Screening and Referral of Orthopedic Patients into Care Coordination to Decrease Readmissions

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Abstract

Background

The negative impact on patient outcomes due to unplanned hospital readmissions places a financial strain on the health care system. The Centers for Medicare and Medicaid reported 30-day readmission rates as a fair indicator of quality services. Hospitals face monetary penalties for readmission rates exceeding the national benchmark under the Affordable Care Act. Hip and knee replacements were added to the list of conditions in 2014 authorizing Centers for Medicare and Medicaid to penalize hospitals for readmissions within 30 days of discharge.

Local Problem

When comparing an urban academic hospital to other hospitals in the state of Maryland, 44 hospitals have lower readmission rates for knee and hip replacement patients. Analysis of knee and hip replacement readmissions for two hospitals in Maryland within the same system for year 2017 reported readmission findings of 21 for both knee and hip, 79 for hip only, and 91 for knee only. Both hospitals had a 12% readmission rate in 2017.

Interventions

The healthcare team identified high, intermediate, and low risk total hip or total knee revision replacement patients at discharge by using the LACE risk-screening tool. Patients were referred into care coordination. Low-risk patients received a telephone phone call prior to their first appointment post-discharge. Intermediate and high-risk patients received follow-up phone calls for 30 days post-discharge, and then received a visit by the care coordinator during their outpatient follow-up visits with the surgeon to review the plan of care. Readmissions, emergency department visits, and no-show appointment rates were tracked before and after implementation of the LACE risk screening and care coordination.

Results

Readmission rates, emergency department visits, and no-show appointments in the first quarter (July-September, 2018) were compared to the second quarter (October-December, 2018) when the LACE screening tool was implemented. Readmissions within 30 days post-discharge decreased from one to zero. The no-show appointments were zero in Q1 and five in Q2 were a P-value of 0.02. Reasons for no-show appointments included diarrhea and transportation issues. There was an increase from one to three emergency department visits with a P-value of 0.32. The reasons for the emergency department visits post-LACE included wound check, abdominal pain, and femur fracture related to the revision of hip arthroplasty surgery.

Conclusions

The LACE Index scoring found to be helpful in this orthopedic care coordination program for identifying patients at low, intermediate, and high-risk for readmission within thirty days post-discharge. Introducing care coordination appeared to enhance post-discharge support and improve hand-offs between the inpatient and outpatient setting of healthcare.

Background and Significance of the Problem

The negative impact on patient outcomes due to unplanned hospital readmissions places a financial strain on the health care system. The estimated Medicare spending of $17.4 billion on unplanned readmissions in a year is staggering (Betancourt, Tan-McGroary, & Kenst, 2015). The Centers for Medicare and Medicaid Services (CMS) established 30-day readmission rates as a fair indicator of quality services and hospitals face monetary penalties for readmission rates that exceed the national benchmark under the Affordable Care Act (Bernatz, Tueting, Hetzel, & Anderson, 2016). Hip and knee replacements were added to the list of conditions in 2014, authorizing CMS to penalize hospitals for readmissions within 30 days of discharge (Bernatz et al., 2016). CMS requested that hospitals focus on total hip replacement as an area of quality improvement and cost savings due to the ever-increasing rise in the number performed in the U.S. (Gandhi, 2017).

By 2030, estimates of more than 3,000,000 total knee replacements and 500,000 total hip replacements will be performed annually in the United States (Zmistowski, et al., 2013). The national rate of readmissions within 30-days was 4.4% for patients receiving a hip or knee replacement (U.S. Centers for Medicare & Medicaid, 2013). Compared to other hospitals in Maryland, this urban academic hospital had higher readmission rates than did 44 hospitals for knee and hip replacement patients (U.S. Centers for Medicare & Medicaid, 2013). Analysis of knee and hip replacement readmissions for two hospitals in Maryland within the same system for year 2017 reported these readmission findings: 21 readmissions for patients with both knee and hip replacements, 79 for hip only, and 91 for knee only (CRISP, 2017). Both hospitals had a 12% readmission rate in 2017. This is significantly higher than the national average of 4.4%.

The most common cause of readmission for total joint replacement was reported to be surgical site infection (Bernatz et al., 2016; Bond et al., 2014; Boraiah et al., 2015). Surgical site

infections occurred up to a rate of 2.52 infections per 100 cases in hip replacement and 2.26 infections per 100 cases in knee replacement (Miletic, Taylor, Martin, Vaidya, & Kaye, 2014). Modifiable risk factors that affect poor patient outcomes after total joint replacement included morbid obesity, uncontrolled diabetes, nutritional deficiencies, staphylococcus aureus colonization, tobacco use, venous thromboembolic disease, cardiovascular disease, neurocognitive, psychological, and behavioral problems, physical deconditioning, and fall risk (Yu, Garvin, Healy, Pellegrini, & Iorio, 2016). Readmission often raises the patient's risk of adverse health outcomes. Patients readmitted are more at risk for mortality, admission into another healthcare institution, or deterioration of physical functioning within 6 months post-discharge (Preyde & Brassard, 2011). Other contributing factors increasing the likelihood of readmissions include inadequate post-discharge support and insufficient follow-up, medication-related issues and failed handoffs (Alper, O'Malley & Greenwald, 2015). These circumstances resulted in diminishing patient satisfaction while the cost of medical resources continue to spiral upward.

