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Improving Stress Echocardiogram Access for Patients with Low-Risk Chest Pain in the Emergency Department Clinical Decision Unit

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Clinical Leadership Theme

This improvement project focuses on the Clinical Nurse Leader (CNL) curriculum element of *Clinical Outcomes Management.* The CNL will function as a Clinical Outcomes Manager. As the CNL for this project, evidence will be used to change practice and improve outcomes. Fundamental aspects of a CNL that align with this project include clinical leadership for patient-care practices and delivery, participation in identification and collection of care outcomes, and being accountable in the evaluation and improvement of point-of-care outcomes, including the synthesis of data and evidence to evaluate and achieve optimal outcomes (American Association of Colleges of Nursing, 2013). The following describes the global theme of this project: We aim to improve the stress echocardiogram (echo) appointment process for patients with low-risk chest pain. The process begins when the Echocardiography Laboratory (Echo Lab) receives an order for a stress echo from the Emergency Department Clinical Decision Unit (ED CDU). The process ends when the patient arrives for their stress echo in the Echo Lab. By working on this process, we can expect (1) improved patient satisfaction with appointment scheduling, (2) improved patient scheduling turnaround time expectations, (3) improved patient access, (4) improved ED workflow, and (5) decreased ED length of stay.

Statement of the Problem

The ED is a medical treatment area of a hospital where acute care patients present without prior appointment, either by ambulance or by their own means. It is a complex department that provides initial treatment of different types of illnesses and injuries. It operates 24 hours a day with varying staffing, including registered nurses (RNs), ED technicians, medical assistants, and office assistants. The ED CDU is where patients with chest pain are received and evaluated. Early discharge of patients with low to intermediate risk chest pain is determined

using high sensitivity troponin assay (markers of myocardial necrosis) and assessment by a modified HEART score through the HEART pathway assessment form (Appendix A). The modified HEART score is the recommended approach to risk stratification for patients with chest pain who have possible acute coronary syndrome (ACS), but not do not have an ST segment elevation myocardial infarction (STEMI) demonstrated on the electrocardiogram (ECG). The modified HEART score involves the assessment of the patient's **H**istory, **E**lectrocardiogram, **A**ge, **R**isk factors, and **T**otal score. A low risk score is zero to three and intermediate risk score is four or more. Per the ED CDU protocol (Appendix B) and the proposed Echo Lab stress appointment workflow (Appendix C), once it has been determined that the patient with low-risk chest pain is safe for discharge, cardiology evaluation/follow-up and completion of a stress echo is recommended 72 hours post discharge. The Echo Lab is a department in the hospital that provides cardiodiagnostic services such as transthoracic echos, transesophageal echos, and stress echos (dobutamine and treadmill). The patient population includes those who need evaluation for atherosclerosis, aneurysms, cardiomyopathy, congenital heart disease, congestive heart failure, pericarditis, and valvular heart disease. Due to the Echo Lab's current staffing model and space capacity, they are not able to accommodate the patients with low-risk chest pain from the ED CDU. The purpose of this project is to address the Echo Lab's limitations and develop a plan to improve scheduling access for stress echos for this patient population. There is some urgency in this improvement project since the current stress echo scheduling turnaround time is 21 days (Appendix D). Improving scheduling access would improve overall patient care, patient satisfaction, and staff satisfaction.

Project Overview

The site for this project is a level one trauma center located in northern California. This organization is open 24 hours a day, seven days a week and provides dynamic services to a diverse population. The Echo Lab is the microsystem that this project will highlight. The Echo Lab's hours of operation are Monday through Friday 7:00 am until 6:30 pm and 8:00 am until 4:30 pm on Saturday and Sunday. Referrals to the Echo Lab are received from outpatient physicians, inpatient units, Catheterization Angiography Laboratory (Cath Angio Lab), and the ED. The highest volumes of referrals are from the inpatient units and the ED.

Currently stress echos are available Monday through Friday from 8:00 am until 5:30 pm in four procedure rooms and Saturdays from 8:00 am until 4:30 pm in one procedure room. There is one registered nurse (RN) and one echo sonographer assigned to each stress echo procedure room. Six to eight stress echos in combination with transesophageal echos are performed in each procedure room daily. According to the accreditation and hospital guidelines, a physician must be on hospital grounds and available for consultation for stress testing.

The Echo Lab's employees include 24 sonographers, 11 RNs, five office assistants, one manager and one assistant manager. The sonographers and RNs work eight or ten-hour shifts. There are usually 14-16 sonographers and four RNs scheduled to accommodate the daily lab needs. One lead sonographer and one lead RN is scheduled daily to manage the department flow, address any staffing problems, and prioritize echo and stress echo orders. The manager and assistant manager huddle with the staff three times a day, at the beginning of the shift, middle of the shift, and at the end of the shift. They discuss any issues that need immediate attention. The pace of the department varies throughout the day. It is often slower at the beginning of the shift and becomes progressively busier.

The project analysis began at the beginning of the week to quantify the backlogged number of echo and stress echo requests from the prior week and weekend. We monitored all daily stress echo requests over four weeks and determined the scheduling turnaround time with the Echo Lab stress echo tracking tool (Appendix E). The average daily census is 58 transthoracic echo studies and 30 stress echo studies. The echo and stress echo requests are reviewed by the office assistants, the lead RN, and lead sonographer. Each request is prioritized, based on urgency, diagnosis, and need. The Echo Lab could only accommodate 24 stress echo studies daily with the current RN staffing and space capacity.

The following describes the specific aim statement: We aim to improve stress echo scheduling access for patients with low-risk chest pain by decreasing the scheduling turn-around time from 21 days to three days or less by August 31, 2017. According to the ED CDU Rapid Chest Pain Protocol (Appendix B), patients with low-risk chest pain do not have to wait to complete the stress echo and can be discharged from the ED. The stress echo can be completed as an outpatient test. Based on the four-week analysis and observation, the global aim statement aligns with the specific aim statement.

