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Implementing the AMI READMITS Risk Assessment Score Within a Referral Protocol to Increase Referrals for Follow-up Among Patients with Type I Myocardial Infarction

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Table of Contents……..2

Abstract

Background: The hospital's post- myocardial infarction (MI) referral protocol does not address patient risk characteristics. Referrals to a post- MI clinic have been lower than expected. Evidence suggests the AMI READMITS score can predict readmissions within 30 days after discharge among patients with acute MI.

Aim: This quality improvement study evaluated a referral protocol that integrated the AMI READMIT score to increase appropriate referrals after discharge.

Methods: Patient chart data was analyzed to assess changes in referrals and timely follow-up from pre-intervention to intervention. A survey assessed providers' satisfaction with the new referral protocol.

Results: Among 57 patients (n=29 pre-intervention; n=28 intervention), documented referrals increased significantly from 66% to 89% (χ^2=4.571, *df*=1, *p*= 0.033); and timely appointments increased by 10%, which was not significant (χ^2=3.550, *df*=2, *p*= 0.169). Most providers agreed the new protocol was easy to use, useful in making referral decisions and improved the referral process. All agreed the risk score should be incorporated into electronic clinical notes via smart phrase. Provider opinions related to implementing the risk score in clinical practice were mixed. Qualitative feedback suggests this was due to lack of validation of the AMI READMITS score in reducing readmissions.

Conclusions: This study demonstrated that an evidence-based referral protocol can increase appropriate referrals among patients with MI. Provider adoption may be enhanced by incorporating the protocol into electronic clinical notes. Future research to validate the accuracy AMI READMITS score in predicting readmissions could further support the implementation of the protocol in clinical practice.

Introduction

The Society of Hospital Medicine (2019) recommends early follow-up after discharge as a strategy to prevent early unplanned hospital readmissions. Patients who have early follow-up after discharge, have a lower risk of 30-day readmissions (Tung, Chang, Chang, & Yu, 2017; Tong, Arnold, Yang, Tian, Erdmann, & Esposito, 2018; Jackson, Shahsahebi, Wedlake, & DuBard, 2015). Currently, the national average of 30-day readmission rates after MI is between 10 % and 20 % (Rymer, Chen, Thomas, Fonarow, Peterson, & Wang, 2019). To meet or perform better than national average, a post- MI NP managed clinic was created at the hospital's Outpatient Center to follow-up with patients who were discharged with diagnosis type I MI. According to the Forth Universal Definition, type I MI includes ST-elevation MI (STEMI) and non-ST elevation MI (NSTEMI) (Thygesen et al., 2018). The criteria for type I MI includes the "detection of a rise and/or fall of cardiac troponin with at least one value above the 99th percentile and with at least one of the following: symptoms of acute myocardial ischemia; new ischemic electrocardiographic (ECG) changes; development of new pathological Q waves; imaging evidence of new loss of viable myocardium or new regional wall motion abnormality in a pattern consistent with an ischemic etiology; identification of a coronary thrombus by angiography including intracoronary imaging or by autopsy" (Mukherjee, 2018, August 25, [Fourth Universal Definition of Myocardial Infarction]). To promote referrals after discharge, cardiology nurse practitioners (NPs) developed a post-MI referral protocol but it did not highlight readmission risk and was not being used consistently. The number of referrals to the clinic was lower than expected.

This QI study aimed to increase the percentage of adult patients with type I MI who are identified as at risk of unplanned 30-day readmission and referred to see a cardiologist or an NP at a

post-MI clinic within either 7 or 14 days after discharge by revising the existing referral protocol to include patient readmission risk variables to guide clinicians about the appropriate timing of referrals for each patient. It was anticipated that this process change would increase total and timely referrals to a cardiologist or to a post-MI clinic and, over the long term, avoid unplanned 30-day readmissions.

Background and Significance

Unplanned hospital readmissions are expensive and estimated at 15 to 20 billion dollars annually (Alper, O'Malley, & Greenwald, 2017) but the cost may be much more significant. It is reported that in 2011, hospital readmissions were associated with a cost of $ 41.3 billion (NEJM Catalyst, 2018). The hospital readmission is defined as a patient admission to a hospital within 30 days after discharge (Centers for Medicare and Medicaid Services, 2018). Under the Hospital Readmission Reduction Program (HRRP), the Centers for Medicare and Medicaid Services withheld $528 million of hospital reimbursement in 2016 (Advisory Board, 2016) and $564 million in 2018 (American Hospital Association, 2019). Unplanned readmission after ST-elevation MI (STEMI) has led to a significant economic burden, with a 47.9% increase in cumulative management costs between 2010 and 2014 (Kim et al., 2018). In 2013, the total cost of unplanned 30-day readmission after MI was $854 million (Mansuri, 2017).

Due to patients' complexity and multiple confounding factors related to patients' health, environment, socioeconomic status and literacy, it is hard to avoid all unplanned readmissions; however, it is important to address effective hospital and clinical management, discharge planning, patient education and early follow-up as the components of readmission prevention strategy (American Hospital Association, 2015). To reduce the risk of readmission among patients with MI, it is critical to ensure that they have strategies to recover at home rather than returning to hospitals.

A post- MI clinic was opened at the hospital's Outpatient Center to address patient needs after discharge and to reduce rates of unplanned readmissions within 30 days after discharge with diagnosis type I MI. Since opening, most appointment slots remained unfilled and the number of referrals to a clinic was lower than expected. Between September, 2018 and February, 2019 248 patients with diagnosis STEMI or NSTEMI and Troponin I level > 1.25 ng/ml were discharged from the hospital. In 2018, the total number of patients admitted and discharged with diagnosis STEMI or NSTEMI and any Troponin I level above normal was 313. Most of these patients were discharged from the hospital's cardiac units. Between April, 2018 and May, 2019, a post- MI clinic received 91 referrals.

The hospital's cardiology units utilize the Early Screen for Discharge Planning (ESDP) to identify patients at higher risk for disability, the CHADS VASC score to identify patients with atrial fibrillation who are at high risk for stroke, the MAGGIC risk calculator for heart failure, the 10-year ASCVD risk calculator of heart disease, and the STS Risk Calculator to identify patients at high risk for open heart surgery, but the post-MI referral protocol did not address patient risk characteristics. It was hypothesized that revising the current post-MI referral protocol to include a readmission risk assessment would increase provider awareness of patients who were at high risk for readmission and would improve appropriate and timely referrals after discharge.

Needs Assessment

A SWOT analysis of the hospital Cardiology Division and a post-MI clinic was conducted to analyze the barriers and facilitators associated with successful study development and implementation (included as Appendix A).

Strengths: The hospital and its clinics operate accordingly to the hospital's strategic plan. The hospital goals align with the Institute for Healthcare Improvement (IHI) (2019) Six Aims for

Changing the Health Care System (Institute for Healthcare Improvement, 2019) and the Centers for Medicare and Medicaid Services requirements. In accordance with the strategic plan, the hospital is oriented towards improvements in health care quality and safety. For instance, current EPIC electronic medical record system was adopted due to its multiple benefits. It simplifies ordering and improves communication between providers and facilities. This system makes medical records review easier by helping to locate patients' demographic and health information at the spot. The hospital consistently receives the Magnet recognition for excellent nursing care. The hospital supports and promotes evidence-based practice.

Weaknesses: The EPIC dashboard contains a set of strict priorities which must be addressed ahead of some issues identified by clinical care providers. For example, in an effort to improve rates of referrals to a cardiologist or a post-MI clinic, NPs send weekly reminders to the hospital teams that provide care to patients with MI. NPs have observed that when the reminder messages are not sent, rates of referrals drop drastically and often go to zero. The current reminder system is not efficient and fails to achieve desired results. Ideally, all risk assessments should be integrated into the EPIC. This is possible to achieve but may take a very long time due very specific priority rules at the EPIC site.

Opportunities and Threats: Growing technology, commitment and access to inner city population with significant health needs, active presence in the Medicare market create endless opportunities for research and inpatient and outpatient services modifications to better serve patients and train employees. At the same time, health care cost escalation, economy slowdowns, and competing healthcare facilities are realistic threats and may always create clouds on the horizon. The hospital must compete and offer workable solutions to achieve measurable improvements in patients' health.

Problem Statement

The cardiology NPs observed that the existing post-MI referral protocol intended to promote referral to a cardiologist or to a post-MI clinic within after discharge (included as Appendix B) was not being implemented consistently and rates of referral to a post-MI clinic remained lower than expected. An evidence-based risk assessment referral protocol for identifying patients at risk of early readmissions after type I MI (included as Appendix C) that is integrated into clinicians' workflow had potential to increase the rate of timely referrals to a cardiologist or a post-MI clinic and, in long term, may decrease rates of unfavorable health outcomes after MI and decrease rates of unplanned hospital readmissions.

Purpose

The purpose of this QI study was to evaluate an evidence-based risk assessment referral protocol that is integrated into a clinician's workflow to increase the rate of referrals and timely appointments with a cardiologist or a post-MI clinic among patients with type I MI.

Practice Question (PICO)

Compared to a post-MI referral protocol that does not include patient readmission risk factors, does an evidence-based risk assessment referral protocol that is integrated into clinicians' workflow increase the percentage of adult patients with type I MI who are identified as at risk of unplanned 30-day readmission and referred to a cardiologist or a post-MI NP clinic within 7 to 14 days after discharge from the hospital?

Aims and Objectives

Aim

The aim of this study was to increase the percentage of patients with type I MI who are identified as risk for early unplanned readmission and appropriately referred to a cardiologist or a post-MI NP clinic. It was expected that the percentage of total referrals would increase from approximately 30% to 60% and the percentage of timely referrals will increase from approximately 50 % to 100%.