Transitional care, also known as care coordination and care management, can drive down medical costs and improve quality of care for patients with complex health care needs (Goodell, Bodenheimer, & Berry-Millett, 2009). Transitional care operating as a multidisciplinary approach ensures a patient is receiving proper education along with resources and follow-up care post-discharge, which avoids readmission to the hospital. Scoring tools, such as the LACE index can be used by the healthcare team to identify high, intermediate, and low risk patients for readmission (Alper, O'Malley & Greenwald, 2015), and refer them to transitional care coordination for closer monitoring.

A team of Canadian researchers developed the LACE index, a validated risk-assessment tool measuring four factors to predict unplanned readmissions within thirty days of discharge (van Walraven et al., 2010). These factors, from which the acronym LACE index was derived, include length of stay (L), acuity of admission (A), patient co-morbidity (C), and number of visits to the emergency department in the last six months (E). The researchers endorsed this tool due to extensive testing over one million randomly selected medical and surgical patients after their discharge. They also found the results to be discriminative (c statistic= 0.684) and accurate (Hosmer-Lemeshow goodness of fit statistic of 14.1, $p = 0.59$).

The purpose of this quality improvement project was to implement the LACE index for patients undergoing a revision of a total hip or knee replacement in an urban academic hospital in the Mid-Atlantic region. The short-term goal was to identify patients at discharge for high, intermediate, and low risk for readmission and refer those patients into care coordination. Other short-term goals included reducing readmission rates, no-show appointments, and emergency department visits. The anticipated long-term goals of the project were lowering healthcare costs.

Theoretical Framework: Knowledge to Action

The knowledge to action (KTA) framework was the theoretical framework for this project. Developed from more than 30+ planned action theories promoting the application of research, the two main cycles in this circular framework are knowledge creation and action, which closes the knowledge-to-practice gap and make practice changes (Straus, Tetroe & Graham, 2013).

Analysis and research of the topic were best evidence to implement this project were of the knowledge create cycle. To fully understand the scope of readmission problems in the orthopedic population, the project director performed literature searches, examined and critiqued

the research. In addition, barriers and facilitators of implementation were assessed. The action cycle followed with the project's implementation in the urban academic healthcare center. This entailed screening orthopedic patients and submitting referrals for care coordination. In the final stages of the knowledge to action cycle, the project director assessed outcomes and identified practices to sustain these changes. The true intent of the knowledge to action framework was creating a positive practice change.

Literature Review

The evidence points to use of a patient risk stratification plan to avoid the high probability of hospital readmission after discharge. This review will focus on the evidence supporting use of the LACE index to identify patients at high risk for readmission or death. It will also discuss the LACE index score that has been most predicative. Appendix A is a summary of the findings and level of evidence from studies included in this review.

The effectiveness of use of the LACE index to identify patients for low and high rates of readmission is chronicled in multiple studies. Spiva, Hand, VanBrackle, and McWay (2015) used the LACE index in a U.S. hospital to identify patients at high-risk for readmission. Patients with several co-morbidities, recent emergency room visits, high acuity levels, and increased length of stay in the hospital contributed to a higher LACE index score. Although Spiva et al. (2015) reported the LACE index was predictive of readmission, they found cofounding variables that may influence the score, such as hospital system inefficiency, early discharge, uninsured status, untreated diseases, and admissions to unidentified outside hospitals may also influence readmission rates. Yazdan-Ashoori, Lee, Ibrahim, and Van Spall (2016) found that a LACE index score of 10 or greater was associated with a 94% sensitivity for identifying high-risk patients for readmission.

Implementation Plan

Design, Sample, and Setting

This quality improvement project involved orthopedic patients undergoing a revision of a total hip replacement or total knee replacement in a large tertiary academic center in the Mid-Atlantic region.

Procedures

The project included training to the health care team on care coordination, LACE index, and pre-visit planning phone calls. The senior clinical nurses and charge nurses received teaching on how to score a patient with the LACE index through case studies and open discussion. This training allowed the senior clinical nurses and charge nurses to identify high, intermediate and low risk patients using the LACE index during their inpatient stay. The care coordinators received the telephone protocol for how often to contact patients.

Changes in practices included referrals of orthopedic patients into care coordination based on risk for readmission. The administrative assistant in the orthopedic department would send out a weekly email of scheduled patients coming into the hospital for a revision of a hip or knee replacement. Charge nurses and senior clinical nurses started the LACE index upon the patient's admission on the first day through chart review of the patient's history and physical and discussion with the patient at the bedside. The LACE index form was placed in the front part of the patient's chart. The LACE index score was calculated by the charge nurse or senior clinical nurse on the last day of hospitalization once the length of stay was definitive. The inpatient senior clinical nurses and charge nurses sent the lead transitional care coordinator and project director the patient's contact information and LACE index score via email, when a LACE screening was completed to ensure patients were referred into care coordination. The nurse

practitioners also adopted email hand off with patients to the transitional care coordinators to ensure proper communication from the inpatient to the outpatient setting to review anticipated needs post discharge.

Upon the patient's discharge, different activities occurred depending upon the patient's LACE risk score. Patients with a LACE risk score of 1-4 were followed by outpatient primary care nurses or a primary medical assistant with a pre-visit phone call prior to the first post-operative appointment. The primary nurses and medical assistant obtained a history of present illness, reconciled medications, offered recommendations for clinic visit, discussed any signs or symptoms of infection, ensured home health visits if ordered, answered patient questions and concerns, discussed the importance of following up with their primary care provider, and performed a risk screening for falls, safety, and depression. Intermediate risk patients with a LACE score range of 5-9 were assigned to a care coordinator with follow-up to include phone contact once a week to ensure the patient had proper resources and reinforce discharge education. Patients at high risk for readmission with a LACE score of 10 or higher were targeted for transitional care coordination. The follow-up for these high-risk patients included phone calls 2-3 times a week following discharge. The purpose of the calls was to educate, coordinate care, answer questions and reiterate the importance of making follow-up appointments.