Rationale

A root cause analysis (RCA) and a 5Ps framework assessment was performed to identify the needs leading to the problem. Observations and time studies were conducted using a tracking tool. Data from the microsystem was collected and utilized to confirm the scheduling access problem. According to the data, there was limited access to schedule stress echos. Patients and providers were informed that the next available appointment for a stress echo was in 21 days. The RCA identified the need to expand the Echo Lab hours of operation, provide adequate staff, improve electronic patient scheduling, identify space, and identify equipment needs (Appendix

F). The 5Ps framework confirmed that there was a need to improve the current stress echo scheduling process. Performing observations and measuring the turnaround scheduling time gave our team insight into that process.

Members of the Cardiovascular Health and ED leadership team have been meeting weekly to discuss the plan and project. Utilizing the current staff, changing the staff work schedule, and acquiring space for an added stress echo procedure room will support this project. Since the Echo Lab will not need to hire additional staff, there will be no added labor costs or additional staff training needed for the project. The only labor cost will involve revising the current patient scheduling template, adding extra appointment slots for patients. It would take three to four hours for an office assistant to complete this task. The hourly rate for an office assistant is $30 per hour. Labor costs for this task would be $90 - $120. It's also important to acknowledge that the members of the leadership team started discussing the project in late April and started working on the project in May. The approximate hourly rate of each member of the leadership team is $70-$100/hour. We started meeting weekly in May for one hour. With approximately 6 members of the leadership team meeting weekly, the average cost of the team meeting is about $420-$600/week. We anticipate the total cost of the time spent by the leadership team to be $3,360 to $4,800, assuming they are meeting weekly until the end of June. We anticipate the implementation of our interventions in early July and I will observe the need to adjust our plan. To deploy a new stress echo procedure room, purchasing new stress test equipment and an ultrasound system is necessary. The cost of new stress test equipment is $40,000 and $200,000 for an ultrasound system. Adjusting the staff schedule would mean adding four extra stress echo appointment slots per day. Adding another procedure room would create six extra stress echo appointment slots per day. Based on the organizational service

charge revenue center, the cost of a stress echo is $3,500.00. If we were to fill these appointment slots with the patients with low-risk chest pain, the Echo Lab could generate an extra $175,000/week or $9,100,000/year (Appendix G). With the implementation cost of $244,920, our net potential revenue would be $8,855,080. It should also be noted that time spent on conducting observations and research is not included with the cost of the project based on the agreement that I would obtain this information for internship and educational purposes. Even though I would not be generating any cost, spending ten hours a week on this project could generate labor costs of $900 per week. This project will not only be cost effective and revenue generating, but it will also improve patient and staff satisfaction.

Methodology

The objective of this project is to improve stress echo scheduling access for patients with low-risk chest pain. Since the ED CDU is instituting an early discharge pathway for outpatient stress echo testing and/or a cardiology follow up within three days post discharge, it is imperative to assess the Echo Lab microsystem and identify the current state of the scheduling process. Through observations and time studies we confirmed the gaps in the scheduling process and implemented the necessary changes of workflows to improve patient, provider, and staff satisfaction while helping the ED improve their throughput and decrease the ED CDU length of stay. To support this project, the Lewin's Change Management Theory needs to be implemented (Appendix H). The three stages of Lewin's Change Management Theory include unfreezing, change, and refreezing. Unfreezing involves the staff preparing for the change, implementing a revised patient schedule and staff schedule. Change implies that the staff has accepted the need for change and has engaged in implementing the change. Refreezing embraces the change as part of the new norm. According to Grossman & Valiga (2013), leaders must help others

recognize the need for change, work with them to implement the change, evaluate the effect of change, and participate in the change process.

Once we identified the need for new equipment, adequate staffing, additional space, and the need to adjust the patient schedule, we understood that the biggest challenges would be changing the staffing model to accommodate the new schedule and finding space for another stress echo procedure room. It was important to get staff and leadership support prior to implementation. We demonstrated the increased stress echo volume trends over last few fiscal years and the projected growth over the next year and received approval to purchase the stress test equipment and ultrasound system. We had to ensure that we had enough RNs and sonographers scheduled daily to accommodate the potential stress echo demand. Knowing we had eight-hour shift RNs who were interested in changing to ten-hour shifts was encouraging, but we needed to determine what work hours would support the project. After discussion with the ED team, the rapid chest pain protocol would generate two to four extra stress echo requests per day until 5:30 pm. To provide coverage Monday through Friday until 6:30 pm, we needed two RNs to change their work schedule from 8:00 am until 4:30 pm to 8:00 am until 6:30 pm. This new schedule would support the capacity to complete more stress tests throughout the day. The proposed new staffing model would include five to six RNs and maintain 14 to 16 sonographers daily. The total number of working hours for the RNs would not change, only the shift times. At least one RN and one sonographer would be scheduled to work 8:00 am until 6:30 pm daily to accommodate any late stress echo requests. We offered the new shift to all the nurses and would determine the assignment based on seniority. Since all the senior RNs did not want to change their current shift, we offered the new shift to two RNs who requested to be considered.

After receiving the new stress test equipment and ultrasound system, we converted one of the regular echo rooms into a stress procedure room and implemented the new RN and sonographer work schedule. Opening another stress test procedure room and extending the lab hours will allow an increased scheduling bandwidth. During the implementation phase, test cycles will be performed by utilizing the Plan-Do-Study- Act (PDSA). According to Nelson, Batalden, & Godfrey (2007), the PDSA model for improvement conducts test of change in a disciplined and rapid fashion. It provides an approach to test ideas and encourage learning. We should not lose sight of our aim and what we are trying to accomplish. Data and metrics are the sources of measuring the success of the project. The problem, plan, and goal were captured on a simple A3, a problem-solving tool built around the PDSA thinking (Appendix I). It is a concise summary demonstrating the stress echo scheduling problem and solutions of extending Echo Lab hours, revising staff schedules, modifying the patient appointment template, and expanding stress echo procedure room capabilities. It also serves as a communication tool for staff to utilize. I will conduct similar observations and time studies that were performed in the initial assessment and will expect to find a decrease in the stress echo scheduling turnaround time.