Objectives

1. To implement an evidence-based readmission risk assessment referral protocol within the hospital's cardiology units for the purpose of identifying Type I MI patients at risk for unplanned 30-day readmission after discharge from the hospital.
2. To evaluate the impact of an evidence-based readmission risk assessment referral protocol on referral rates and post-discharge follow-up timing by reviewing EPIC charts to assess changes in referral frequency and assessing providers' satisfaction with the new referral protocol.

Literature Review

PubMed, Cochrane and Google databases were used to conduct a systematic search for studies related to post-MI readmissions and published in the past 10 years. No randomized controlled trials (Level I evidence) or Quality A studies were identified during evidence search. Twelve reports, ten research pieces of evidence (Level III, Quality B) and two non-research pieces of evidence, were selected and included in the literature evidence table (Appendix D). All included studies examined factors associated with the readmission risk after MI and most frequent readmission causes. Of these, two research groups examined the re-hospitalization cost after MI and found this cost to be significant (O'Brien, Valsdottir, Wasfy, Strom, Secemsky, Wang, & Yeh, 2017; Kim, et al., 2018).

Time-sensitive discharge referrals are important, as there is an association between early post-discharge follow-up and reductions of unplanned readmissions (Jack et al., 2009; Tung, Chang, Chang, & Yu, 2017). Under the Hospital Readmission Reduction Program (HRRP), the United States hospitals receive federal financial penalties for excessive readmissions (Centers for Medicare and Medicaid Services, 2019). To prevent unplanned readmissions, it is helpful to identify patients with MI who are at higher risk for readmission prior to discharge from the hospital. Studies show that patients with certain comorbidities (e.g., diabetes, anemia, COPD, longer length of hospital stay, higher Kilip class) and demographic characteristics e.g., gender, age) may fall under risk for being readmitted following MI (Dunlay, Weston, Killian, Bell, Jaffe, & Roger, 2012; O'Brien, Valsdottir, Wasfy, Strom, Secemsky, Wang, & Yeh, 2017; Smith, Makam, Darden, Mayo, Das, Halm, & Nguyen, 2018). Also, higher comorbidity index may associate "with greater independent odds of readmission" (Kwok et al., 2018, para. 4 in "Results"). Evidence-based readmission risk assessment tools are necessary to improve clinicians' ability to identify patients with high readmission risk, to recognize the importance of early post-discharge follow-ups, and to guide clinicians' referral decisions.

A variety of factors associated with unplanned readmission among patients with MI have been identified in the literature. While there is some overlap in identified risk factors across studies, there is also variability (included as Appendix E for a summary of risk factors identified across studies). Dunlay, Weston, Killian, Bell, Jaffe, & Roger (2012) examined 30-day hospital readmissions after MI and concluded that diabetes, procedural complications after percutaneous intervention (stroke, bleeding event, vascular complication), longer hospital stay (LOS 3 days or longer), COPD, anemia, and higher Killip class at presentation were associated with the higher readmission risk. Kim et al. (2018) examined the 30-day readmission rates, cause, and cost of

readmission among patients who sustained ST-elevation MI (STEMI) and concluded that female sex, AIDS, anemia, chronic kidney disease (CKD), collagen vascular disease, diabetes, hypertension (HTN), pulmonary hypertension, congestive heart failure (CHF), atrial fibrillation and increased hospital length of stay (LOS > 4 days) were independent predictors of the 30-day readmission ($p < 0.001$)**.** Furthermore, these authors concluded that the 30-day readmission is associated with an approximately 50% increase in hospitalization costs. Kini et al. (2018) examined readmissions among patients with Medicare benefits who sustained MI and concluded that older age, sex (women), race (black), heart failure at first medical contact, diabetes, in-hospital complications, were associated with the higher readmission risk after MI ($p< 0.001$). Rodriguez, Acharya, Olson, & Cler (2015) evaluated risk factors for readmission and discovered that diabetes, older age, days from admission to coronary catheterization, prescribed medical therapy at discharge, HTN, stroke, major psychiatric disorders, chronic kidney disease and heart failure independently associate with unplanned readmission after MI. Consistent with Kim et al. (2018) and Kini et al. (2018), O'Brien, Valsdottir, Wasfy, Strom, Secemsky, Wang, & Yeh (2017) found that women had a significantly higher readmission risk compared to men. In contrast to findings that post-MI readmission risk increases with age, these authors also found the effect to be stronger for younger women.

A variety of readmission risk models are used to predict unplanned readmission incidence across all medical conditions (Kansagara, Englander, Salanitro, Kagen, Theobald, Freeman, & Kripalani, 2011; Smith, Makam, Darden, Mayo, Das, Halm, & Nguyen, 2018). Some of these models were not developed specifically for patients with MI but have been utilized to predict unplanned post-MI readmissions. For instance, the EMR model helps to examine all available hospital factors associated with readmissions. At the same time, it demonstrated higher

discrimination “in predicting ischemic heart disease readmissions” than the HOSPITAL score derived from Elixhauster comorbidities index (Rana, Tran, Luo, Phung, Kennedy, & Venkatesh, 2014, p. 377). While it acceptable to apply non- MI specific readmission risk assessment models to patients with MI, it is important to understand if these models have adequate sensitivity to predict post-MI readmissions. Smith, Makam, Darden, Mayo, Das, Halm, & Nguyen (2018) conducted a systematic review for studies examining the predictive ability of the readmission risk models among patients who sustained MI and concluded that existing models fail to provide adequate information to help clinicians identify patients at higher readmission risk after MI. The predictive ability of existing models was found to be modest.

In an effort to establish an accurate and actionable prediction model to identify patients with acute myocardial infarction (AMI) who are at high risk for readmission, Nguyen, Makam, Clark, Zhang, Das, & Halm (2018) examined the characteristics of all patients who were hospitalized for MI in six north Texas hospitals from 2009 to 2010 and who were readmitted within 30 days after discharge. The 2009-2010 timeframe was selected to ensure that AMI cohorts across all selected hospitals were comparable, because during this time hospital-based readmission interventions were not yet widespread. The authors included all readmission prediction variables from multi-condition electronic health records (EHR) readmission models and additional variables that met specific inclusion criteria. The authors included consecutive hospitalizations among adult patients who were 18 years or older and were discharged with a diagnosis of AMI defined by ICD-9-CM codes, excluding subsequent episodes of care for AMI. For individuals who had multiple re-hospitalizations during the study, the authors included only the first re-hospitalization. The results of this study revealed that readmitted patients had very different social, demographic and clinical characteristics; however, seven variables -- renal

function (serum creatinine > 2 mg/dl), elevated brain natriuretic peptide (BNP), age (> 18 years), history of diabetes, female sex, no intervention with timely percutaneous coronary intervention (PCI), and low systolic blood pressure (SBP < 100 mm Hg) -- were included in the AMI READMITS risk prediction model, which includes a scoring system with points assigned to each variable**.** The AMI READMITS score validity was tested using 5-fold cross validation method and had good discrimination (C-statistic 0.75, 95% confidence interval [CI], 0.70-0.80, optimism-corrected C-statistic 0.73, 95% CI, 0.71-0.74).

With the majority of Level III (non-experimental) evidence and generalizability limitations of other studies reviewed, the AMI READMITS model is most promising in predicting unplanned readmissions within 30 days after discharge. It is unique in its specificity for prediction of post-MI readmission risk and can be easily implemented bedside in the practice setting. Further investigation and testing are needed to support this model translation to clinical practice and to justify practice changes. Currently, the data is insufficient to support the external validity and accuracy of the AMI READMITS in predicting 30 days unplanned readmissions after MI or increasing rates of timely referrals after discharge from hospitals.

Risk assessment is one of many strategies recommended as part of quality improvement efforts aimed at reducing readmissions (American Hospital Association, 2015). It was predicted that integrating the AMI READMITS score into the hospital's post-MI readmission risk assessment protocol would help to stratify patients according to the readmission risk level and help clinicians decide how soon patients should see cardiac care providers after discharge.

The proposed protocol changes were compatible with the American Hospital Association (2015) suggestion that hospitals should implement strategies directed towards life quality

improvements and prevention of unplanned readmissions. Furthermore, the proposed protocol changes were compatible with the hospital's cultural values and practice norms. The proposed changes did not require any financial expenditure, which was aligned with the institutional stakeholders' goal for monetary spending. It was anticipated that practice changes would be supported if a pilot project demonstrated improvements in identifying and referring patients who were at higher readmission risk after type I MI.

EBP Translation Model

To facilitate translation of evidence into practice, Rosswurm and Larrabee's Model was used (Rosswurm, & Larrabee, 1999). This model was chosen due its clearly identified action steps (Mohide, & King, 2003).

Step I (Assess needs for change): The current post –MI referral protocol does not highlight readmission risk variables and is not fully integrated into the discharge workflow. Per observation, the hospital's cardiology units manage 5 to 12 patients with ST-elevation MI every week but only 1 to 3 patents are referred to a post- MI clinic and usually every 3 to 5 weeks. While there may be different reasons behind low referral rates, it was important to understand if an evidence-based readmission risk assessment referral protocol that is integrated into clinicians' discharge workflow would lead to improvements in referral and timely follow-up rates. The SWOT analysis indicated that the hospital supports care quality improvement; thus, this project was aligned with the institutional philosophy and goals.

The following stakeholders were identified to discuss the current process and to inform about proposed changes in the referral process: cardiology attending physicians, nurse managers, nurse practitioners, cardiology fellows, residents, and clerical staff.

Step II (Link problem interventions and outcomes): The proposed revised risk assessment protocol includes the AMI READMITS score and was aimed to: 1) increase the percentage of adult patients with type I MI who were correctly identified as risk of unplanned 30-day readmission and 2) increase the percentage of timely referrals to a cardiologist or to a post-MI NP clinic.