Clinic visits took place during the follow-up appointments with the transitional care coordinators for high and intermediate risk patients to ensure the patient and family comprehended the plan of care within the 30 days post-discharge. High risk patients received a visit by the transitional care coordinator at the bedside prior to discharge to develop a rapport with the patient and family. The orthopedic surgeon, nurse practitioner, primary nurses, primary medical assistant, care coordinator, and transitional care coordinator were notified via email the

day before the patient's appointment for intermediate and high-risk LACE scores to confirm the patient's plan of care was being met.

Data Collection Plan

The LACE index was the main data collection tool for the risk of readmissions in this project (Appendix B). Permission to apply the LACE index in the project was granted by the developer and research (Appendix C). Readmission rates were collected and compiled from various organization databases by the corporate quality management department (Appendix D). Other data collection plans included auditing the primary nurses' documentation of phone calls after the orthopedic clinics to gather patient counts for no-show appointments (Appendix E). Reports were produced from the clinical informatics team to report patients who missed clinic appointments each week. Manual chart audits were completed and compared to appointments kept versus missed appointments. The emergency department visits were tracked in the first quarter (Q1) and second quarter (Q2) by a follow-up phone call by the project director after discharge. This audit was completed by the project director for every patient screened by the LACE tool and referred to the primary nurses or primary medical assistant, care coordinators, or transitional care coordinators. Readmissions were also tracked through follow-up phone calls after discharge and compared to the organization databases.

Data Analysis Plan

A data report was generated by the project director from the reports provided by the corporate quality management department and clinical informatics team, audits of the electronic medical record, and phone calls to patients. The LACE score was entered into the data report. The data was coded and entered in excel for further data analysis. The Fisher's exact was used to

test the significance of the LACE index and care coordination on readmissions, emergency department visits, and no-show appointments.

Institutional Review Board

Precautionary measures were adhered to ensure data security of all health-protected information. All patients were assigned a de-identified number to ensure confidentiality. All LACE screening tools, audits, and data collection charts were stored in a locked cabinet. The project description was submitted to the University's Institutional Review Board for a Non-Human Subjects Research determination and approved. Organizational approvals were obtained prior to implementation of the project. Additionally, the project director checked with the clinical site representative, manager, and senior leadership for any other approvals needed before implementation of the project.

Results

The sample size during implementation of LACE index included 20 patients who were referred into care coordination. However, one patient, who was excluded from the data analysis, did not require follow-up with the main orthopedic surgeon or other orthopedic providers. Another patient excluded was screened at the end of the implementation timeframe, and the data fell into the next quarter. Lastly, two patients were kept out of the data analysis since they were unreachable after multiple phone contacts Thus, only 16 patients were included in the data analysis. Six patients were low-risk for readmissions or death. Seven patients were intermediate risk for readmissions or death. Three patients were high risk for readmission or death.

The primary outcomes compared were readmission rates, number of no-shows and emergency department visits for three months before (July-September, 2018) and three months after (October-December, 2018) implementation of the LACE index (Table 1). There was one

readmission in the first quarter (Q1) and no readmissions in the second quarter (Q2) within 30 days post-discharge. The P-value for readmissions was 1.00 and not statistically significant. The one readmission that occurred in Q1 was due to the nursing facility unable to care for the patient's complex medical needs including the home ventilator at night.

The no-show appointments were zero in Q1 and five in Q2 with a P-value of 0.02. One patient missed two appointments, due to diarrhea and transportation issues. Initially, the patient omitted information to the care coordinator regarding the diarrhea issues during appointment rescheduling.

Only one patient visited the emergency department in Q1 prior to the introduction of the LACE risk screening and three patients went to the emergency department in Q2 with a P-value of 0.32. In Q1, the high-risk patient was readmitted through the emergency department due to the rehab center being unable to manage the patient's co-morbidities, including the home ventilator at night. The same patient came back to the emergency department twice on separate occasions for a gastrointestinal hemorrhage and sepsis. This patient needed another knee arthroplasty revision approximately a month and a half later after his initial knee arthroplasty revision. In Q2, one patient visited the emergency department due to a loose stitch and received a simple wound check. This patient was not readmitted into the hospital. Another emergency department visit during Q2 was due to abdominal pain and the work-up was negative. Another patient went to the emergency department due to a periprosthetic femur fracture that was related to the revision of the knee arthroplasty. This patient was readmitted and had a low-risk LACE screen during the first admissions; however, the readmission occurred 31 days post-discharge from her initial surgery. Since this occurred on day 31 of discharge, it was not counted as a readmission in this

quality improvement project. However, the emergency department visit occurred on day 30 post discharge prior to the patient's transfer back into the organization's facility.

The number of phone calls completed by the care coordinators was tracked for intermediate and high-risk patients. There were 7 intermediate risk patients during the implementation period. For week one, there was a 42% compliance on 1 phone call for intermediate risk patients. For week two, there was a 71% compliance on 1 phone call for intermediate risk patients. For week three, there was a 28% compliance on 1 phone call for intermediate risk patients. For week four, there was a 42% compliance on 1 phone for intermediate risk patients. There were 3 high risk patients during the implementation period. For week one, there was a 66% compliance on 2-3 phone calls for high- risk patients. For week two, there was 0% compliance on 2-3 phone calls for high risk patients. For week two, two out of the three patients received 1 call. For week three, there was a 33% compliance on 2-3 phone calls for high risk patients. For week four, there was a 0% compliance on 2-3 phone calls for high risk patients. On week four, two out of the three patients received one call.