Data Source/Literature Review

As mentioned previously, the site of the project is the Echo Lab in a level one trauma center in Northern California. The Echo Lab serves patients referred from outpatient physicians, inpatient units, Catheterization Angiography Laboratory, and the ED, with the highest volumes of referrals from the inpatient units and the ED. The Echo Lab's hours of operation are Monday through Friday 7:00 am to 6:30 pm and 8:00 am to 4:30 pm on Saturday and Sunday. Currently, stress echos can be performed in four procedure rooms. Six to eight stress echos in combination with transesophageal echos are performed in each procedure room daily. The Echo Lab is a

revenue generating department with moderate expenses. After performing a microsystem assessment, time studies, and receiving leadership feedback of dissatisfaction of stress echo scheduling, we determined the need for this project. The following literature review compiled for this project supports the rapid chest pain protocol, early discharge of low-risk patients, and the recommendation of a stress echo versus more invasive treatment to rule out coronary anomalies.

In a study by Levsky et al. (2013), they compared the performance of stress echocardiography (SE) and coronary computed tomography angiography (CTA) in Emergency Department (ED) patients with chest pain who had low to intermediate risk of coronary artery disease. The study measured the admission rate, length of stay in the ED/hospital, and the estimated cost of care. They concluded that literature and experience suggest that SE may triage more patients to discharge from the ED than CTA. This proved that SE would be favored due to cost and lack of potential cancer risk from radiation from CTA. Invasive treatment would also be avoided.

A review performed by Tygesen, G.B., Hakonsen, S.J., & Uhrenfeldt, L. (2016), found that simple scoring systems that predict the likelihood of same-day or early discharge after assessment may be used to assess patients, and can be appropriate for ambulatory care management. The study examined ED overcrowding and concluded that input, throughput, and output factors were important. They identified inappropriate, avoidable, preventable or unnecessary admissions to the ED and concluded that the use of assessment tools to identify patients who could be safely discharged could improve ED length of stay.

Sepehrvand, N., Zheng, Y., Armstrong, P.W., Welsh, R.C., & Ezekowitz, J.A. (2017) reviewed the accelerated diagnostic protocols (ADPs) that were developed to allow ED

physicians to identify appropriate patients with low-risk chest pain for safe early discharge. They looked at patients from the Providing Rapid Out of Hospital Acute Cardiovascular Treatment (PROACT) trials, where patients presented to the ED with chest pain or dyspnea. The researchers identified that the primary outcome interest was 30 day major adverse cardiac events and the diagnosis of acute coronary syndrome occurring within 30 days after ED presentation. They concluded that a simplified assessment of chest pain score accelerated diagnostic protocol to assess patients with chest pain using contemporary troponins.

Beri, et al. (2016), reviewed data from the Copeptin Helps in the Early Detection of Patients with Acute Myocardial Infarction (CHOPIN) trial, which enrolled patients with acute chest pain. The study demonstrated that patients with a normal electrocardiogram (ECG) and a low troponin and copeptin level at presentation and after two hours were candidates for early discharge with outpatient follow up, including stress testing. The study concluded that the combination of a normal ECG with a normal troponin and copeptin at presentation and after two hours defines a low-risk population for MI or death at 180 days. They were also candidates for early outpatient testing and follow up. Their data also recommended that early stress testing may reduce the rate of cardiac re-hospitalization.

Riley et al. (2016), demonstrated that the HEART pathway had a significantly lower cost per individual compared with the usual treatment. The use of the HEART pathway is a decision tool used to classify patients presenting with undifferentiated chest pain into high and low-risk major adverse cardiovascular events (MACE). This study showed that despite increasing use of noninvasive testing, the basic clinical tools of history, physical examination, electrocardiography, and troponin (biomarker testing) are recognized for early identification of low-risk patients. This study concluded that the use of the HEART Pathway to risk stratify

decreased objective cardiac testing, increased rates of early discharge, decreased length of stay without increasing the risk for adverse events or recurrent evaluations for chest pain.

Altherwi, T. & Grad, W.B. (2015), concluded that their accelerated diagnostic protocol (ADP) identified patients with low-risk chest pain without an increase in major adverse cardiovascular events (MACE). Patients with a negative ADP were appropriate for early discharge from the emergency room and short-term follow up. They also demonstrated that by using their ADP, 20% of patients with low-risk chest pain could avoid further workup in the emergency department.

Initially, performing a PICO search for the literature articles reviewed was somewhat challenging, but I determined that the use of more specific words produced more articles. There were limited resources available specific to echo scheduling and access. After a few attempts, the PICO search statement is P - patients with low-risk chest pain, I - create stress echo appointments, C - no stress echo appointments available, O - improved patient access.

Timeline

The projected timeline for this project is three months. The initial phase includes informing the stakeholders and presenting the business plan from May 1st through May 12th, 2017. Phase two is the coordination of meetings for team members which takes place between May 1st and July 31st, 2017. The third and fourth phase is in collaboration with one another, occurring between May 1st and May 15th which involves purchasing and determining the space for the new stress test equipment and ultrasound system. The fifth and sixth phase is the revision of the patient scheduling template and revising the staffing model during June 1st and June 9th, 2017. We don't anticipate taking a whole week to complete, but are allowing time to accommodate any issues. Phase seven, the implementation of the new equipment and staffing

model occurs between June 12th and July 11th. Lastly, phase eight takes place between July 3rd and August 30th. This time allows for review and revision of the interventions, thus implementing the PDSA process. I will be conducting time studies during this period to evaluate if the project was successful in decreasing the scheduling turnaround time for stress echos (Appendix J).

