare our hip fracture outcomes with similar academic institutions[29].3).

Reduction in delirium is one of the main complications our pathway aimed to impact. Given the two key improvements in the pathway were the increase in nerve blocks and increase in carbohydrate drinks, we created statistical process control (SPC) graphs to try to determine if special cause variation occurred. In addition, our electronic medical record (EMR) was able to directly capture these variables and did not rely on provider coding and documentation. The SPC graph has time on the X-axis (July 2021 to July 2014, sequentially) and the data on the Y-axis. Along with the data points the average (green line, “CEN”, for central) is plotted along with the UCL (upper control limit) and LCL (lower control limit). These control limits show the boundaries that are three standard deviations above and below the average and measure the overall variability [30]. Note that for normal distribution and avoiding Type I Error statistical error we used ±3SD for the control limits. This has false positive probability of only 6.5% . When a single point or multiple points fall outside the control lines, this implies statistically significant improvement (special causal variation) [30].

Results

There was a total of 183 patients in the first time period and 189 patients in the second time period. The average age in both time periods was 77 years, there were more female than male patients in each time period (Table 1). There was a significant increase in the number of patients transferred from outside hospitals from 15% to 19% (N=28, 95% CI 14.1, 16.3 and N=37, 95%CI 17.8, 20.2, p <.001).

Cardiology consultation

After introduction of the pathway, there was a significant increase in the number of patients with cardiology consultation, from 35.1% (N=65, 95% CI 29.4, 40.2) to 39.4% (N=74, 95% CI 34.9,46.7, P <.0001). There was a significant decrease in the average time from ER arrival to cardiology consultation, 27.8 hours to 17.6 hours, (95% CI 14.4, 41,2) and 95% CI 11.5, 29.3, respectively) P < .0001.

Delirium measure reduction, acute kidney injury, and enhanced recovery pathway

There was a significant increase in the number of patients who received preoperative nerve blocks during the first time period from 42% (N=80/183, 95% CI 35.2, 49.4) to 62% (N=114/189, 95% CI 55.1, 69.5), P < .0001 in the second time period.

With the addition of carbohydrate drinks to the inpatient EMR order set and expansion of availability throughout the hospital significant increase in the number of patients consuming carbohydrate drinks. There was an increase from the first time period of 56.3% (N =104, 95% CI 50.6, 60.9) to 63.8% (N =120, 95% CI 56.5, 69.2), P < .0001. However, the proportion of patients with delirium did not change 14.3% (N=26, 95% CI 11.2, 18.7) in period 1 to 13.1% (N = 24, 95% CI 10.6, 18.3) in period 2, P = 0.63) (Figure 2). there was a significant reduction in number of patients who had acute kidney injury from 7.2% (N=11) 95% CI 3.4%, 11.2%) and 4.4% (N=6) 95% CI 1.2%, 8.1%).

Time to surgery and first postoperative physical therapy session

The proportion of patients who underwent surgery in less than 24 hours was 58% (N =99), 95% CI 4.9,15.9) in period 1 and 53% (n=93, 95% CI 6.5,15.1) in period 2 (P = 0.07). We then examined outliers who did not have operative repair within 24 hours. There was a significant reduction in the mean time to operative repair, from 45.7 h (95% CI 40.8, 54.2) to 42.9 h (95% CI 37.3, 45.4), P < .0001.

Postoperatively, the number of patients who had physical therapy within 24 hours, increased from 60.8% (N=121, 95% CI 117, 126) to 73.7% (N=129, 95% CI 124, 135) (P < .0004).

Length of stay, discharge disposition, and readmissions

There was a significant decrease in LOS from a mean of 8.1 (±5.7SD) days to 7.2 (±4.9 SD) days, between the two study periods (P<.0001). Our data demonstrate a lower length of stay compared to Vizient data of comparative institutions with a mean LOS of 8 days (42).

There was an increase in the number of patients who were discharged home, 13/183 (6%) (CI 9, 17) vs 18/189 (9%) (CI 13, 23), P < .0001) The number of 30-day readmissions remains the same, 8% in

period 1 (N =16, 95% CI 6.2, 11.3,) and 7% (N=12, 95% CI 5.3, 9.8) , P = 0.277.