Several unexpected barriers were encountered during the project. The most significant barrier occurred when the outpatient manager stopped the roll out of pre-visit planning phone calls for all patients in the surgeon's clinic, except for the patients in the quality improvement project. The reason for this decision was that the manager's operational plan was to roll-out the pre-visit planning with the trauma teams first prior to the orthopedic teams. Another barrier was that the senior nurses and charge nurses in the inpatient unit were unable to have the final calculated LACE index score until the patient's day of discharge. At times transitional care coordinators were unable to see patient's prior to discharge due to their current workload for the day. Transitional care coordinators had a current phone call protocol for contacting patients once

a week. The lead transitional care coordinator believed that three calls a week would not be feasible.

Discussion

The sample size pre-LACE index included 18 patients in Q1 that did not have the LACE index screening completed nor were these patients referred into care coordination. The pre-LACE patients included the surgeon's patients that had a revision of a hip or knee replacement and no intervention was done at this time. The sample size post-LACE index included 16 patients in Q2 who were screened by the LACE index and were referred into care coordination. Prior to the LACE index screening there was one readmission and after the LACE index screening there was no readmissions. Patients may also benefit from greater telephone contact to discuss concerns over the phone to improve the post-discharge support.

Q1 had zero no-show appointments and in Q2 there was five. This number may be decreased with more primary nurses, medical assistants, care coordinators, and transitional care coordinators reinforcing the importance of follow-up appointments. Patients may be missing appointments due to transportation issues and illness could have occurred in any quarter. Patient who miss appointments due to transportation issues could be referred to the transitional care team to assist with finding appropriate resources. Further analysis would be needed to evaluate the causes of the no show appointments to evaluate appropriate interventions needed to improve the care coordination program.

There was one emergency department visit prior to introducing LACE and three emergency department visits after LACE implementation. The emergency department visits may have increased due to chance alone in Q2. One reason for an emergency department visit was the orthopedics surgeon's discretion for the patient to seek a higher level of care during his clinic

visit. If the facility was provided with the care coordinator's contact information, the work-up for the abdominal pain could have been started at the rehab facility to avoid an emergency department visit. Another reason for an emergency department visits included the patient's perception to seek medical attention due to a concern of a fracture. This emergency department visit may have been prevented in the care coordinator advised the patient to come back to the clinic for x-rays and evaluation. Lastly a patient had a concern for infection with his sutures and wanted to seek care closer to his home at the emergency department. The care coordinator could have asked the patient to describe his incision and perhaps watchful waiting could have occurred instead of an emergency department visit.

The compliance of phone contact from the care coordinator to the patients from week one to week four varied from 28% to 71% for the intermediate patients, and 0% to 66% for the high-risk patients. Several reasons may have contributed to some of the low compliance rates in making phone calls. It may have been due to a change in the care coordinator's work flow to be more involved in the clinics and less office time. The care coordinators already had a case load of patients that they were following on top of the referrals from this project. In addition, the transitional care coordinator's duties have expanded to being involved in direct patient care and less time in the office during the implementation period. The manager of the outpatient setting changed the care coordinator and transitional care coordinators roles to be present during the clinics and actively seeing patients. Due to this change, the care coordinators had a difficult time keeping up with their case loads in addition to referrals from the LACE index. Also, the transitional care coordinator also had her own previous work flow to contact patients weekly instead of two to three times a week. The new telephone protocol may have been hardier to adapt due to the time constraints of working in clinic on top of keeping up with phone calls.

The barrier of the roll out of pre-visit planning phone calls to all the patients in the surgeon's clinic may have been due to the outpatient manager's priorities for other additional trainings to be completed by staff members. The outpatient manager wanted to ensure that training was provided to 12-hour outpatient nurses on the charge nurse role. During that same time, the roll out of the quality improvement project was also taking place when charge nurses were receiving training. This barrier could have been avoided if the manager and project director facilitated a timeline and agreement on when to begin pre-visit planning phone call training. The transitional care coordinator at times was unable to meet the patient prior to discharge from the hospital. The protocol was set up to notify the transitional care coordinator and project director of the LACE index score and patient's contact on the day of discharge via email. The charge nurse or senior clinical nurse could have notified the transitional care coordinator via phone and may have allowed for a quicker response to meet the patient at the bedside. Lastly the care coordinators were not being compliant with contacting patients per the protocol for intermediate and high-risk patients. This may have been due to the care coordinators duties in the clinic changed to be more present during the patient's visits and took away from office time to call patients. There could have been improvements made by allowing the primary nurses and medical assistant to help with phone calls to increase compliance of phone contact.

No evidence was found in the literature that implementing the LACE risk screening tool and care coordination was associated with less no-show appointments and emergency department visits. Emergency department visits are unpredictable at times for patients. The primary nurses, medical assistant, care coordinators, and transitional care coordinators may have not asked patients to call the office first prior to going to the emergency department. The increase in emergency department visits from Q1 to Q2 may be to patients seeking out care due

to their perception of medical attention needed. However, LACE risk screening combined with care coordination may significantly reduce the risk of readmissions. To fully understand the significance of the LACE index and care coordination, a data collection for a year or longer may be needed to evaluate the effectiveness of the screening and referral of orthopedic patients.