Expected Results

After implementation of a new staffing and scheduling model, acquirement of new equipment, and activation of a new stress echo procedure room, I expect to fulfill my specific aim statement of improving access for patients with low-risk chest pain by decreasing the scheduling turn-around time from 21 days to three days or less by August 31, 2017. As a CNL, I anticipate some initial resistance from the staff. I will be supportive of the anxiety that the staff might be experiencing. I will provide guidance and coaching, review the simple A3 as a reminder of our objective and conduct discussions with the staff to welcome feedback and confirm that they understand the project and its' effect on the Echo Lab and the ED. I anticipate that after a few weeks post implementation of the new schedule, the staff members would feel more comfortable in their roles. Patient, staff, and physician satisfaction assessments and time studies will be conducted to confirm the success of the project.

Nursing Relevance

This quality improvement project demonstrated the gaps in the current process and workflows in the Echo Lab. The creation a rapid chest pain protocol in the ED affected the Echo Lab's capacity to absorb these patients. Our team identified the scheduling inefficiencies and empowered the staff to create a well-organized and cost-effective process. This project promoted staff engagement and improved patient satisfaction. There were numerous studies that

supported this type of collaborative project as indicated in the data source/literature review section. As a Clinical Outcomes Manager, I used data to change practice and improve outcomes. This fulfills the CNL competency of utilizing performance measures to assess and improve the delivery of evidence-based practices in order to deliver high quality of care (American Association of Colleges of Nursing, 2013).

Summary Report

The purpose and aim of this project was to improve stress echo scheduling access for patients with low-risk chest pain by decreasing the scheduling turn-around time from 21 days to three days or less by August 31, 2017. Patients with low-risk chest pain do not have to wait to complete the stress echo and can be discharged from the ED. The stress echo can be completed as an outpatient test. There was some urgency in the implementation of this project because it was a collaborative effort with the ED. The ED recently implemented a rapid chest pain protocol and the Echo Lab needed to have the capacity to provide stress echos within three days post patient discharge. The Echo Lab is a department in a large teaching hospital that provides cardiodiagnostic services such as transthoracic echos, transesophageal echos, and stress echos (dobutamine and treadmill). The patient population includes those who need evaluation for atherosclerosis, aneurysms, cardiomyopathy, congenital heart disease, congestive heart failure, pericarditis, and valvular heart disease.

The methods used to implement my project included observations, time studies, and the PDSA process. I conducted initial observations and time studies over four weeks to identify the current state of the scheduling turnaround time for all stress echos. It was determined that stress echo requests were prioritized, but patients were still not being scheduled in a timely manner. The scheduling turnaround time was 21 days. I performed a root cause analysis to understand

why there was a delay in scheduling. The root cause analysis identified the need to expand the Echo Lab hours of operation, provide adequate staff, improve electronic patient scheduling, identify space, and identify equipment needs. We created a simple A3 to document and communicate our goal, our root cause analysis, and project plan. Once the team identified the space for an additional stress echo room, we requested the purchase of new stress testing equipment and an ultrasound system. Team discussions were held to determine the new staffing model. We confirmed that we did not have to hire additional staff. We established that we needed to change two RN schedules. The other staff schedules were not affected. To accommodate the new lab hours, our office assistant needed to change the patient scheduling template. It was important for the leadership team to remain transparent with the staff and keep them informed of the project progress. Once we received the new equipment, we implemented the new RN schedule to align with the new Echo Lab hours.

Our team reviewed literature provided by the ED regarding the use of high-sensitive troponins and the use of the HEART assessment tool to identify the at-risk patients with chest pain. We also studied the ED CDU chest pain protocol to understand the Echo Lab's role in the process. We often referred to our project plan and A3 as a reminder of our goal and tasks.

After the implementation of a new stress procedure room and new patient and staff scheduling model, we could accommodate not only the patients with chest pain from the ED CDU, but all other scheduling requests. Initially, we thought we were going to add five extra stress echo slots per day. This project created eight to ten extra stress echo appointment slots. The additional stress echo procedure room created six stress echo appointments and the change of the RN schedule created an opportunity to add two to four extra appointments in the afternoon. This new capacity would improve scheduling access, patient and physician

satisfaction, and generate hospital and professional revenue. Time studies and observations two weeks post intervention demonstrated improved stress echo scheduling turnaround time from 21 days to 1 day (Appendix K).

My sustainability plan would include assessing and documenting the ED CDU low-risk chest pain stress echo requests. We will be tracking the requests for approximately six months. We will document when the patient was scheduled and when the patient completed the stress echo. This data will be shared with the ED team and together we will determine the success of the project. We will evaluate the new RN and sonographer staffing model, extended lab hours, and assess patient, staff, and physician satisfaction.

This project not only improved scheduling access, but it improved patient and staff satisfaction. The team contributed to the proposed interventions and remained engaged throughout the project timeline. Change is often difficult to accept. Although the Echo Lab team was resistant to the change initially, they embraced the process. This project would not be possible without the full support of the Echo Lab staff and leadership team, my preceptor, and my professors. It was exciting to be part of a high-quality team that gave me the opportunity to learn. Through this project, I have gained academic and professional experience that will assist me in my future endeavors as a Clinical Nurse Leader.