Mortality

One patient died during each time period. According to Vizient data (42), our mortality rate of 0.5% in each time period is lower than other comparative institutions over this time period with observed mortality rates of 1.7-1.9%. During the entire study period, we had a higher case mix index (CMI) of 2.7-2.8, compared to other institutions or other academic medical centers during the study period with an average CMI of 2.5-2.6

Anemia and blood utilization

We included iron and erythropoietin as perioperative interventions designed to treat preoperative anemia and reduce postoperative blood transfusion. There were low numbers of patients prescribed iron (2%, N = 3) and erythropoietin (2%, N =3) during the first time period, this increased to 6% of patients prescribed iron (N = 14) and 7% of patients prescribed erythropoietin (N = 11) during the second time period, ($p < .001$). There was a significant reduction in number of units of blood transfused during both the intraoperative period, mean (23 units ±16 SD versus 19 units ± 14 SD, $p<0.0001$) and during the hospital stay, mean (56 units ±32 SD versus 51 units ±29 SD, $p<0.0001$).

We applied the dynamic anatomy of the statistical process control (SPC) to better understand the improvement of the pathway. Figures 2a and 3a below depict the SPC assessment on selected variables, delirium and acute kidney injury. We hypothesized that the increased use of nerve blocks would reduce the incidence of delirium over time and higher utilization of carbohydrate rich drinks would reduce the incidence of delirium. These graphs can lead to increased confidence as to whether the pathway results in quality improvement (QI). Each SPC graph has time on the X-axis (July 2021 to July 2024, sequentially) and the data (% or numbers) on the Y-axis. Along with the data points the average (green line, “CEN”, for central) is plotted along with the UCL (upper control limit) and LCL (lower control limit). The control lines/limits show the boundaries that are three standard deviations (SD)above and below the mean and measure the overall variability. Note that for normal distribution and avoiding Type I Error statistical error we used ±3SD for the control limits. This has false positive probability of only 6.5% . When a single point or multiple points fall outside the control lines, this implies statistically significant improvement.

The carbohydrate drinks graph (Figure 3b) shows that there is one point that touches the UCL line. In November 2023 and fifteen points above the average (April 2023-June 2024) while there is a shift of fifteen points below the average in the earlier period (July 2021-December 2022). These indicates that there is statistical difference in performance between these two periods of the implementation of the pathway (less than 5% possibility that this occurs by chance alone) . The nerve block graph (Figure 2a) exhibits similar characteristics on improvements. There is a single point that is above the UCL line (March 2024), fifteen points above average and twenty points shift below the average for the entire period (less than 5% possibility that this occurs by chance alone). The graph for delirium shows the number of points above and below the mean is almost similar and no point is above the UCL line or below the LCL line. This depicts common cause variation and interventions on the pathway did not significantly reduce delirium. There are similar results for acute kidney injury with no point above the UCL or below the LCL lines but most of the points in the second period, from January 2023 to July 2024, are below the average as compared with the first period. In sum, the SPC dynamic analysis can be used as a guide in evaluating the improvement work, reinforce the confidence in the implementation of the pathway by highlighting the inflection points that show the intervention was more than the common cause variation.

Conclusions

The focus of this retrospective analysis was on hospitalist education, the application of regional anesthesia, and evidence-based use of preoperative cardiac testing and cardiology consultation.
This study evaluates a hospitalist-led multidisciplinary care pathway designed to optimize perioperative management, reduce length of stay, and minimize complications

Our hospitalist-led multidisciplinary pathway demonstrated improvements in several key areas of hip fracture care and led to a reduced length of stay and increase in peripheral nerve block use, with sustained low rates of delirium and mortality despite a high CMI.

We also showed a significant reduction in time to cardiology consultation for preoperative cardiac evaluation after the implementation of hospitalist-focused education and collaboration with specialists. Although the number of patients with a cardiology consultation increased during the two time periods, this may reflect the overall comorbidities in our population with increasing numbers of outside hospital transfers. Notably the important results from our study demonstrate a reduction in cardiology consultation time to help expedite operative repair in 24 hours.