The findings in the project can be compared to other studies. The patient who was readmitted back to the hospital in the quality improvement project prior to the introduction of the LACE had a history of an orthopedic surgery. Garrison et al. (2016) found similar findings in their patients who were readmitted back into the hospital with 10.6% of the 16.6% patients who were readmitted had a history of an orthopedic surgery. In this quality improvement project, one of the patients who was readmitted to the hospital and comorbidities and other risk factors for rehospitalization. Similar risk factors were reported by other studies in which patients had a high risk of unplanned readmission within 30 days of hospital discharge (Siracuse & Chamberlain, 2016; Wang et al., 2014).

One of the patients in the quality improvement project came back to the emergency department due to the nursing facility unequipped to care for the patient due to the patient's complex medical needs. Vat et al. (2015) found similar results with patients identifying reasons for returning to the emergency department after discharge included having limited resources for help with their medical care. One difference in the findings of this quality improvement project compared to the literature was that LACE index scores ranged from low to high risk with those patients that had emergency department visits. Wang et al. (2014) found congestive heart failure patients with higher LACE scores of ≥ 10 had higher rates of emergency department revisits. The LACE scores in the quality improvement project did not show an association of high LACE scores with higher rates of emergency department visits. This may have differed because of the

difference in patient populations in that Wang et al. (2014) studied congestive heart failure patients.

Other considerations include one patient who went to the emergency department due to discharge to a rehab facility unable to handle the patient's acuity level. This is an important event that should be highlighted at a future meeting with case management and the care coordination teams to ensure that there is proper placement of patients upon discharge to facilities with resources to accommodate high acuity patients with multiple co-morbidities.

The LACE risk screening tool allowed for early intervention of care coordination to assist patients in their recovery from surgery. Before the quality improvement project, there were no referrals into care coordination with this patient population to the outpatient clinic. A larger sample size and longer implementation period may have allowed for more accurate results for the use of the LACE index and care coordination. Care coordination allows for early intervention of patient's post-discharge to follow-up with the surgeon sooner instead of utilizing urgent care or the emergency department when discussing red flags over the phone. This in turn leads to better patient outcomes when the patient returns to the same hospital where the surgery was done instead of another hospital for any postoperative complications. The strengths of the project included having a multidisciplinary team involved where the roles and responsibilities were clearly defined in the beginning of the implementation phase. The limitation of the project includes the small sample size. The sample size was based on one orthopedic surgeon's caseload of revisions of hip and knee replacements. There may have been differences in outcomes with readmissions, emergency department visits, and no-show appointments if there was a larger sample size that included other orthopedic patients within this organization. Other limitations include the cofounding variables that were not collected but may have influenced the results. For

example, the orthopedic surgeon changed his technique for incision closure to utilizing glue instead of the wound vac during the implementation period.

Conclusion

Due to the small sample size and short period of implementation it was difficult to evaluate the full effectiveness of using the LACE index. However, this quality improvement project was the first steps in developing an evidence-based referral process for care coordination for an orthopedic surgical population. While the introduction of the LACE index decreased readmissions from one to zero when comparing Q1 to Q2, the emergency department and no-show appointments increased. A better understanding of the reasons patients went to the emergency department may allow for revisions to be made during telephone contact to assist with decision making. The LACE Index scoring was found to be helpful in this orthopedic care coordination program for identifying patients at low, intermediate, and high-risk for readmission within thirty days post-discharge. Introducing care coordination also appeared to enhance post-discharge support and improve hand-offs between the inpatient and outpatient setting. Finally, the use of phone calls for support was beneficial to building relationships between the staff and patient populations in this outpatient setting. A future quality improvement project may evaluate the impact of using the LACE index and upon readmissions, emergency department visits, and no-show rates over a longer implementation period to understand the full complexity of patient outcomes and tailor care coordination interventions to problems discovered post-discharge.

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Table 1

Readmissions, Emergency Department Visits, and No-show appointments Pre and Post LACE Risk Screening

	Pre LACE (n=18)	**Post LACE (n=16)**	**P-Value**
Readmission, n (%)	1 (6)	0 (0)	1.00
ED Visit, n (%)	1 (6)	3 (19)	0.32
No show visits, n (%)	0 (0)	5 (17)	0.02

Appendix A

Author, year	Study objective/intervention or exposures compared	Design	Sample(N)	Outcomes studied (how measured)	Results	Level and Quality Rating
Vat, Common, Laizner, Borduas, & Maheu (2015)	-To recognize the reasons for patients returning to the emergency department after discharge	qualitative, descriptive study	-convenience sample of eight patients from a teaching hospital in Montreal, Canada	-Bounceback Probability Legend -LACE index screening tool	-The patients attributed their return to the emergency department after discharge to several themes: 1.) being discharged too soon 2.) being too weak to go home at discharge 3.) having limited resources for help at home 4.) insufficient discharge instructions	6B
Spiva, Hand, VanBrackle, McVay (2016)	-To identify patients at high risk for preventable hospital readmission within 30 days post-discharge	retrospective cohort design	-598 patients randomly selected from 1,172 eligible patients from a 102 bed, community hospital in the Southeast U.S.	-LACE index -LACE index with additional risk factors	-90% of admissions were emergent and out of the 598 patients, 161 were followed by a 30-day readmission -Analysis revealed that using a LACE score ≥8 to predict readmission status would increase the model's predictive ability (75.8% vs. 49.1%) -The LACE score correctly classified 79 of the 161 readmitted patients with a sensitivity of 49% -Patients with an assigned PCP had 95.3% higher odds of readmission than patients without PCPS -Medicaid patients had 197.5% higher odds of readmission than Medicare insured patients, and 100.8% high odds of readmission than patient privately insured patients -patients with gait disturbances had 238.6% higher odds of readmission compared to patients without gait disturbances	4A
Tan, Low, Yang, & Lee (2013)	-To validate the LACE index screening tool	retrospective study	-127,550 discharged patients in a	-LACE index	-16% of patients had a LACE index ≥ 10 -These patients were older, had an ICU stay during admission, had a high	6A