Step III (Synthetize best evidence): Evidence discussed in the Literature Review section supports the importance of post-discharge follow-up and revealed a promising risk- assessment model intended for use with patients who sustained acute MI.

Step IV (Design practice change), Step V (Implement and evaluate change), Step VI (Integrate and maintain change in practice): Further discussion of these steps follows in the methodology, evaluation plan and analysis sections of this proposal.

Methodology

Project Design

This QI study has involved implementation of an evidence-based readmission risk assessment referral protocol and a post-implementation providers' survey. A review of patient charts and completed risk-assessment referral form for the time period of two month prior to intervention and two month during intervention was conducted for the purpose of obtaining data that measured: 1) percentage of total referrals among patients with type I MI; 2) percentage of patients seen within the recommended timeframes; 3) percentage of completed referral forms for patients with type I MI.

A descriptive survey design was used to assess providers' satisfaction with the evidence-based readmission risk assessment referral protocol. Quantitative items assessed clinicians' perceptions related to the usability and usefulness of the new protocol. Qualitative questions gathered clinician's opinions related to integrating the new referral protocol into clinical practice.

Setting

This study was implemented within the hospital's inpatient cardiology units. The total number of beds in these two units is 58. Cardiology fellows, residents and NPs who discharge patients with MI, have participated in the project. Cardiology attending physicians, nurse managers and clerical staff were informed about the study and asked for support.

Patient Population

The study was conducted by reviewing the charts of all adult patients (≥ 18-year-old) who were discharged from the hospital's cardiology units with a diagnosis of type I MI (STEMI and NSTEMI). Patients with MI who were admitted or transferred to other medical units were excluded due to pilot nature of this study. Patients with type II MI and those who were referred to coronary bypass surgery were excluded as well, as these patients are not referred to a post-MI clinic. We estimated that the current referral rate is 30% and current timely referral appointments is 50%, and established a target total referral rate of 60% and timely referral appointments of 100%. It was anticipated that pre- and-post- intervention charts would reveal generally homogeneous patients given the shared diagnosis of type I MI and age (≥ 18-year-old).

Subject Recruitment

During the study timeline, the medical records of all adult patients (≥ 18-year-old) who were discharged from the hospital's cardiology units with a diagnosis of type I MI (STEMI and

NSTEMI) were reviewed. Data collection continued throughout the 2 months pre- intervention and 2-months intervention time.

Cardiology fellows, NPs, and residents were identified as providers who initiate discharge and asked to participate in the study. The investigator approached cardiology NPs, fellows and residents and asked for 10 minutes meeting. Due to providers' time limits and work schedule differences, the investigator met with participants at different times. During meetings, the investigator conducted a short power point presentation covering a post-MI clinic role, current referral rates and new evidence-based referral form (included as Appendix G) which needed to be completed every time providers discharged a patient with type I MI. Providers were asked to leave a completed form in a marked box located at the cardiology units workstations. Each box was marked as the "post-MI referral forms box". The clerical staff members were informed about boxes and purpose. The investigator collected completed forms on weekly basis. Given the importance of this initiative for improving patient outcomes after type I MI and relatively short intervention phase (2 month), we anticipated that all providers would agree to participate. Providers' compliance with implementing the new protocol was monitored by comparing the number of completed referral forms with the number of patients with type I MI who were discharged each week. This strategy supported timely interventions which were implemented if it was observed that forms were not utilized each time a patient with type I MI was discharged. The following interventions were implemented: reminder emails were sent out, providers were re-educated.

At the end of the study, the investigator asked NPs, fellows and residents to complete an anonymous survey which was created by the study team (included as appendix F). An online survey tool, Google Forms, was utilized to administer the survey. A link to the survey was

emailed to all participating providers. The purpose of the survey was to evaluate providers' satisfaction and perceptions related to the usability and usefulness of the revised readmission risk assessment protocol.

Consent Procedure

The hospital's IRB has approved this study as a non-research, QI study. Consent was not needed.

Risks and Harms

The hospital's IRB has classified this study as a QI study. Potential loss of patient privacy was addressed by not including patient identifiable information on the Excel spreadsheet which was used to collect information during the chart review. Data related to each patient was identified using a unique number (1 pr, 2 pr, 3 pr,… , and 1 po, 2 po, 3 po,…). The risk-assessment form contained a discharge date, a referral date and a calculated risk score only. To increase security of the data, it was saved in password-protected cardiology office computer registered with the Information Technology (IT) at the hospital, and stored on a hospital server in the folder located under the Secure Analytic Framework Environment (SAFE) virtual desktop. The principle investigator (PI), the primary and secondary investigators were employed by the hospital and completed the HIPAA and the CITI training courses. Data which was no longer needed was destroyed. At the end of the study, saved information was destroyed by shredding papers and wiping electronic files.

Costs and Compensation

Patient compensation was not considered as this study involved medical records review. To minimize providers' time investment, it was estimated that the post- intervention survey

would take between 5 to 10 minutes to complete. The evidence-based risk assessment form was emailed to all participating providers. In addition, we provided printed copies of the form. We determined that it should take no longer than 5 minutes to complete the form.

Intervention

The revised risk assessment protocol (included as Appendix C) was implemented within the cardiology units. To inform clinicians about the study and the new protocol, face-to face meetings were conducted. The clinicians were informed that the revised post-MI risk assessment protocol will be tested to determine if it would help to improve a referral process among patients who sustained type I MI. Cardiology NPs, fellows and residents were asked to use the risk-assessment form (included as Appendix G) to calculate patients' risk for readmission, and refer patients to a post-MI clinic if patients could not see a cardiologist within 7-14 days after discharge. The revised readmission risk assessment form was emailed to all identified providers. Every week during the intervention phase, the investigator sent a reminder emails to ensure form completion. Providers were asked to calculate and write the score, the discharge and referral dates, to where referrals were made (a cardiologist or a post-MI clinic), date of appointment and a reason for not scheduling an appointment or not referring on the risk assessment form, and to drop the completed forms in specific, labeled boxes located at the cardiology units work stations. The investigator collected the completed risk assessment forms weekly. When a number of referrals did not match a number of completed forms, the investigator followed with discharging providers to understand why the form was not completed. Clerical associates who work at the cardiology units were informed about boxes and its purpose. A courtesy email was sent to the cardiology attending physicians and nurse managers to inform about the project and its length and to receive support for the study.

In the post- intervention phase, all identified providers were asked to complete short anonymous survey (included as Appendix F). An online survey tool, Google Forms, was utilized to administer a survey. The purpose of the survey was to evaluate providers' perceptions related to the usability and usefulness of the revised readmission risk assessment protocol to understand if a new protocol will sustain long-term.

Outcomes measured

The following outcomes were measured during this project:

Outcome 1: Increased referrals to a cardiologist or a post-MI clinic among patients with Type 1 MI

- Evaluation Question: Does use of an evidence-based readmission risk assessment referral protocol increase referrals at discharge among patients with Type I MI?
- Process Measure: % of referrals among patients with type 1 MI who were discharged from the hospital
- Data collection: Data to answer this question was collected by reviewing the medical records of patients obtained from EPIC before and during implementation of the new protocol. This data included patients who were referred and who were not referred.

Outcome 2: Increased scheduled post- discharge follow-up appointments within recommended timeframe (7- 14 days) among patients with type I MI

- Evaluation Question: Does use of an evidence-based readmission risk assessment referral protocol increase appointments scheduled within recommended timeframe after discharge among patients with type I MI?
- Process Measure: % of patients who were scheduled to be seen within recommended timeframe after discharge

- Data collection: Data to answer this question was collected by reviewing the medical records of patients obtained from EPIC before and during implementation of the new protocol. This data included patients who were scheduled and who were not scheduled within recommended timeframe.

Outcome 3: Provider satisfaction with the usability and usefulness of the new protocol.

- Evaluation Question: What are providers' perceptions related to the usability and value of the revised evidence-based risk assessment referral protocol?
- Outcome Measure: Provider satisfaction ratings
- Data Collection: This data was collected from a short post-implementation survey which included scale, open-ended and nominal variable questions.

Outcome 4: Consistent provider adoption of the evidence-based risk assessment referral protocol.

- Evaluation Question: How consistently do providers utilize the new referral protocol when discharging patients with type 1 MI?
- Process Measure: % of completed risk assessments forms for patients with type I MI
- Data Collection: To assess this outcome, we compared the number of completed forms with the number of post-MI patients who were discharged with the diagnosis type I MI.

Long term outcomes that were not measured during this study include a reduction in unplanned readmissions to the JHH within 30 days after discharge and the related costs associated with these readmissions.

Project Timeline

The study was conducted between May 1, 2019 and April 30, 2020.

Resources Needed

Resources needed for this study included access to EPIC, a secured computer to store collected data, SPSS software, and manpower to administer the new protocol (mid-level cardiology providers, cardiology fellows and residents).

Evaluation

The evaluation for the study included questions, performance measures, data collection methods, timing, and the specific data elements related to each anticipated outcome. Details and a table summarizing this plan included in "Outcomes measured" section of this paper and in the Appendix H.

Data Analysis, Maintenance & Security

Statistics to assess the impacts of this QI study were calculated using SPSS software. Descriptive and Chi-square statistics were calculated to assess the change in percentage of referrals. Descriptive statistics were used to determine the level of provider satisfaction related to each survey item. A content analysis method was used to synthesize themes from the one open ended question asking clinicians to share their thoughts and suggestions related to the new protocol.

For more data maintenance and security, please refer to section Risk and Harms. Data accuracy was verified by a second investigator who reviewed a sample of the raw and coded data prior to the data analysis phase.