We also show a significant increase in the number of patients who consumed carbohydrate drinks and received nerve blocks after our educational intervention and addition of these orders to our electronic medical record this was a sustained increase with time. During this time period there was a lower rate of acute kidney injury reduction in delirium. Although . Although our numbers were low, with future data analysis over a longer period of time, time and with increased number of patients using the carbohydrate rich drinks this may help reduce incidence of both delirium and AKI. There is a strong association in the literature with delirium and AKI [31-35]. AKI precipitates delirium due to impaired renal clearance of drugs and toxic metabolic waste products. A potential explanation for the direct neurotoxic effect of AKI is from the accumulation of potential uremic neurotoxins [33].

Preoperative carbohydrate consumption to shorten the duration of fasting and fluid restriction, alleviate preoperative and postoperative discomfort, improve perioperative stress responses, thus reducing glycogen depletion and maintaining blood glucose levels [35, 37,38,]. This is thought to attenuate the stress response in the perioperative period and reduce the inflammatory state associated with delirium seen in small studies [36-38]. However more research, including larger, multi-center trials with a broader range of patients, is needed to further confirm the benefits.

Although there is currently no conclusive evidence demonstrating carbohydrate clears have a direct role in preventing or mitigating postoperative AKI, carbohydrate loading may offer indirect benefits through mechanisms like reducing insulin resistance, the postoperative inflammatory state, and improving overall patient recovery, which could potentially contribute to better kidney outcomes. More research is necessary to fully understand the specific mechanisms and direct impact of carbohydrate loading on postoperative AKI. Our SPC data analysis did show a trend towards a reduction in AKI and a longer term study with more patients may demonstrate if there is a significant impact.

In the literature, there are multiple high-quality systematic reviews and meta-analyses which demonstrate that peripheral nerve blocks significantly reduce pain and opioid use and are associated with a lower incidence of postoperative delirium in elderly patients with hip fractures, especially in those without pre-existing cognitive impairment [13, 16].
Ultrasound-guided nerve blocks significantly reduced pain measured 2 hours after injection,

decreased preoperative intravenous morphine equivalents (–5.34 mg [95% CI, –8.11 to –2.58]; P = .003), and decreased delirium (risk ratio [RR], 0.6 [95% CI, 0.38 to 0.94]; P = .03) [39] Our SPC charts demonstrated a significant increase in the use of nerve blocks with time and a trend toward lower rates of delirium.
Our SPC dynamic analysis was used as a guide to evaluate the improvement work with our key interventions and reinforce the confidence in the implementation of the pathway. There was a sustained increase in nerve blocks and use of carbohydrate drinks with time. There was also a decrease in AKI and delirium. Further studies are needed to evaluate a causal relationship but our results demonstrate adherence to the pathway and early data suggesting a possible improvement in outcomes. Future total sample size increases might be able to further detect statistical evidence of a sustained and significant shift in process of the pathway implementation.

There was a significant increase in the number of patients who had physical therapy within 24 hours of operative repair. Despite improvements in time to earlier physical therapy there were low numbers of patients discharged to home during both time periods, which may reflect the overall medical complexity of our patient population. The proportion of patients presenting for operative repair in 24 hours is similar to the results of others [40]. Readmission rates at our institution were lower than those from some authors [41].

There was a reduction in blood utilization and an increase in use of iron and erythropoietin but numbers were too small to determine if there was truly a significant difference. Elderly patients with hip fractures often receive allogeneic blood transfusions during the perioperative period [42]Studies have shown that 39–70% of elderly patients undergoing hip fracture surgery receive postoperative blood transfusion [43, 44, 45].The proportion of patients who received a blood transfusion significantly decreased with time from 31% to 27% . More data is needed to see the impact over time.

Our results suggest that implementation of multispecialty care coordination could potentially improve care and reduce unnecessary testing in geriatric fracture patients. There are a number of prior studies on co-management models of hip fracture care and most have featured geriatricians or hospitalists as consultants rather than the primary service, making our pathway unique. Future studies should examine long-term results of hospitalist-led hip fracture care pathways.