	outside of Western developed countries		Singapore General Hospital		Charlson Comorbidity Index, lower socioeconomic class, and longer lengths of stay in the hospital -These patients had a higher risk of 30-day unplanned readmission after discharge -LACE index can determine patients with low and high rates of unplanned readmission	
Panhwar, Cunningham, Al-Kindi, Thomas, Singh, Ginwalla (2017)	-To examine if the LACE index screening tool predicts 30-day readmissions in all patients with heart failure and patients with heart failure and cognitive impairment	cohort study	-97 patients admitted into a U.S. hospital with heart failure	-LACE index and mini-cog tool	-92% of patients had a high LACE score (>10) -High LACE score patients had a longer length of stay and higher mean number of medications -21 patients in the high LACE group were readmitted compared to the 1 patient in the low LACE group -Patient with high LACE scores and cognitive impairment had a higher rate of readmission	4B
Hakim, Garden, Jennings, & Dobler (2017)	-To analyze the rate of 30-day readmissions -Assess the accuracy of the LACE index for 30-day readmissions	retrospective cohort study	-2,662 patients with COPD in an Australian tertiary hospital	-LACE index	-25% of patients were readmitted to the hospital within 30 days post-discharge -56% of those readmissions were due to COPD -other main reasons for readmission included heart failure and pneumonia -on average, patients were readmitted within 13.3 days, with 7 days being the most common time -LACE index has a moderate predictive ability for 30-day readmissions following hospitalizations for COPD	4A
Garrison, Robelia, Pecina, Dawson (2016)	-To compare different risk screening tools	cohort study	-26,279 hospital admissions for 14,663 adult primary care patients	-LACE index -LACE+ index -HOSPITAL score	-16.6% of patients were readmitted within 30 days of discharge -10.6% of patients had an orthopedic surgery -6.0% of patients had a trauma surgery	4A

					-No statistical significance of differences in the performance of the LACE, LACE+, or HOSPITAL scores (all perform similarly on primary care patients)	
Yazdan-Ashoori, Fu Lee, Ibrahim, & Van Spall (2016)	-To assess whether the LACE index was a predicator of 30-day readmission or death	prospective cohort study	-378 patients with heart failure at a hospital in Canada	-LACE index	-91% of patients had LACE scores ≥ 10 -Patients with higher LACE scores had increased odds of 30-day readmissions or death	4A
Mixon, Goggins, Bell, Vasilevskis, Nwosu, Schildcrout, & Kripalani (2016)	-To compare whether the B-PREPARED and CTM-3 has differences in the predictive abilities of readmission and then compare to the LACE index	cohort study	-1239 adult patients hospitalized for cardiovascular diagnoses at Vanderbilt University Hospital	-B-PREPARED -CTM-3 -LACE index	-B-PREPARED score was better at predicting readmission or death compared to the CTM-3; however, neither predicted 30-day and 90-day readmissions as well as the LACE index	4A
Tong, Erdmann, Daldalian, Li, & Esposito (2016)	-To compare the LACE, STEPWISE logistic, LASSO logistic, and AdaBOOST for readmission risk	cohort study	-109,421 adult inpatients discharged from hospitals in the Chicago metropolitan area	-LACE -STEPWISE -LLASSO -AdaBoost	-LACE has moderate discrimination power to predict readmission risk	4A
Yian, Zhou, Schreiber, Sodl, Navarro, Singh, Bezrukov (2016)	-To identify incidence and risk factors of 30-day hospital readmissions rates and mortality rates after surgery	retrospective cohort study	-1,387 patients who had surgery after sustaining a proximal humerus fracture in Southern California	-LACE	-30-day readmission rate was 5.6% -47% of readmissions were due to surgery related problems -Severe liver disease and LACE score ≥ 10 were independent risk factors of readmission -1 year mortality rate was 4.86%	4B
Wang, Robinson, Johnson, Zenarosa, Jayswal, Keithley, & Delaney (2014)	-To assess the accuracy of the LACE index in CHF patients	retrospective cohort study	-253 patients with CHF exacerbations in an urban hospital	-LACE	-patients with high LACE scores ≥ 10 had significantly higher rates of ED revisits -LACE scores were slightly higher in readmitted patients vs. non-readmitted patients	4B

			emergency department		-history of MI and PVD increased the risk of unplanned readmission within 30 days of hospital discharge	
Au, McAlister, Bakal, Ezekowitz, Kaul, & Walraven (2012)	-To assess the ability of the Charlson score, the LACE score, LaCE score, CMS-endorsed Krumholz, and Keenan scores for readmission within 30 days after discharge	cohort study	-59,652 adults discharged alive after heart failure hospitalization in Canada	-Charlson -LACE -LaCE -CMS-endorsed Krumholz -Keenan	-LaCE index (includes length of hospital stay, age, Charlson score, # of ED visits in the previous 6 months) was superior to the Charlson score and CMS-endorsed Krumholz score for predicting readmission risk or death within 30 days of discharge	4A
Siracuse & Chamberlain (2016)	-To develop a scale for predicting readmission rates and verify the RATHRR Scale for total hip replacement patients and implement risk-reduction strategies	cohort study	-268, 518 patients from New York and California (derivation cohort) -153,560 patients from Florida and Washington (validation cohort) from the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality -patients were undergoing total hip replacement	-readmission rate -The Readmission After Total Hip Replacement Risk Scale	-30-day readmission rate was 5.89% for the derivation cohort and 5.82% for the validation cohort -following factors were associated with increased risk of readmission after total hip replacement: age > 71 years, African American, low income, revision replacement, liver disease, CHF, COPD, renal failure, diabetes, fluid and electrolyte disorder, anemia, rheumatoid arthritis, coagulopathy, HTN, obesity	4A
Runner, Bellamy, Vu, Erens, Schenker, & Guild (2017)	-To validate the modified frailty index as a predicator of postoperative	cohort study	-90,260 patients undergoing primary total knee	-Modified Frailty Index (MFI) -MFI vs. American	-an increased MFI score increases 30-day mortality ($P < .001$) -an increased MFI score is associated with higher rates of postoperative	4A