Findings

Patients' demographics

Fifty-seven patients met the study inclusion criteria (N=57): 29 patients (n=29) during the pre-intervention phase and 28 patients (n= 28) during the intervention phase. There were 35 male (61.4%) and 22 female (38.6%) patients. Twenty-five patients (43.9%) were from age groups 41-60 and 61-80, respectively. These two groups represented the majority of included patients. Seven patients (12.3%) were from 81 and older age group. There were no patients in the age group 18-40. Based on the AMI READMITS score calculation, 33 (57.9%) patients were from a low-risk group (includes extremely low and low risk for readmission) and 24 (42.1%) were from a high-risk group (includes moderate, high and extremely high risk for readmission).

Outcome 1: Increase referrals to a cardiologist or a post-MI clinic among patients with Type 1 MI

Findings demonstrated a statistically significant increase in documented referrals after implementing the new referral protocol. During the pre-intervention phase, 66% of patients with type I MI were referred to see a cardiologist or a nurse practitioner at a post-MI clinic. During the intervention phase, 89% of patients were referred and there was no documented referral for 11% of patients. During the intervention phase, the percentage of referrals increased by 23% and there was no documented referral for 34% of patients. As shown in Bar Chart 1 and Table 1, Chi square results indicated that the increase in referrals was statistically significant.

Bar Chart 1: Total Appointments Scheduled as Recommended Before and During Intervention

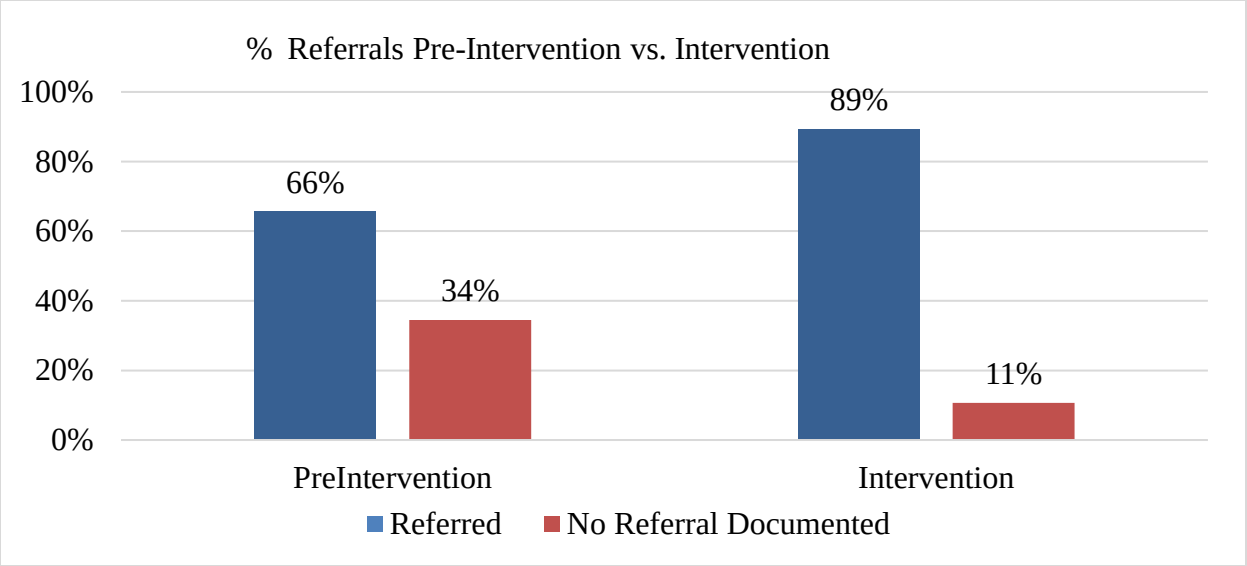

Table 1: Total Referrals Before and During Intervention

	Referred		No Referral Documented		Total	
Pre-Intervention	19	(33.3%)	10	(17.5%)	29	(50.9%)
Intervention	25	(43.9%)	3	(5.3%)	28	(49.1%)
Total	44	(77.2%)	13	(22.8%)	57	(100.0%)

(χ^2=4.571, *df* =1, *p*= 0.033)

Outcome 2: Increase scheduled post- discharge follow-up appointments within recommended timeframe: within 7 days for patients from high-risk group and within 14 days for patients from low-risk group

Data analysis examined whether patient referrals fell within the recommended timeframe of 7 days for high-risk group (included moderate-to-extremely high risk) and 14 days for low-risk group (included low-to-extremely low risk). Data showed that during the intervention phase, the percentage of patient appointments that were scheduled as recommended increased from 16% to 26%, an increase of 10%. The date of referral was not documented for 21% of patients during the

pre-intervention phase and 11% of patients during the intervention. The percentage of follow-up appointments scheduled after 7- 14 days after discharge from the hospital increased by 2 % during the intervention phase which was not statistically significant (see Bar Chart 2 and Table 2)

Bar Chart 2: Opinions about the AMI READMITS score implementation in clinical practice

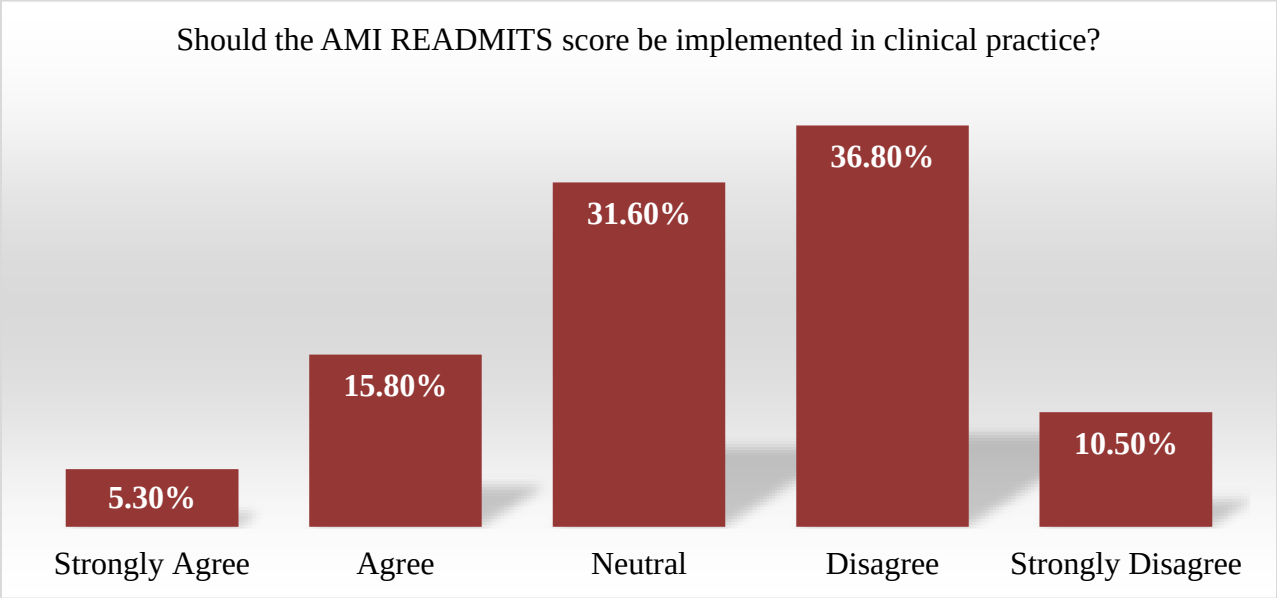

Table 2: Total Appointments Scheduled as Recommended Before and During Intervention

	Scheduled As Recommended		Date Not Documented		Total	
Pre-Intervention	9	(15.8%)	12	(21.1%)	29	(50.9%)
Intervention	15	(26.3%)	6	(10.5%)	28	(49.1%)
Total	24	(42.1%)	18	(31.6%)	57	(100.0%)

(χ^2=3.550, *df* =2, *p*= 0.169)

Outcome 3: Provider satisfaction with the usability and usefulness of the new protocol.

Surveys were emailed to 25 cardiology fellows and 3 cardiology NPs who participated in this study. 18 of the 28 clinicians (15 cardiology fellows and 3 cardiology NPs) responded for a response rate of 64%. We could not determine which residents rotated through the cardiology units during the intervention phase; thus, we did not email a survey to residents. Cardiology fellows were asked to forward a survey to residents who had clinical responsibilities at the cardiology units during the intervention phase. 1 resident responded, resulting in a sample size of 19 participants. When asked if the protocol was easy to use, 79% "agreed" to "strongly agreed" that the protocol was easy to use. Eighteen of the 19 participants (95%) agreed or strongly agreed that the protocol was useful in making referral decisions. Sixty-eight percent agreed or strongly agreed that the AMI READMITS risk assessment score improves referral process. All participants (100%) agreed or strongly agreed that there should be an option to incorporate the AMI READMITS risk assessment score to electronic clinical notes via smart phrase. When asked whether the AMI READMITS risk score should be implemented in clinical practice, responses were mixed. A common theme among the four participants who responded with comments was related to the need for additional data to validate the usefulness of the AMI READMITS to improve referrals and reduce readmissions. These clinicians were unconvinced that the score should become a part of clinical practice at this time due to insufficient external validation. In addition to these comments, one participant commented that "manual calculation [of the risk score] is not ideal".

Outcome 4: Consistent provider adoption of the evidence-based risk assessment referral protocol.

Data analysis showed that most clinicians were consistent in completing a risk assessment form for every patient with Type I MI. Of the 28 patients discharged, 23 (82%) forms were completed.

Five forms were not completed due to a provider uncertainty on when form completion was required, forgetfulness, or a patient departing to a different state or a different country. Most (89.5%) of providers reported completing a form every time they discharged a patient with type I MI; 10.5% were inconsistent.

Study Limitations

This study used a self-created survey. Due to the QI nature of this study and our goal to assess providers' satisfaction with the specific risk assessment score, we felt that utilization of self-created survey was appropriate; however, sensitivity of this survey was not externally validated.