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Appendix A

MODIFIED HEART SCORE AND HEART PATHWAY ASSESSMENT FORM

Modified HEART Score

- The HEART Score is the recommended approach to risk stratification for all chest pain patients who have possible ACS, but do not have STEMI

HEART Score		Points
History	Highly Suspicious	2
	Moderately Suspicious	1
	Slightly Suspicious	0
ECG	Significant ST-depression	2
	Non-specific repolarization abnormality	1
	Normal	0
Age	≥ 65	2
	45-65	1
	≤ 45	0
Risk factors	3 or more risk factors	2
	1-2 risk factors	1
	No risk factors	0
Total		

Low risk: total score 0-3
Intermediate risk: total score 4 or more

Mahler et al. ***Circ Cardiovasc Qual Outcomes*. 2015**

HEART Pathway Assessment Form

HEART Score:

Patient ID _____
☐ Initial Assessment
☐ Second Assessment

History:

High-Risk Features:
- Middle- or left-sided
- Heavy chest pain
- Diaphoresis
- Radiation
- N/V
- Exertional
- Relief of symptoms by sublingual nitrates

Low-Risk Features:
- Well localized
- Sharp pain
- Non-exertional
- No diaphoresis
- No N/V

☐ Highly Suspicious	**2 points**	**Mostly high-risk features**
☐ Moderately Suspicious	**1 point**	**Mixture of high-risk and low-risk features**
☐ Slightly Suspicious	**0 points**	**Mostly low-risk features**

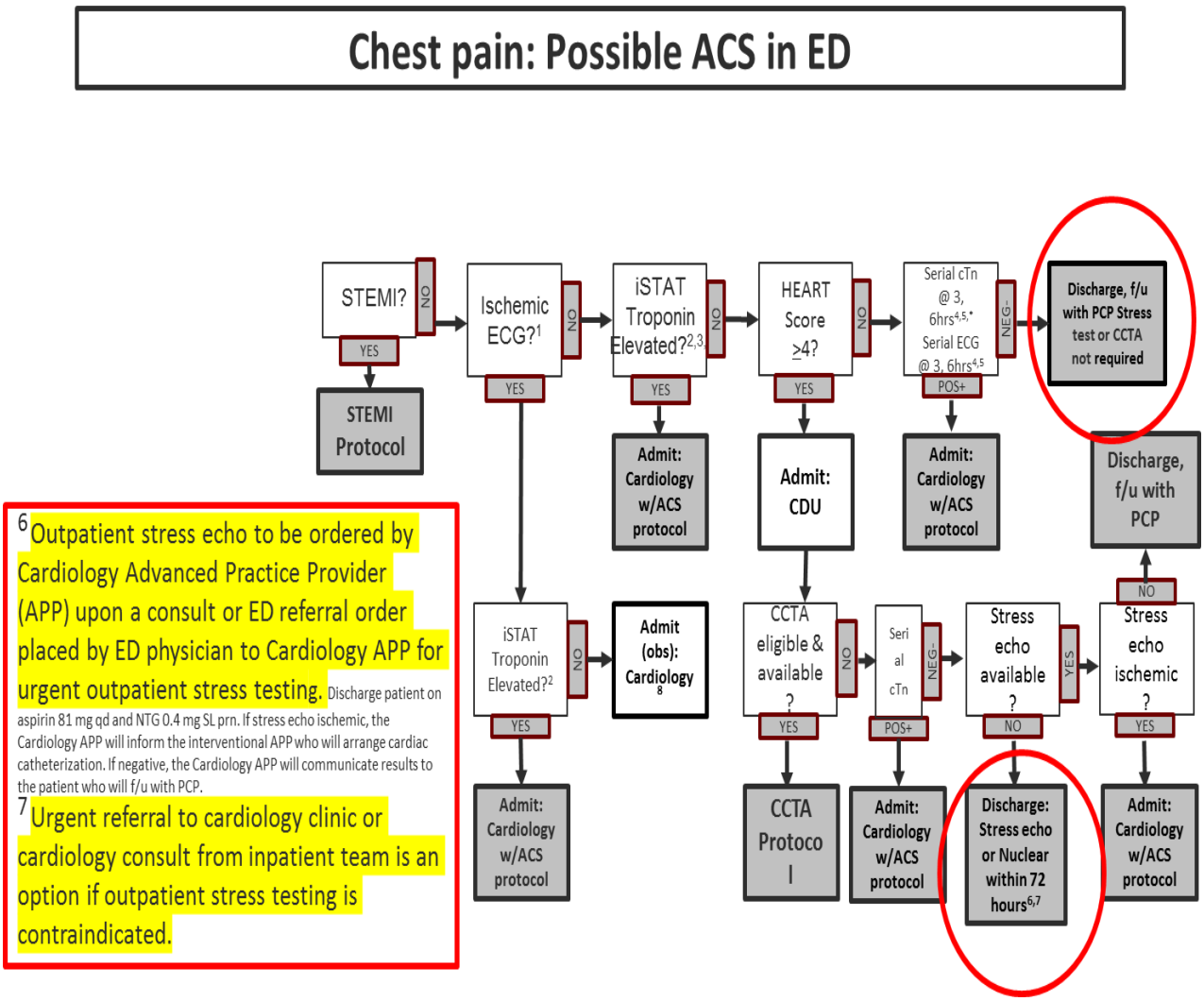
ECG:

☐ New ischemic changes	**2 points**	• Ischemic ST-segment depression • New ischemic T-wave inversions
☐ Non-specific changes	**1 point**	• Repolarization abnormalities • Non-specific T wave changes • Non-specific ST-segment depression or elevation • Bundle branch blocks • Pacemaker rhythms • LVH • Early repolarization • Digoxin effect
☐ Normal	**0 points**	• **Completely normal**