Some limitations of our study include the fact that this is a single center institution and comorbid conditions such as delirium and AKI were abstracted via ICD-10 code and relied on provider reporting rather than individual chart review. Strengths of our study include that education on initiatives cs such as carbohydrate rich drinks and nerve blocks and cardiology evaluation lead to sustained provider use of these measures. This intervention is easy to implement with buy-in from multiple specialties to help coordinate care in a frail population with a demonstrated trend toward improvement in outcomes, and an overall low mortality. Education initiatives for hospitalists with engagement and education of subspecialists can help improve metrics such as expediting operative repair and subspecialty consultation, reduce blood transfusion rates and delirium, and improve time to ambulation

Figure 1

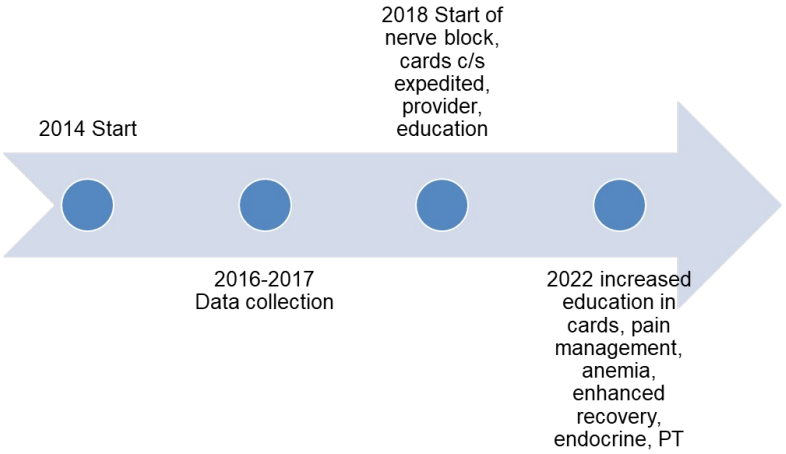


Table 1: Demographic and Results from Period 1 (7/2021-12/2022) compared to Period 2 (1/2023-7/2024)

		7/2021-12/2022	1/2023-7/2024		
Demographics	Volume (total)	183	189		
	Male (#)	57	62		
	Female (#)	126	127		
	Age (average)	77yrs	77yrs		
		7/2021-12/2022	1/2023-7/2024	Chi Square	P Value
OSH Transfer	OSH Transfers (% of Total)	15%	19%	64.1	<.0001
LOS (Avg days)	LOS (Average # of days)	8.1	7.4	20.3	<.0001
ED to Admission	Average Time from ED Arrival to Admission Order (in hours)	7.43	6.78	0.34	0.560
	Number Meeting the goal (less than 2 hours)	19	22	7.05	0.008
Cardiology	% of total patients with cardiology consult	35.1%	39.4%	138.0	<.0001
	Average time from ED arrival to cards consult completion	27.8 hours	17.6 hours	5.4	0.001
IP Admit to OR	% meeting the goal (Less than 24 hours)	58.2%	56.0%	191.0	<.0001
Time to First PT Session	% meeting the goal (Less than 24 hours)	60.8%	73.7%	3.4	0.049
Nerve block	% of patients who received a nerve block	42%	62%	182.0	0.001
Pre-Op Drink	% of patients who received a pre-carbohydate drink	56.3%	63.8%	68.6	<.0001
Discharge to Home	% of patients discharged to home	6%	9%	11.1	0.004
Delirium	% with Delirium	14.3%	13.1%	49.1	<.0001
Readmissions	% 30- Day Readmission	8%	7%	1.17	0.277
Blood Utilization	% Iron	2%	7%	6.8	<.0001
	% Epogen	2%	6%	2.6	<.0001
	RBC Transfused in OR (#)	23	19	262.0	<.0001
	RBC Transfused During Encounter (excluding OR, #)	56	51	329.0	<.0001
AKI	% with AKI	7.2%	4.3%	5.1	<.0001