Since this study was based on patient charts review, we were unable to determine if lack of a documented referral accurately represented patients who were not referred. Although clinicians routinely document referrals in clinical notes or discharge summaries, there is a possibility that some referrals were made without documentation. This was most notable during the pre-intervention phase data when there was no formal procedure in place for documenting referrals. When a referral date and place was missing on a referral form completed during the intervention, we were able to trace the referral status of patients who were referred to a post-MI clinic or to a cardiologist affiliated with the hospital or who adopted the EPIC medical records system; however, we were not able to trace the referral status for those patients who might have received verbal referrals to unaffiliated cardiologists or to a cardiologist who used a different electronic medical record system or paper charts.

We did not conduct psychometric testing of the AMI READMITS score and there is a significant limit of published evidence to validate its use in predicting unplanned early

readmissions. Therefore, we cannot predict whether the increase in referrals found in this study will reduce unplanned early readmissions and reduce costs of hospital care.

Our study has low external validity. It was limited to one hospital and to cardiac care units only; therefore, it remains unknown if a referral protocol that includes the AMI READMITS score will significantly improve referral rates if tested in different settings, or if survey responses from providers outside of cardiology specialty would be similar to responses provided by other health care providers.

Discussion

Implications for Practice

The evidence-based referral protocol used in this study significantly increased appropriate referrals among patients with type I MI. In addition, the new protocol increased documentation of referrals, which provides evidence that the new protocol may be useful for future QI initiatives related to this study and possibly other studies.

Although there was an increase in appointments scheduled as recommended within 7 to 14 days after discharge, the change was not significant. It would be helpful to understand why some appointments were not scheduled as recommended. We did not assess challenges related to appointment scheduling. For instance, there could schedule conflicts when outpatient providers cannot see patients within 7 to 14 days after discharge. Additional studies are needed to learn more about challenges with follow-up after discharge and to develop appropriate strategies to increase the percentage of patients who receive post-discharge appointments within certain time.

The study results indicate providers' general support for the new protocol, at the same time highlighting mixed opinions related to the AMI READMITS implementation in clinical practice. Based on clinicians' hesitancy to implement the new protocol in practice without further

validation, it appears that the insufficient number of studies investigating effect of the AMI READMITS score on readmissions reduction may play a significant role in underutilization of this score in clinical practice. Initial work demonstrated this score may be the most promising and accurate in predicting early readmissions as it outperformed other multi-condition readmission models (Nguyen, Makam, Clark, Zhang, Das, & Halm, 2018).

Implications for Healthcare Policy and for Executive Leadership

Evidence-based findings should guide healthcare policy makers and executive leadership in making decisions related to patient care and health outcomes improvement. Results of this study showed positive impact of an improved protocol that includes readmission risk factors on referrals among patients with type I MI. In October 2019, Medicare has cut payments to over 2,000 national hospitals due to readmissions within 30-days after discharge (Kaiser Health News, 2019, October 1). Readmissions after MI is a health care quality metric and it is publicly reported (Khot, Johnson, Wiggins, Lowry, Rajeswaran, Kapadia, Menon, Ellis, Goepfarth, & Blackstone, 2018). The hospital tracks the percentage of unplanned readmissions within 30-days after discharge, including readmissions after MI. This percentage is compared to the national average readmissions after MI. Currently, the hospital's Cardiology prefers all patients with MI to have a follow-up within seven days to two weeks after discharge but the current protocol does not speak for why this time frame was chosen. For many other risks, such as stroke, falls, heart failure (HF) and readmissions associated with HF, complications after surgery, the hospital's cardiology teams use risk scores as a practice standard. Adaptation of the specific risk assessment within the post-MI referral protocol will help the hospital to improve practice quality and help clinicians to make more educated discharge decisions.

Implications for Quality/Safety

Improvements in clinical practice can be achieved through different strategies, two of them are improving healthcare practice quality and safety (Farley, Baumlin, Hamedani, Cheung, Edwards, Fuller, Genes, Griffey, Kelly, McClay, Nielson, Phelan, Shapiro, Stone-Griffith, & Pines, 2013). We believe clinical protocols should be designed in a way that they help clinicians to make best possible decisions related to patient care. Current post- type I MI referral protocol does not provide sufficient information to clinicians who make referral decisions. In contrast, an improved protocol based on the AMI READMITS score calculation and guidelines on how soon after discharge patients should have a follow-up fills the gap between what needs to be accomplished and why it needs to be accomplished.

Hospitals want to reduce the length of stay (LOS) to prevent hospital-relates complications and reduce healthcare cost (Health Catalyst, 2018, November 6). While early discharge strategy may help to reduce the cost of care and hospital-related complications, early follow-up after discharge plays tremendous role in keeping patients from returning to the hospital within 30 days after discharge. Early follow-up helps patients to put everything together and help providers to identify health issues and gaps in post-discharge care which often lead to readmissions. Both, efficient pre-discharge referrals and early follow-up after discharge, may prevent unnecessary readmissions and improve health care quality.

Plans for Sustainability and Future Scholarship

The study demonstrated that provider adoption of the protocol may be enhanced by incorporating it into electronic clinical notes. This can be done by including calculated score and follow-up recommendations directly into the notes. For example, the Rothman Index (RI) algorithm collects certain patient parameters from a significant amount of electronic health data and derives a score representing patients' condition and acuity in hospital settings (McLynn,

Ondeck, Cui, Swanson, Shultz, Bovonratwet, & Grauer, 2018). It would be possible to use an algorithm to calculate and automatically insert the AMI READMITS score in progress notes alerting clinicians about the risk for readmission. Once providers see the score, they will use a specific smart phrase to generate recommendations for a follow-up time after discharge. To achieve intervention sustainability, we recommend implementing this solution in a stepwise approach, first running a pilot project before permanent changes are made.

In addition to studying the impact of integrating the new protocol into the EHR, future QI studies should explore more specifically how and why the new protocol impacts clinician's decision-making and behavior related to post-MI referrals. For example, it may be useful to study whether the AMI READMITS score increases clinicians' awareness of the need for timely referral. In addition, further study related to the barriers to scheduling of referrals within the recommended timeframe is also needed.

Conclusion

The study demonstrated that implementing an evidence-based referral protocol that integrates the AMI READMITS risk assessment can increase appropriate referrals among patients with type I MI. Most clinicians who used the revised referral protocol indicated that it was easy to use to make referral decisions prior to discharge, but also wanted to see the risk score calculation incorporated into electronic clinic notes via smart phrase. While a majority of participating clinicians agreed that the AMI READMITS score is useful in making referral decisions, additional evidence validating the use of the AMI READMITS score to reducing readmissions is needed to support their acceptance and adoption of the new protocol in clinical practice. Additional QI study after the AMI READMITS score is further validated could further support the long-term adoption of the improved referral protocol in clinical practice.

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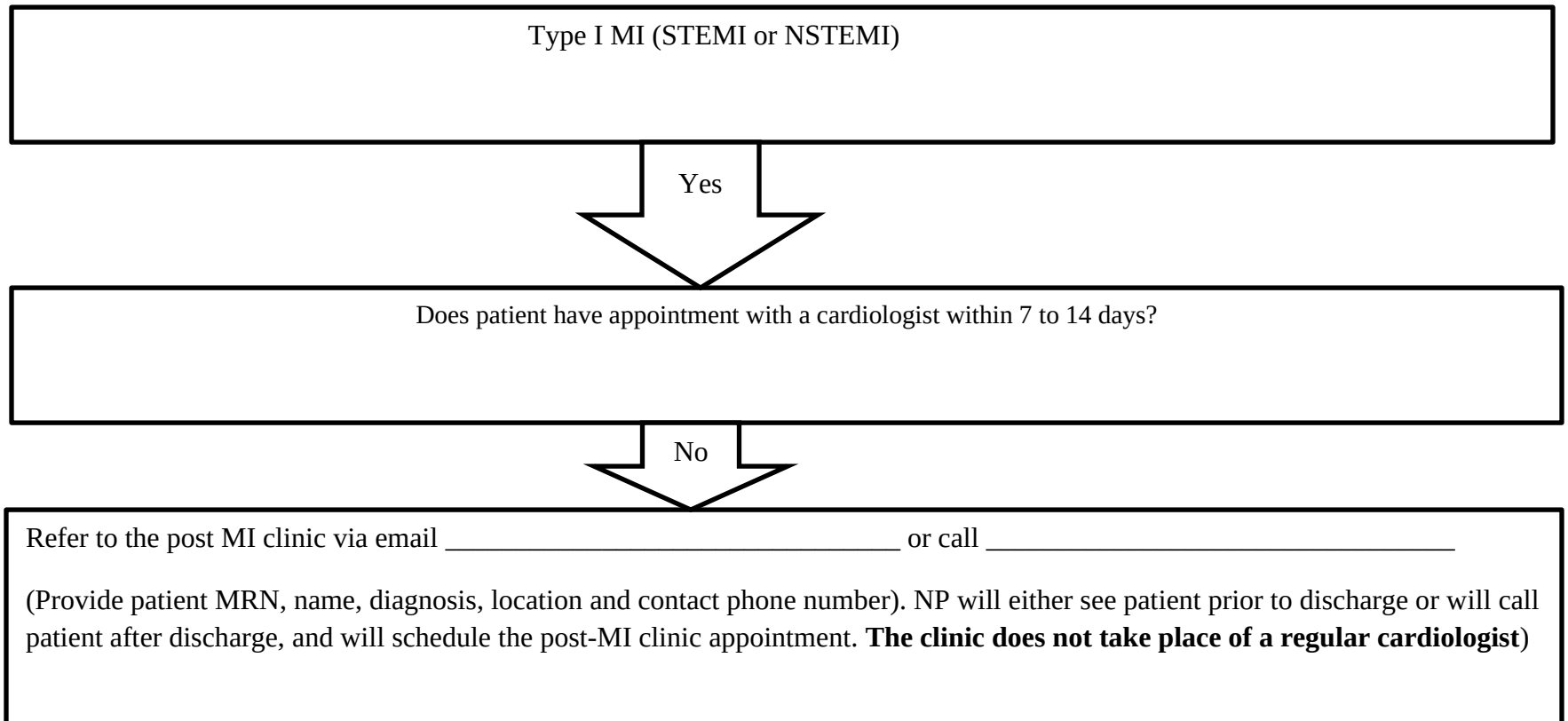
APPENDICES