Mahler et al. ***Circ Cardiovasc Qual Outcomes*. 2015**

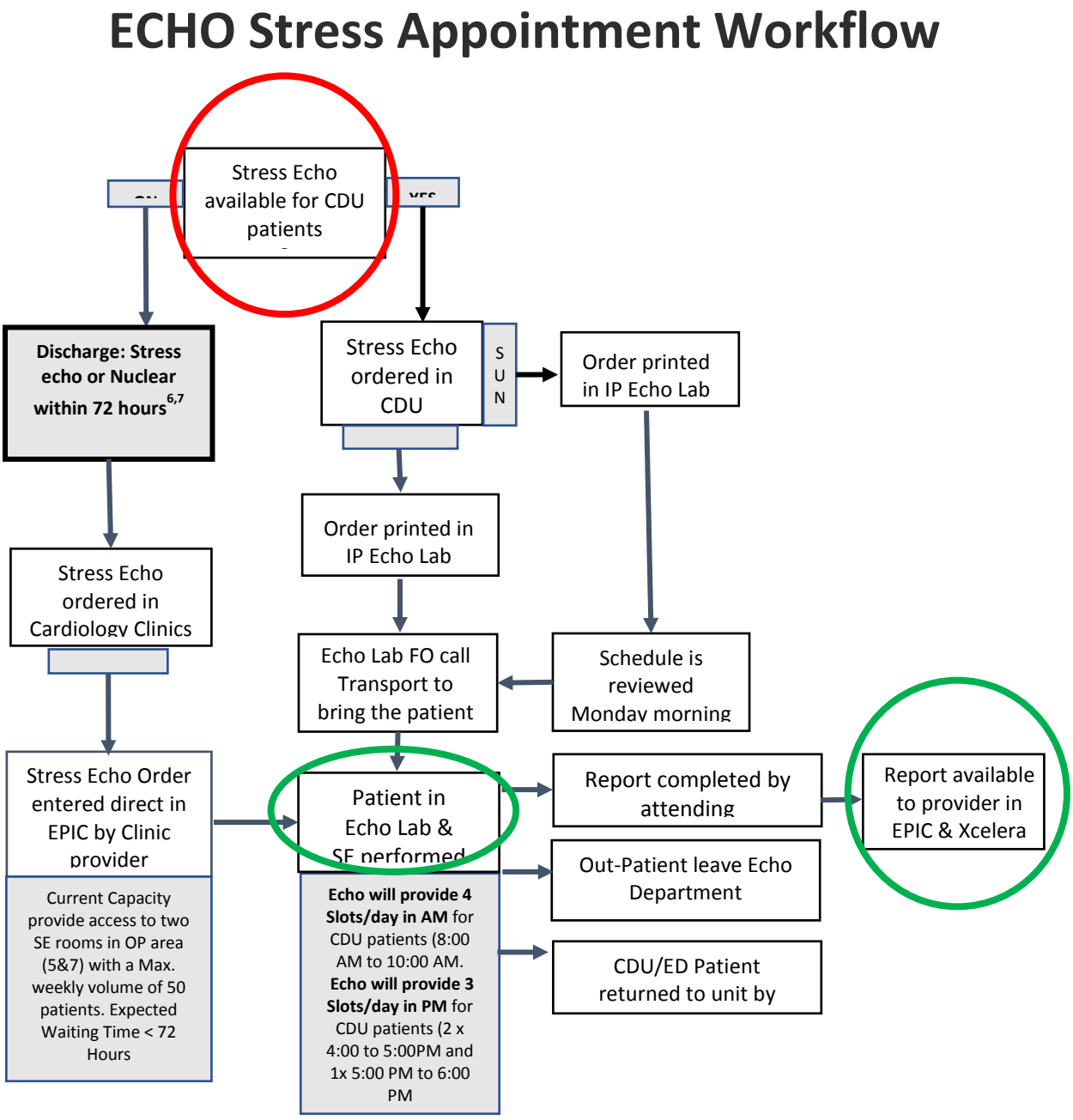
Appendix B

ED CDU RAPID CHEST PAIN PROTOCOL WORKFLOW



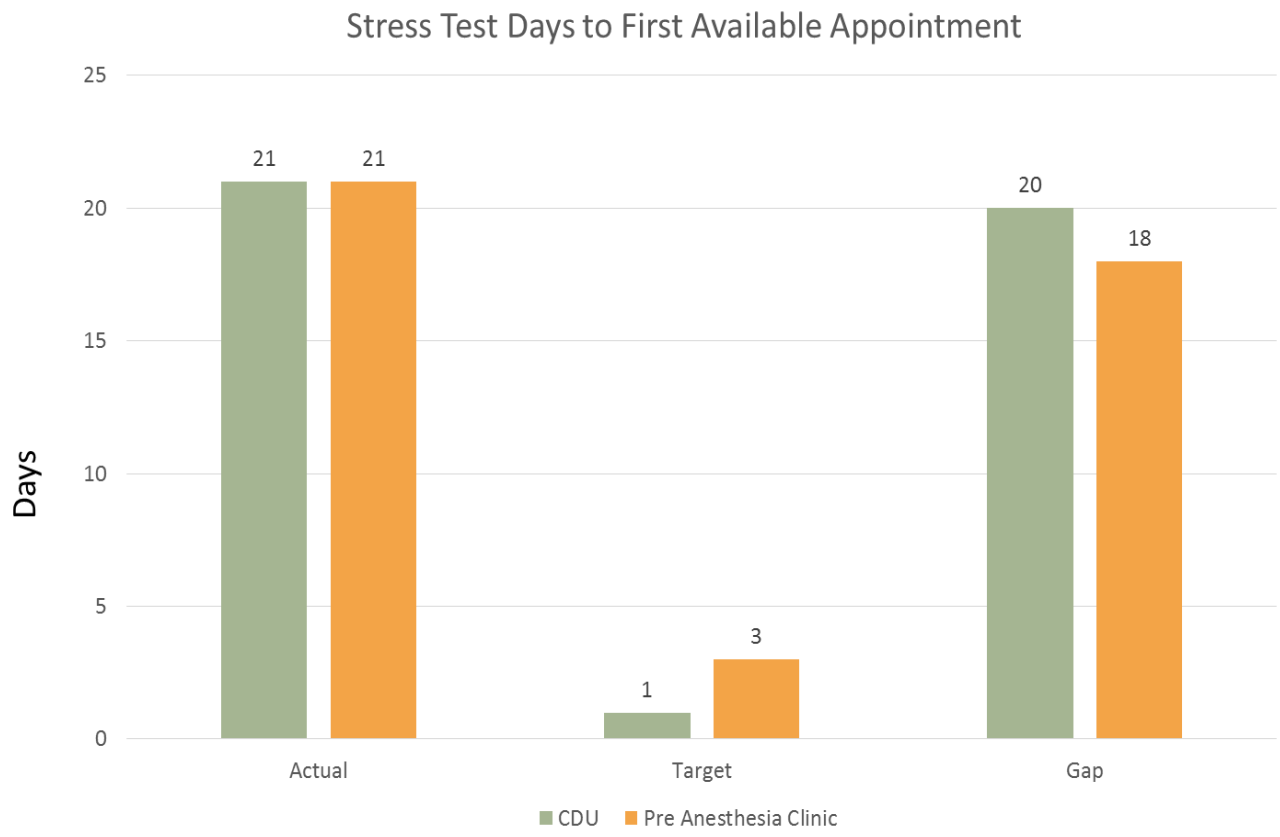
Appendix C

ECHO STRESS APPOINTMENT WORKFLOW



Appendix D

STRESS ECHO SCHEDULING TURNAROUND GRAPH



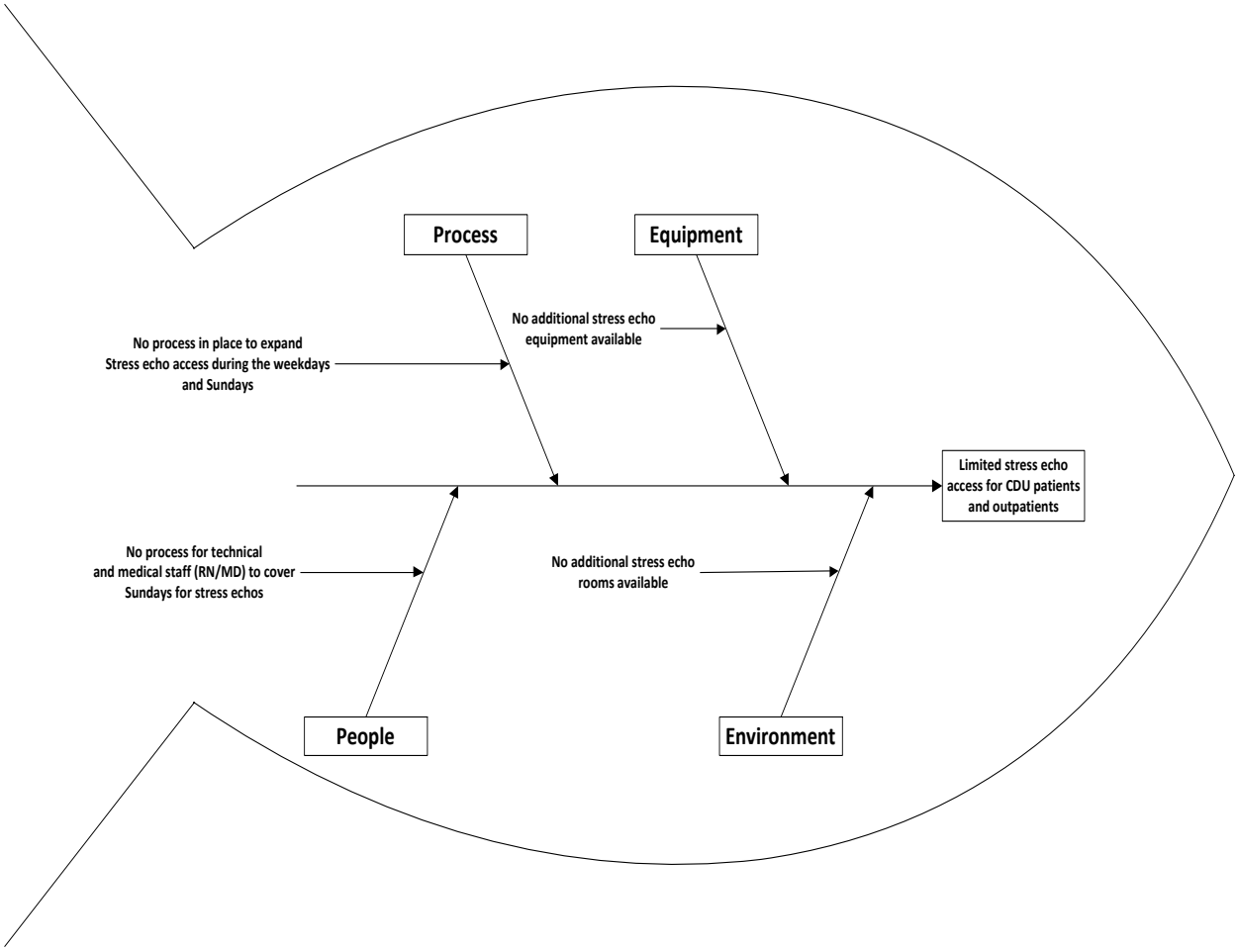
Appendix E

ECHO LAB STRESS ECHO TRACKING TOOL

Acute Chest Pain ED Protocol- ECHO LAB STRESS ECHO TRACKING TOOL												
Date	Mon		Tue		Wed		Thu		Fri		Sat	
	IP (CDU)	OP (Chest Pain -ED Protocol)	IP (CDU)	OP (Chest Pain -ED Protocol)	IP (CDU)	OP (Chest Pain -ED Protocol)	IP (CDU)	OP (Chest Pain -ED Protocol)	IP (CDU)	OP (Chest Pain -ED Protocol)	IP (CDU)	OP (Total)
	Time of Test (Military Time 00:00)		Time of Test (Military Time 00:00)		Time of Test (Military Time 00:00)		Time of Test (Military Time 00:00)		Time of Test (Military Time 00:00)		Time of Test (Military Time 00:00)	