	complications, reoperations, and remissions in patients undergoing a primary total knee arthroplasty		arthroplasty from the American College of Surgeons National Surgical Quality Improvement Program database	Society of Anesthesiologists score	complications: infection, wound, cardiac, pulmonary, renal complications -MFI was a stronger predicator of reoperation compared with American Society of Anesthesiologists score	
Singh, Inacio, Namba, & Paxton (2015)	-To examine whether an underlying diagnosis of rheumatoid arthritis or osteoarthritis impacts the 90-day readmission rates after total hip arthroplasty or total knee arthroplasty	retrospective cohort study	-34,3111 patients with rheumatoid arthritis or osteoarthritis undergoing unilateral primary total hip arthroplasty or total knee arthroplasty	-90-day readmission	-90-day readmissions were 8.5% in rheumatoid arthritis and 6.7% in osteoarthritis -most common readmissions included joint prosthesis infection and septicemia in rheumatoid arthritis and joint prosthesis infection and postoperative infection in osteoarthritis	4B
Boraiah, Joo, Inneh, Rathod, Meftah, Band, Bosco, & Iorio (2015)	-To analyze the relationship between the RRAT score and readmission after primary hip or knee arthroplasty	cohort study	-9,930 primary hip and knee arthroplasty procedures at New York University Langone Medical Center's Hospital for Joint Diseases	-association of individual risk factors and the RRAT score with readmissions	-2.08% of the 9,930 patients were readmitted during study period -surgical site infection was the leading cause of readmission -higher RRAT scores are correlated with a greater chance of readmission and can be a predictor of readmission -an RRAT score of >=3 was found to be a higher risk of readmission	4A
Brauer, Lyons, Keller, Mutch, Colditz, & Glasgow (2019)	-To evaluate the LACE, Charlson comorbidity index score, and emergency department visits -To develop and evaluate a novel index	Retrospective cohort study	-440,742 patients discharge after colorectal surgery in the databases of Healthcare Cost	-death or readmissions 30-days after discharge	-rate of death or readmission within 30 days after discharge was 14% -the LACE index applied to surgical patients demonstrated a poor model fit (C=0.631)	4A

	in predicating readmissions		and Utilization Project in New York, California, and Florida			
Jamei, Nisnevich, Wetchler, Sudat, & Liu (2017)	-To evaluate a predictive model to identify high-risk patients and implement cost-effective post-discharge interventions	Cohort study	-data from 323,813 hospital stays in California	-artificial neural network model compared to LACE	-LACE showed a precision of 0.20 in identifying high-risk patients -the neural network model yielded a precision of 0.24, a 20% improvement over LACE	4B
Low, Lee, Ong, Wang, Tan, Thumboo, & Liu (2015)	-To validate the LACE and compare its performance with a regression model to predict 30-day readmission risk	Cohort study	-5,862 general medicine patients in Singapore	-LACE -30-day readmissions	-variables associated with readmission 30 days post-discharge: age, charlson comorbidity index, white cell count, serum albumin, ED visits in previous 6 months -LACE had a c-statistic of 0.628 in predicting 30-day readmissions -derived model had a c-statistic of 0.650 -LACE score of 6 or more with a sensitivity of 66.3% and specificity of 53.3%	4B
Amarasingham, Velasco, Xie, Clark, Ma, Zhang, Bhat, Lucena, Huesch, & Halm (2015)	-To evaluate the degree to which EMR-based risk models for 30-day readmission or mortality accurately identify high risk patients and to compare these models to LACE and CMS Hospital Wide Readmission model	Cohort study	-39,604 adults hospitalized and admitted to internal medicine services at 7 large hospitals in Dallas/Fort Worth	-LACE vs. CMS Hospital Wide Readmission model	-the electronic multicondition model for 30-day readmission alone had good discrimination (C statistic 0.66) and performed better than the CMS model -the electronic multicondition model was significantly better than the LACE model (P=0.02)	4A
Cooksley, Nanayakkara, Nickel, Subbe, Kellett, Kidney, Merten, Van Galen, Henriksen,	-To perform an external independent validation of the HOSPITAL and LACE scores	Cohort study	-19,277 patients admitted to the Hospital of South West Jutland and the Odense	-LACE vs. HOSPITAL scores	-LACE had a discriminatory power of 0.648 with poor calibration -HOSPITAL score had a discriminatory power of 0.661 with poor calibration -HOSPITAL score was significantly better than the LACE score for	4B