Appendix A: A SWOT analysis

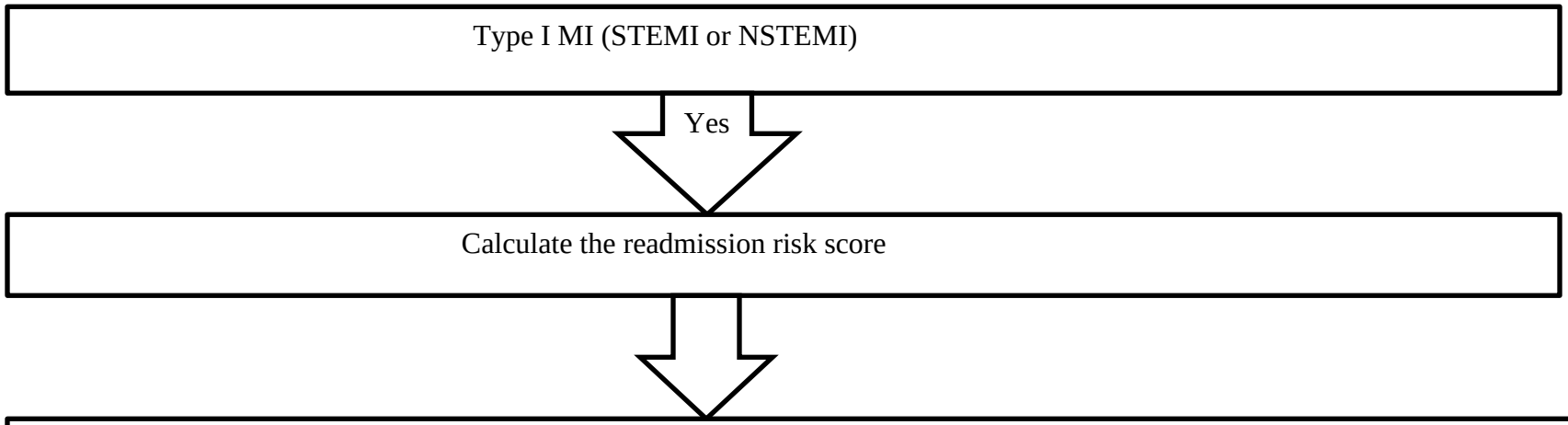
	Beneficial	**Harmful**
Internal	**Strength** • Research support • Various patient risk scores are utilized • Modern technology and free access to large peer reviewed journals • Evidence-based patient management • Oriented towards team work • High patient volume • Multicultural, diverse team • Oriented towards reduction in readmission rates, better patient outcomes, cost reduction which is aligned to the Triple Aim framework (Institute for Healthcare Improvement, 2019) • Nursing with Magnet recognition • EPIC (simplifies ordering and charts review)	**Weaknesses** • EPIC (may take long time to implement certain changes in interface) • Lack of efficient post-MI referral system integrated into clinician workflow • Many unfilled appointment slots at the post-MI clinic

External	**Opportunities** • Growing new technology (Mann, Sprague, & Skaggs, n.d.): distant patient management; connection between EMR systems; increasing and improving communication between the hospital and other health care facilities (example: internet consultations and records transmission)	**Threats** • Economy slowdowns • Regional large health care facilities, which provides identical health services and concentrates on the same community

Appendix B: Current post-MI referral protocol



Appendix C: Proposed revised post-MI referral protocol



Type I MI (STEMI or NSTEMI)	**YES**
AMI READMITS score	Points
Renal function (Cr > 2 mg/dl)	6
Elevated BNP (≥ 50 pg/ml for BNP or ≥ 125 pg/ml for NT pro-BNP)	8
Age (**per decade** > 18 y)	1
History of diabetes mellitus	4
Non- male gender	2
No Intervention with PCI within the first 24 hours	1
Systolic Blood Pressure < 100 mm Hg	3

Nguyen, O.K., Makam, A.N., Clark, C., Zhang, S., Das, S.R., & Halm, E.A. (2018). Predicting 30-Day hospital readmissions in acute myocardial infarction: The AMI "READMITS" (renal function, elevated brain natriuretic peptide, age, diabetes mellitus, nonmale sex, intervention with timely percutaneous coronary intervention, and low systolic blood pressure) score. *Journal of the American Heart Association, 7* (8), e 008882. doi: 10.1161/JAHA.118.008882. * Used with permission from Dr. Nguyen, O.K.

TOTAL POINTS: _____

RISK FOR UNPLANNED READMISSION AFTER AMI

≥ 20	Extremely high
18 to 19	High
16 to 17	Moderate
14 to 15	Low
≤13	Extremely low

Nguyen, O.K., Makam, A.N., Clark, C., Zhang, S., Das, S.R., & Halm, E.A. (2018). Predicting 30-Day hospital readmissions in acute myocardial infarction: The AMI "READMITS" (renal function, elevated brain natriuretic peptide, age, diabetes mellitus, nonmale sex, intervention with timely percutaneous coronary intervention, and low systolic blood pressure) score. *Journal of the American Heart Association, 7* (8), e 008882. doi: 10.1161/JAHA.118.008882. * Used with permission from Dr. Nguyen, O.K.

Score 16 or above- should see a cardiologist or an NP in post-MI clinic within 7 days

Score ≤ 13 to 15- should see a cardiologist or an NP in post-MI clinic within 14 days

Does patient have an appointment with a cardiologist within 7 to 14 days after discharge?

No

Refer to post-MI NP clinic, email _____ or call _____

(Provide patient MRN, name, diagnosis, location and contact phone number). NP will either see patient prior to discharge or will call patient after discharge, and will schedule the post-MI clinic appointment. **The clinic does not take place of a regular cardiologist**)

Appendix D: Literature evidence

This table is adapted from Dearholt, S. & Dang, D. (2018). *Johns Hopkins Nursing Evidence-Based Practice Model and Guidelines*. Indianapolis, IN: Sigma Theta Tau International, Chapters 5, 6, 7, Appendices D, E, F, and G.

Article #	Author & Date	Evidence Type	Sample, Sample Size, Setting	Study findings that help answer the PICO question	Observable Measures	Limitations	Evidence Level & Quality
1	American Hospital Association (2015)	Non-research evidence	N/a	This publication recommends The Change Package with the aim to reduce hospital readmissions among Medicare patients. Among change ideas is a risk assessment tool that requires minimal training and that may fit into routine workflow	Discussed preventable hospital readmissions and includes menu of strategies, change concepts and specific actionable items that any hospital can implement based on need or for purposes of improving life quality and prevent unplanned readmissions	Does not go beyond providing ideas and recommendations to clinicians. Does not discuss specific readmission risk assessment tools. Not approved as a national guideline	Level IV Quality B (sample size not applicable)
2	Cheney (2018)	Non-research evidence	N/a	AMI READMITS tool helps to predict	The author reviewed and summarized	The author extensively quotes other	Level V Quality C

				readmission risk for patients with heart attack	findings from the Journal of the American Heart Association (JAHA) research, which examined health outcomes for 826 acute MI (AMI) patients at six hospitals in Texas (refer to article # 6)	sources instead of providing independent expert evaluation	
3	Dunlay, Weston, Killian, Bell, Jaffe, & Roger (2012)	Research evidence: retrospective cohort study	Patients admitted to an Olmsted County hospital with first-ever MI from 1987 to 2010	Comorbidities (diabetes, COPD, anemia, higher Killip class), longer hospital stay, and procedural complications are associated with increased 30-day readmission risk	Examined 30-day readmission after MI. Measured diagnoses, therapies, and complications of angiography or revascularization procedure	1. Patients who did not return to the same hospital were not captured 2. Only one hospital data was examined (generalizability limitation) 3. Procedural complications were related to 1987-2010 years. Currently, coronary procedures techniques may be different	Level III Quality B

						(upgraded), and percentage of procedural complications may be lower	
4	Kim et al. (2018)	Research evidence: Retrospective cohort data analysis	All ST-elevation MI (STEMI) selected in the Nationwide Readmissions Database 9NRD) from 2010 to 2014. Of 181 545 078 discharge records reviewed, 709 548 patients presented with STEMI.	In the cohort, 41.6% of readmissions were related to non-cardiac causes Cardiac causes included angina, chronic ischemic heart disease, heart failure (13.9%), recurrent MI (11.3%), nonspecific chest pain, arrhythmia (4.2%). The following problems unrelated to MI were strongly associated with 30-day readmission: AIDS, anemia, chronic renal disease, collagen vascular disease, diabetes,	Examined the 30-day readmission rate and the primary cause and cost of readmission	1. Retrospective study with data obtained from the NRD, which does not include detailed information about patient clinical characteristics, such as heart failure class, left ventricle ejection fraction discharge medications, or out-of-hospital mortality data (increased risk that the selected cohort was either underrepresented or overrepresented) 2. ICD-9 code instead of ICD-10 code was used for defining	Level III Quality B

				hypertension, pulmonary hypertension, heart failure, atrial fibrillation. Female sex and length of hospital stay were strong predictors of 30-day readmission as well. 30-day readmission was associated with a ~ 50% increase in cumulative hospitalization cost ($p< 0.001$). The authors highlighted the importance the importance of closer surveillance of cardiac and general medical conditions in the first several weeks after STEMI discharge		patient diagnoses (chance of miscoded data) 3. The NRD includes discharges from 22 states across the United States (results cannot be considered completely generalizable) 4. Non-cardiac causes for readmission were underestimated, as revascularization complications (such as groin bleed, renal failure due to high amount of contrast administration during percutaneous intervention, infection from IV lines placement) were not included	