Appendix F

ROOT CAUSE ANALYSIS



Appendix G

IMPROVING STRESS ECHO ACCESS COST ANALYSIS

Implementation Cost		
Item	Average hourly salary	Total Cost
Office Assistant	$30	$120
Managers/Advanced Practice Practitioners	$70-100	$3360-$4800
Stress Test Equipment		$40,000
Ultrasound unit		$200,00
Total:		**$244, 920**
Projected Revenue		
Item	Cost	Total Cost
Stress Echo (10 extra stress echos/day; 50 stress echos/week; 2600 stress echos/year)	$3500/stress echo	$9,100,000
Implementation Cost		$244, 920
Total Revenue:		**$8,855,080**

Appendix H

LEWIN'S THEORY OF CHANGE

Appendix I

STRESS ECHO ACCESS FOR CDU AND OUTPATIENTS SIMPLE A3

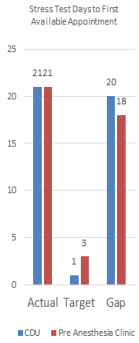
Stress Echo Access for CDU and OP

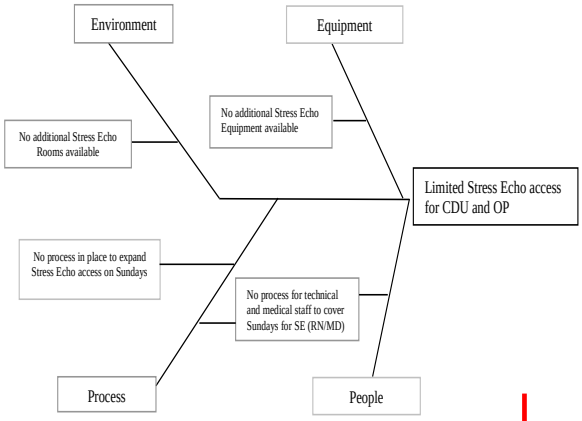
- Echo Lab doesn't meet patients and providers scheduling turnaround time expectations for stress echo

- OP's should be able to be scheduled for a stress echo in no more than 5 days from ordering
- CDU's patients should be able to be scheduled for a stress echo in less than 24 hours

- Current waiting time to get a stress echo as OP is an average of 21 days.
- Maximum CDU patient access for stress echo is 4 pts/day, Monday to Saturday with no Sunday access. A number of pts. are not admitted to CDU due to a lack of Echo Lab capacity

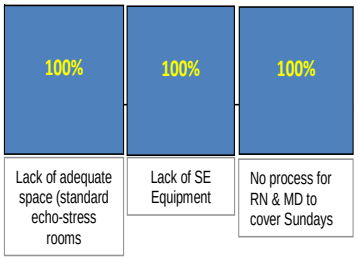
GAP





Goal (Cause)	Actions	By When/By Who
Identify additional space (procedure rooms) for Stress Echo	Review with stakeholders few possible locations: 1. Satellite room (H2330) + A336 (all supplies moved from Satellite room) 2. A336 + A 310 (limited access for SE due to cardiac programs) 3. 2 large rooms in 3 North A3116 –A 3117 (far location from MD's) 4. Satellite + 1 room in 3 North 5. A209 (TTE) converted in SE + A239 (C Kell office) converted for TTE. C Kell move to 3 North 6. ED will provide space. Echo will deploy permanently equipment and provide staff for ED/CDU patients 7. Possible Cath-Lab underused space to be converted to SE room	• CK/IS/MG/RG
Identify type and number of equipment needs	Prepare/submit capital Contingency request for two Stress Systems	CK/MG/RG
Provide adequate staff level for Stress Echo 7 days/week	Identify and implement technical and medical staff coverage process for Sundays	CVH Leadership/MG/G

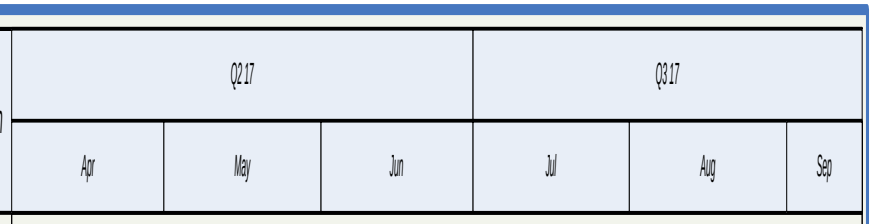
Solutions should address concomitantly all three main causes



Appendix J

TIMELINE/GANTT CHART

Task	Task Name	Start	Finish	Duration
1	Request business plan funding; Inform stakeholders	5/1/2017	5/12/2017	2w
2	Meet with team members	5/1/2017	7/17/2017	11.2w
3	Determine space for additional stress test equipment	5/1/2017	5/8/2017	1.2w
4	Purchase new equipment	5/1/2017	5/15/2017	2.2w
5	Revise patient scheduling template	6/1/2017	6/2/2017	.4w
6	Create new staffing model	6/1/2017	6/9/2017	1.4w
7	Implementation of new equipment and staffing model	6/12/2017	7/11/2017	4.4w
8	Evaluate new scheduling process and staffing model	7/3/2017	8/30/2017	8.6w



Appendix K

Post-Intervention Results