Lassen, & Brabrand (2016)			University Hospital		identifying patients at risk for 30 day readmission (P < 0.001)	
Garrison, Robelia, Pecina, & Dawson (2016)	-To compare the LACE index, LACE+ index, the HOSPITAL Score, and the readmission risk score on hospital admissions	Cohort study	-26,279 admissions for 14,663 patients of adult primary care patients hospitalized	-LACE -LACE+ -HOSPITAL Score -Readmission risk score	-no statistically significant difference in performance among the 4 readmission risk classifiers -LACE had a c-statistic of 0.68 -LACE+ had a c-statistic of 0.66 -HOSPITAL score had a c-statistic of 0.68 -internal RRS score had a c-statistic of 0.67	4A
Camille, Alexis, Christine, Pierre, Brigitte, & Virginie (2018)	-To validate and compare the 80+ score with the HOSPITAL score, LACE, and TRST	Case Control Study	219 case-control pairs from a French University hospital	-SCORE 80+ -HOSPITAL -LACE -TRST	-no significant between cases and controls for the 80+ score, the LACE index, and HOSPITAL score -80+ score had a p-value of 0.87 -LACE score had a p-value of 0.24 -HOSPITAL score had a p-value of 0.60 -the TRST, the mean score of the cases was significantly different from the mean score of the controls (p < 0.001) -LACE had the highest sensitivity 61% -HOSPITAL had the lowest sensitivity 21% HOSPITAL score had the highest specificity 80% -LACE had the lowest specificity 44%	4B

Appendix B

LACE Index Scoring Tool for Risk Assessment of Hospital Readmission

Step 1. Length of Stay
Length of stay (including day of admission and discharge): _____ days

Length of stay (days)	Score (circle as appropriate)
1	1
2	2
3	3
4-6	4
7-13	5
14 or more	7

L

Step 2. Acuity of Admission
Was the patient admitted to hospital via the emergency department?
If yes, enter "3" in Box A, otherwise enter "0" in Box A

A

Step 3. Comorbidities

Condition (definitions and notes on reverse)	Score (circle as appropriate)	
Previous myocardial infarction	+1	
Cerebrovascular disease	+1	
Peripheral vascular disease	+1	If the TOTAL score is between 0 and 3 enter the score into Box C. If the score is 4 or higher, enter 5 into Box C
Diabetes without complications	+1	
Congestive heart failure	+2	
Diabetes with end organ damage	+2	
Chronic pulmonary disease	+2	
Mild liver or renal disease	+2	
Any tumor (including lymphoma or leukemia)	+2	
Dementia	+3	
Connective tissue disease	+3	
AIDS	+4	
Moderate or severe liver or renal disease	+4	
Metastatic solid tumor	+6	
TOTAL		

C

Step 4. Emergency department visits
How many times has the patient visited an emergency department in the six months prior to admission (not including the emergency department visit immediately preceding the current admission)? _____
Enter this number or 4 (whichever is smaller) in Box E

E

Add numbers in Box L, Box A, Box C, Box E to generate LACE score and enter into box below.

LACE

LACE Score Risk of Readmission: ≥ 10 High Risk

Appendix C

Good afternoon Dr. Carl van Walraven,

I hope you had a nice Memorial Day weekend! I am writing to you to gain your permission to utilize your LACE screening tool for my doctor of nursing practice project. I plan to utilize your tool to screen hip and knee replacement patients and refer them into care coordination. I hope you can grant me permission to do so.

Warm Regards,

Danielle Miller, RN, BSN
Doctor of Nursing Practice Student
Family Nurse Practitioner Program at University of Maryland, Baltimore
daniellemiller2019@umaryland.edu
(443)277-9976

Van Walraven, Carl <cvanwalraven@toh.ca> May 29 (12 days ago)

to me

Hi Danielle
Absolutely. Best of luck in your study.
Carl

From: Danielle Miller <daniellemiller2019@umaryland.edu>
Sent: Tuesday, May 29, 2018 2:41:42 PM
To: Van Walraven, Carl
Subject: permission to utilize LACE screening tool

Danielle Miller <daniellemiller2019@umaryland.edu> May 29 (12 days ago)

Thank you Dr. Carl van Walraven! I appreciate your quick response back and allowing me to utilize your screening tool for my scholarly project! It means so much to me. -Danielle Miller

Appendix D

Audit Tool prepared by Corporate Quality Management

Reports from the following data sources: Midas, Finance, Crisp, and HPM Cost Accounting to track the total number of knee replacements and hip replacements, along with the number of hip and knee readmissions. The reports are quarterly, and the first quarter goes from 7/1-9/30. The second quarter goes from 10/1-12/30. The first quarter will include all the meetings and training needed prior to the official roll-out of the project. The second quarter will be the official start date of screening with the LACE and referral into care coordination. The data will be analyzed for readmissions in the first quarter compared to the second quarter. Here is a sample of what the audit tool consists of that is prepared by Corporate Quality Management.

Metric	FY17 Q1 7/1-9/30	Q2 10/1-12/31	Q3 1/1-3/31	Q4 4/1-6/30	FY17	FY18 Q1 7/1-9/30	Q2 10/1-12/31	Q3 1/1-3/31	Target
Total Knee Replacement Volume									
Total Knee Replacement ALOS									
Total Knee Replacement Average Variable Supply Cost									
Total Hip Replacement Average Variable Drug Cost									
Elective Hip/Knee # of PPCs									
Elective Hip/Knee PPC O/E									
All Hip/Knee # of PPCs									
All Hip/Knee PPC O/E									
# of Hip/Knee Readmissions									
Readmission O/E									

Appendix E

Audit Tool: Tracking No-Shows for orthopedic clinic

Protocol: Primary Nurse/Board Runner will look at the clinic schedule no more than an hour after last appointment for patients that didn't show up to clinic. Audit will be placed in project director's mailbox

Date	De-Identified Patient ID	Being followed by Primary Nurse Care Coordinator Transitional Care Coordinator