5	Kini et al. (2018)	Research evidence: Cohort study	All Medicare beneficiaries hospitalized with acute MI in ACTION registry from 2008 to 2014 (N=86,849)	Readmission within 90 days after MI can be predicted based on variables known prior to discharge. Patients who were readmitted more frequently were older, women, black, patients who had heart failure at first medical contact, patients with diabetes, patients with in-hospital complications, such as bleeding event (p value for all predictors < 0.001). These findings offer opportunities to design transitional care services	Readmissions within 90 days after discharge from the hospital with diagnosis acute MI	1. Only Medicare beneficiaries were included (limited generalizability) 2. Only variables from ACTION registry included (some cofounders, such as socioeconomic status, were not included) 3. Data was limited to the hospitals participating in the ACTION (limited external validity) 4. Excluded a large number of patients without > 70 % match to Medicare claims (limited generalizability) 5. Only first readmission was considered 6. Cardiogenic shock was not included into	Level III Quality B

						readmission prediction 7. Discriminatory capability of statistical model was moderate	
6	Kwok et al. (2017)	Research evidence: Retrospective cohort study	Royal Stroke University Hospital, a tertiary health care facility in United Kingdom. All patients admitted between 2012-2014 with AMI (N= 1,869)	Dominant cause of readmission non-cardiac chest pain (50%). Most common cardiac readmissions were for recurrent acute coronary syndrome (17.1%), stable angina (11.6%), and heart failure (9.8%)	Rates of 30-day readmission after AMI	1. Single-center study 2. Most of the patients were Caucasian 3. Pre-admission risk scores were not determined	Level III Quality B
7	Nguyen, Makam, Clark, Zhang, Das, & Halm (2018)	Research evidence: in order to derive and validate models predicting all-cause non-elective 30-day readmission after heart attack, the group of	6 hospitals in north Texas; patients with consecutive acute myocardial infarction hospitalizations from 2009 to 2010 (N=826)	AMI READMITS (renal function, elevated BNP, age, diabetes, non-male sex, intervention with timely percutaneous intervention, and low SBP) "score enables early prospective	30-day hospital readmissions after acute heart attack Comparing the full-stay AMI model to the new the AMI READMITS	1. Generalizability to other regions and settings unknown 2. the AMI READMITS score was not validated externally in other settings, regions and cohorts	Level III Quality B

		researchers conducted retrospective record data analysis		identification of high-risk acute MI patients for targeted readmission reduction interventions within the first 24 hours of hospitalization" (CI 95%, 0.71-0.74). "The full-AMI model with 3 additional predictors (intravenous diuresis, anemia on discharge, and discharge to post-acute care) only modestly outperformed the AMI READMITS" (CI 95%, 0.74-0.76)		3. Medications data was not included 4. The infarct characteristics (such as size and location), as well as door-to-balloon time may have effect on unplanned readmission	
8	O'Brien, Valsdottir, Wasfy, Strom, Secemsky, Wang, & Yeh (2017)	Research evidence: retrospective cohort analysis	The 2013 NRD was used to identify patients with a discharge diagnosis AMI (N=214,824).	The most common readmission diagnoses were: recurrent MI, ischemic heart disease (true	30-day all cause readmission cause and rates by sex and age. Readmission cost	1. The data was collected from a single database and from 21 states which may not reflect the entire United	Level III Quality B

			This sample was stratified to all-cause 30-day readmission by sex and age	angina), heart failure. Cost associated with readmission after MI totaled $ 447,506,740 ($176,743,622 attributed to readmission of women). Women were at the significantly higher readmission risk compared to men; an effect was strongest for younger women (OR 1.21, CI 95% (1.06-1.39 for ages 18-44; OR 1.13, CI 95% (1.07-1.18 for ages 45-64; OR 1.13, CI 95% (1.07-1.19 for ages 65-74), interaction p < 0.001		States population (generalizability limits) 2. Race information (such as black women vs. other races women) was not included 3. Socioeconomic factors were not included 4. The NRD data does not capture all patient health variables	
9	Rana, Tran, Luo, Phung, Kennedy, &	Research evidence: retrospective	Emergency department at the Barwon Health,	Hospital data can help identify patients who are at high risk of	EMR model was compared to the HOSPITAL score derived	1. The study performed in the single center	Level III Quality B

	Venkatesh (2014)	cohort data analysis	Australia (N=1660-patients with a confirmed MI diagnosis admitted between January 2009 and December 2011).	readmission after heart attack. The EMR model has higher discrimination in predicting readmissions (CI 95%, 0-71-0.85)	from Elixhauster comorbidities index (models were evaluated for the ability to identify patients at high-risk for 30-day readmission after heart attack)	(generalizability limitation) 2. The EMR model was not validated externally 3. Readmissions to other hospitals were not tracked 3. Some risk factors were not included (example: metabolic syndrome and waist circumference)	
10	Rodriguez, Acharya, Olson, & Cler (2015)	Research evidence: Retrospective cohort study	Patients readmitted as unplanned within 4 facilities of Methodist Health System (MHS) from October 2011 to September 2014 (N=962)	Older age, days from admission to catheterization, medical therapy at discharge, diabetes (DM), hypertension (HTN), stroke, major psychiatric disorders, insurance status, chronic kidney disease (CKD), and congestive	Readmission to the hospital 30-day after AMI	1. Death as outcome was not included 2. Report is not generalizable to medical centers performing predominantly thrombolytic therapy 3. Retrospective study limits inferential model capacity	Level III Quality B

				heart failure (CHF) associate independently with 30-day readmission (95% CI)		4. Only data from MHS was included (limited generalizability)	
11	Smith, Makam, Darden, Mayo, Das, Halm, & Nguyen (2018)	Research evidence: systematic literature review published through March 2017, and review of 18 readmission risk prediction models	In this study, readmission risk prediction models evaluated (18 models)	"AMI-specific readmission risk prediction models have modest predictive ability and uncertain generalizability" (e: 003885). Existing models do not provide timely information to help with identification of patients who are at high risk for readmission after MI	Risk-assessment models' ability to predict readmissions	1. Studies published in languages other than English and non-indexed studies might have been overlooked 2. Only few included studies compared models within the same population of patients 3. Most examined studies defined MI using both, ICD-9 and ICD-10 codes; thus, it was not clear whether MI definition could influence readmission prediction modeling	Level III Quality B

12	Tung, Chang, Chang, & Yu (2017)	Research evidence: Retrospective observational cohort study	Patients 18 years or older with non-ST elevation myocardial infarction (NSTEMI) (n = 5, 008) and heart failure (HF) (n= 13,577), who were discharged from hospitals in 2010 in Taiwan	After adjustment for patients and hospital characteristics, patients who had a follow-up within7 days after discharge, had a lower risk for 30-day readmission (CI 95%). The length of 7 days was selected based on The American College of Cardiology effort to improve transition care and H2H recommendations (hospital to home)	Association between early follow-up and 30-day readmission after AMI and HF	1. No random assignment 2. Information on disease severity was not available (this confounding factor cannot be excluded) 3. Possibility of unmeasured risk factors (hidden confounding variables) 4. Additional research is needed to investigate whether the effect of early follow-up with nurses or mid-level providers is the same as with physicians 5. Conducted in Taiwan (patients' profiles in other countries could be different; generalizability limitation)	Level III Quality B

Appendix E: Variabilities and overlaps between research studies in risk factors identified

	Dunlay, Weston, Killian, Bell, Jaffe, & Roger (2012)	Kim et al. (2018)	Kini et al. (2018)	Kwok et al. (2017)	Nguyen, Makam, Clark, Zhang, Das, & Halm (2018)	O'Brien, Valsdottir, Wasfy, Strom, Secemsky, Wang, & Yeh (2017)	Rodriguez, Acharya, Olson, & Cler (2015)
Demographics		Female sex	Women Older Black	Older	non-male sex age	Women (younger women)	Older age insurance status
Heart-related conditions		heart failure at first medical contact heart failure atrial fibrillation					congestive heart failure (CHF)
Vitals/symptoms		hypertension, pulmonary hypertension			elevated BNP low SBP		hypertension
Comorbidities	diabetes, anemia COPD higher Killip class	diabetes chronic renal disease anemia AIDS collagen vascular disease	diabetes	anemia	diabetes renal function		Diabetes [renal] chronic kidney disease (CKD) stroke,

							major psychiatric disorders
Interventions/Complications	longer hospital stay (3 days +) procedural complications after percutaneous intervention (PCI)	length of hospital stay (4 days +)	in-hospital complications	Less likely received coronary angiogram or PCI	intervention with timely percutaneous intervention		days from admission to catheterization medical therapy at discharge,

Appendix F: Post-intervention provider survey

1) Identify your current role in cardiology practice
   - Resident
   - Fellow
   - Nurse practitioner
2) During the project, did you use the AMI READMITS score every time you discharged a patient with type I MI?
   - Yes
   - No
   - If not, why not? (please specify)

3) Please rate your agreement with the following statements on the scale from 1 to 5, where

1 = strongly disagree

2= disagree

3= neutral

4= agree

5= strongly agree

a) I found the AMI READMITS risk assessment score easy to use

1	2	3	4	5

b) I found the AMI READMITS risk assessment score to be useful in making referral decisions for patients with type I MI

1	2	3	4	5

c) The new protocol incorporating the AMI READMITS risk assessment score improves referral process