Figure 2a. Number of patients with Delirium Per Month, SPC graph

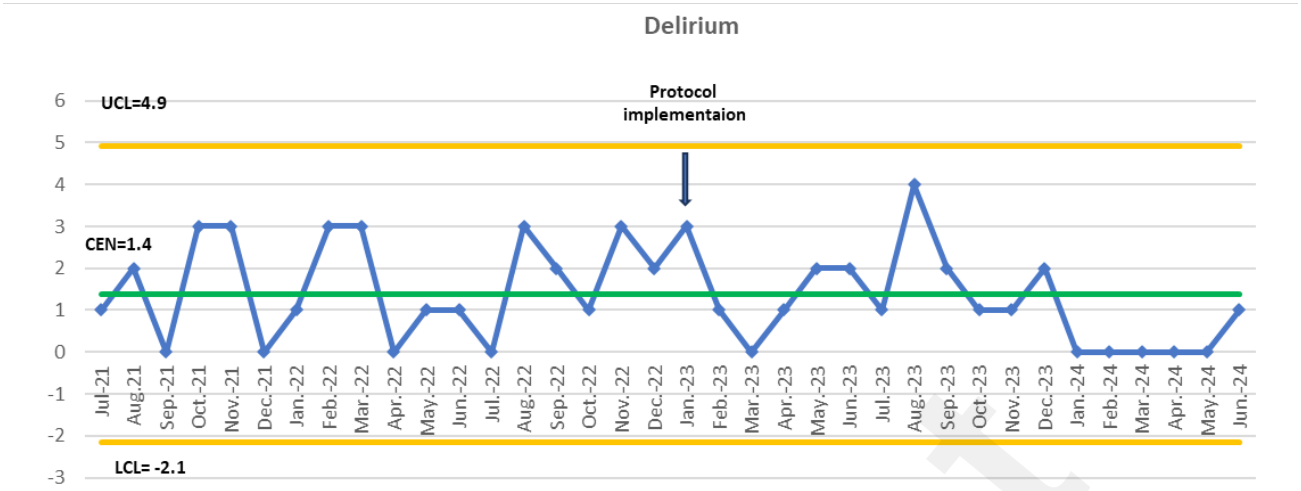


Figure 2b. Number of patients with Nerve Blocks per Month, SPC graph

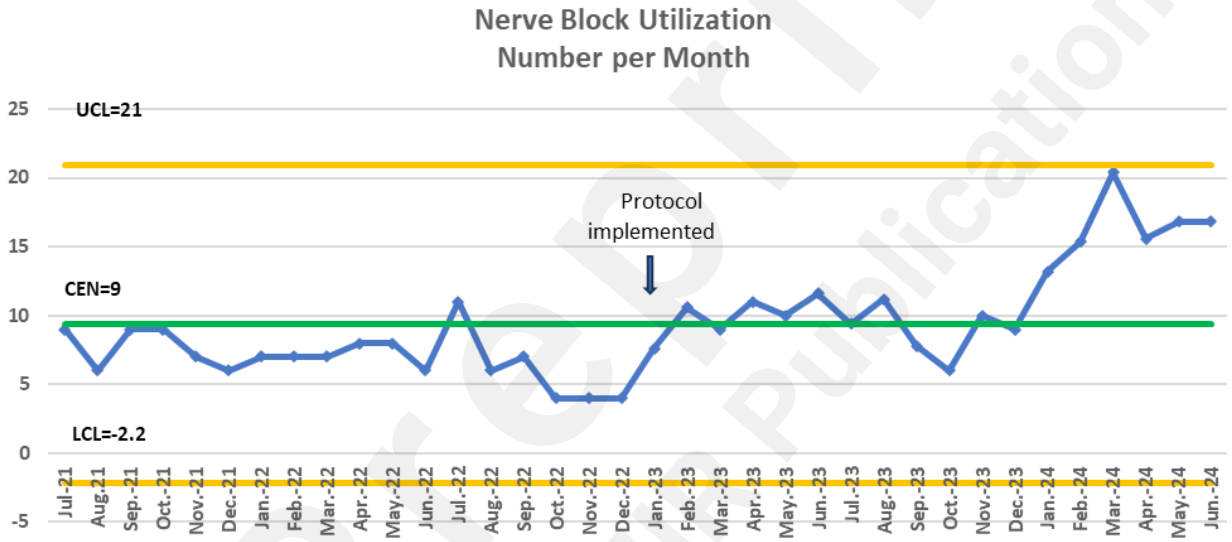


Figure 3a. Number of patients with Acute Kidney Injury per Month, SPC graph