1	2	3	4	5

d) I should have an option to incorporate the AMI READMITS risk assessment score into my clinical notes through smart phrase

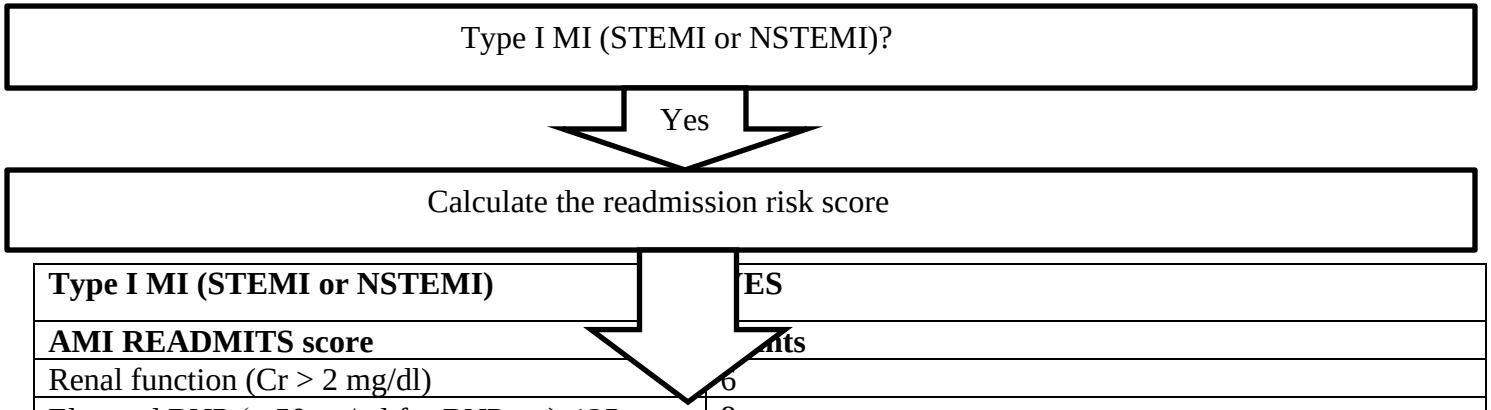
1	2	3	4	5

e) The AMI READMITS risk assessment score should be implemented in clinical practice

1	2	3	4	5

4) Please provide your thoughts and suggestions related to integrating the AMI READMITS risk assessment score to the post-MI referral protocol

Appendix G: Referral form



Type I MI (STEMI or NSTEMI)	**YES**
AMI READMITS score	**nts**
Renal function (Cr > 2 mg/dl)	6
Elevated BNP (≥ 50 pg/ml for BNP or ≥ 125 pg/ml for NT pro- BNP)	8
Age (**per decade** > 18 y)	1
History of diabetes mellitus	4
Non-male gender	2
No intervention with PCI within the first 24 hours	1
Systolic blood pressure < 100 mm Hg	3

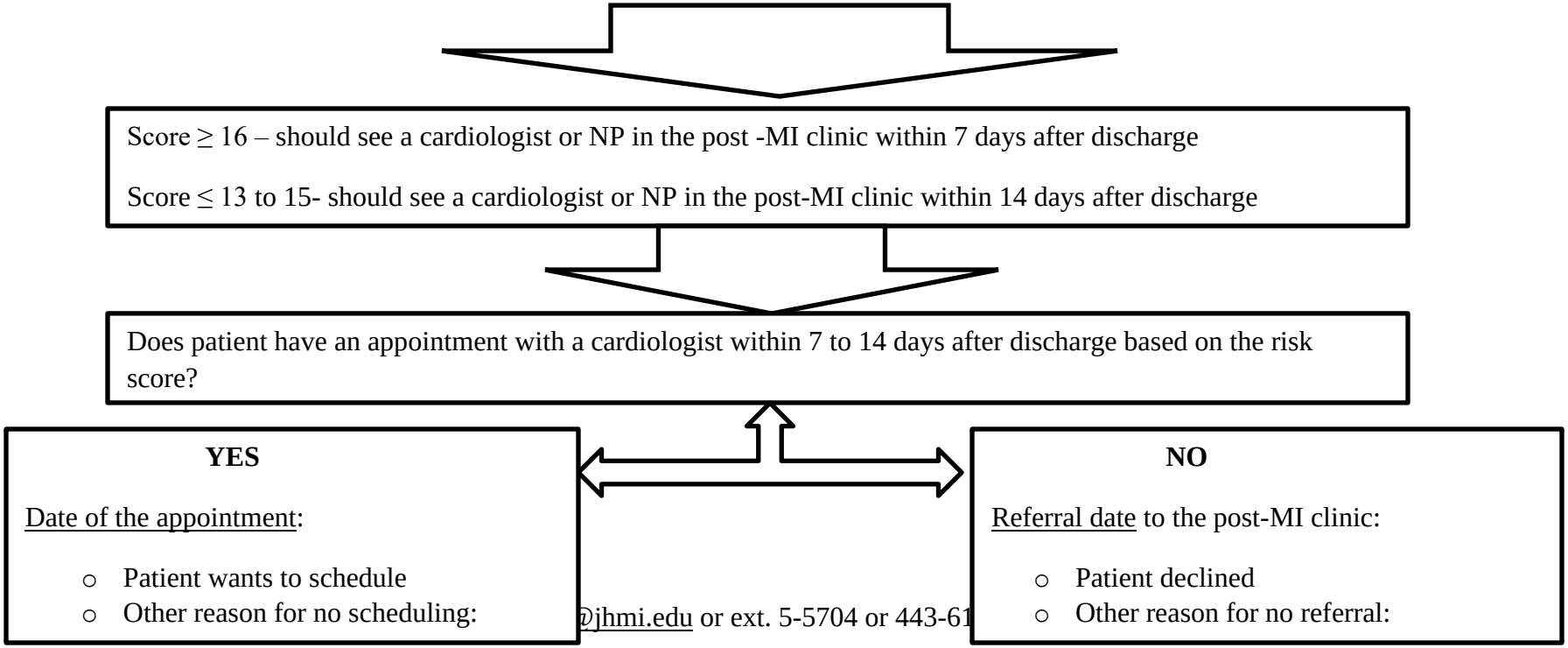
Nguyen, O.K., Makam, A.N., Clark, C., Zhang, S., Das, S.R., & Halm, E.A. (2018). Predicting 30-Day hospital readmissions in acute myocardial infarction: The AMI "READMITS" (renal function, elevated brain natriuretic peptide, age, diabetes mellitus, nonmale sex, intervention with timely percutaneous coronary intervention, and low systolic blood pressure) score. *Journal of the American Heart Association, 7* (8), e 008882. doi: 10.1161/JAHA.118.008882. * Used with permission from Dr. Nguyen, O.K.

TOTAL POINTS: _____

Risk for unplanned readmission after MI:

≥ 20	Extremely high
18 - 19	High
16 -17	Moderate
14- 15	Low
≤ 13	Extremely low

Nguyen, O.K., Makam, A.N., Clark, C., Zhang, S., Das, S.R., & Halm, E.A. (2018). Predicting 30-Day hospital readmissions in acute myocardial infarction: The AMI "READMITS" (renal function, elevated brain natriuretic peptide, age, diabetes mellitus, nonmale sex, intervention with timely percutaneous coronary intervention, and low systolic blood pressure) score. *Journal of the American Heart Association, 7* (8), e 008882. doi: 10.1161/JAHA.118.008882. * Used with permission from Dr. Nguyen, O.K.



(Provide patient MRN, name, diagnosis, location and contact phone number). NP will either see patient prior to discharge or will call patient after discharge, and will schedule the post-MI clinic appointment. **The clinic does not take place of a regular cardiologist**)

Appendix H: Evaluation Plan

Anticipated Outcomes/Questions	**Performance Measures (What)**	**Data Collection Methods (How)**	**Timing (When)**	**Data Elements**
Increased referrals to a cardiologist or the post-	% of referrals among	EPIC chart review	• 2 months pre-intervention	# of patients with type MI discharged from the JHH CCU and PCCU

MI clinic among patients with type I MI	patients with type I MI		• 2 months during intervention	# of referrals
Increased time-sensitive referrals among high- risk patients (includes moderate- to extremely high-risk) and low-risk patients (includes low-risk and extremely-low risk)	% of moderate to extremely high-risk patients scheduled to be seen within 7 days after discharge	EPIC chart review	• 2 months pre-intervention • 2 months during intervention	Risk Assessment factors (within 24 hours after admission) • Renal function • Pro- BNP • Age • History of diabetes mellitus (DM) • Gender • PCI Intervention • Systolic Blood Pressure (SBP) Risk Assessment Score (*Calculated from factors above*) # of low or high-risk patients (*Determined based on score – High Risk? Yes/No; Low Risk Yes/No)* # of patients scheduled to be seen within 7 to 14 days (S*cheduled within 7or 14 days? Yes/No*)
Provider's compliance the new readmission risk assessment protocol	% of completed assessment forms for patients with Type 1 MI	EPIC charts and completed referral forms	• 2 months during intervention	# of completed forms # of Type 1 MI patients discharged *To monitor project progress, provider compliance in completing a risk assessment for each patient will be tracked weekly by comparing the number of completed forms with the number of patients with type I MI discharged.*

Provider perceptions related to the usability and usefulness of the new protocol which includes the AMI READMITS score	Provider satisfaction ratings Qualitative feedback	Provider survey	• After intervention (providers will have 1 month to complete a survey)	Role (Item 1) Reported Use (Item 2) Ease of use (Item 3a) Usefulness (Item 3b) Improvement value (Item 3c) Adoption via smart phrase (Item 3d) Support for long term adoption (Item 3e) Qualitative responses (Items 2 & 4)