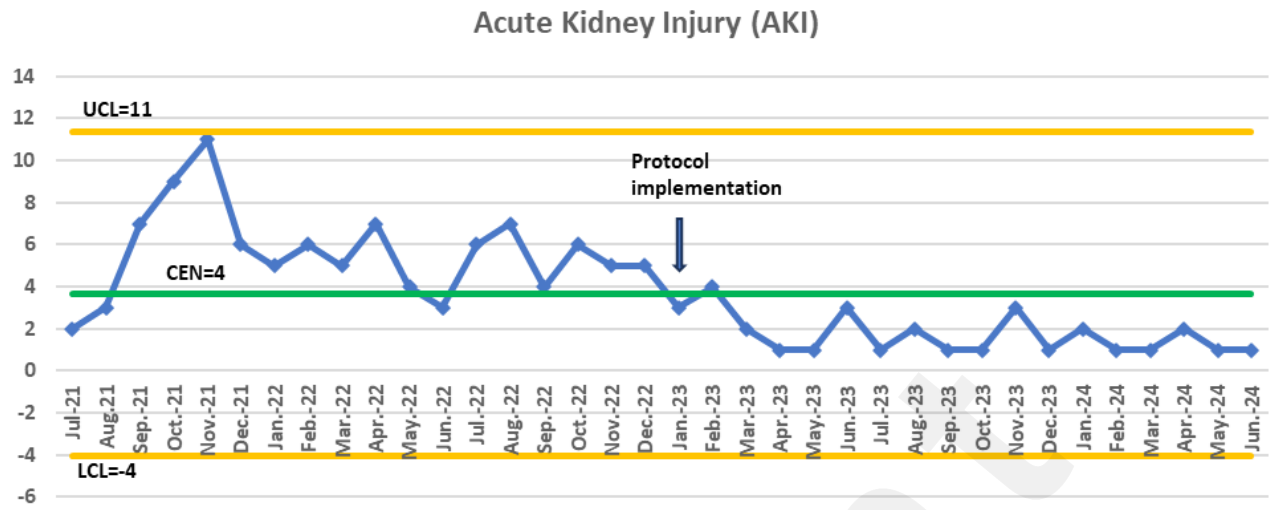
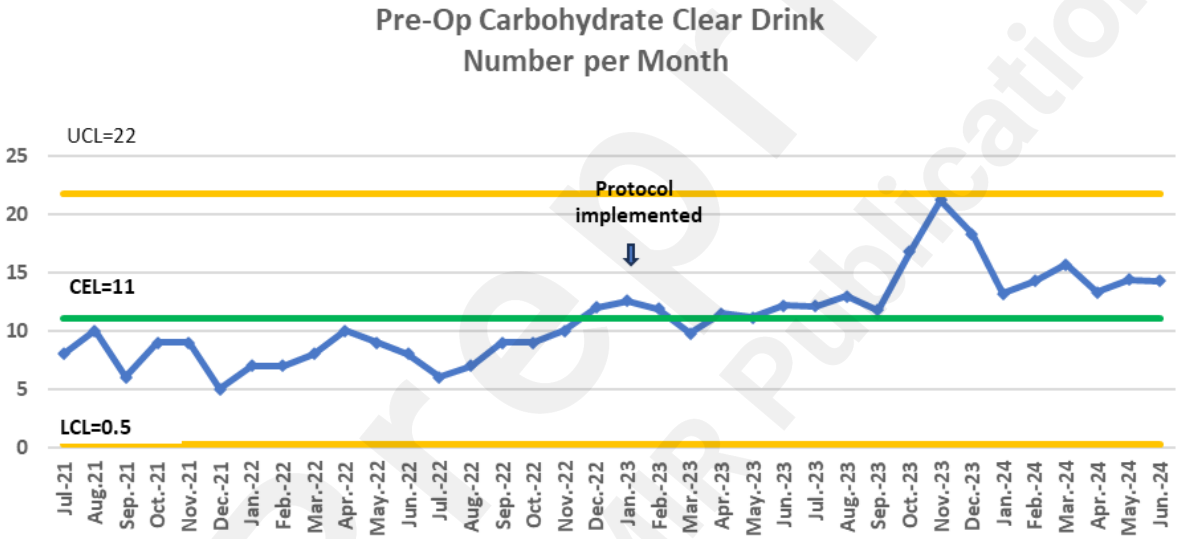


Figure 3b. Number of patients per month who consumed preoperative carbohydrate rich clears, SPC graph



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Supplementary Files