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### RESEARCH ARTICLE

## APPLICATION OF CONTINUOUS QUALITY IMPROVEMENT PROGRAM THROUGH DMAIC MODEL IN OFFERING SAFE AND EFFECTIVE SERVICES IN CARDIAC CATHETERIZATION LABORATORY.

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#### Abstract

This study provides a framework for optimizing efficiency in the CARDIAC CATH LAB..The main objective was to critically examine the major quality indicators of **good operational management** of Cardiac Cath Lab by measuring and minimize the door –to –balloon time, door- to- needle time and TAT (Turn Around Time), evaluating the workload, employee engagement and employee satisfaction We also evaluated Cath lab time utilization, which includes identifying bottlenecks and recommending solutions

**Methods:** Research was carried out by published materials, such as published articles, government publications, international publications and journals, press releases, online portals, implemented intervention project and relevant keyword searches were analyzed to get the results This data was then evaluated on basis of various parameters

**Results:-** It was found that using quality indicators such as DMAIC model, PDCA, C& E Analysis, congruence model, we were able to identify the bottlenecks in the overall management of Cath lab and evaluate the measurement and minimization of Turn Around Time during cardiac procedure and door to balloon time. Staff members and their satisfaction play important role in providing high-quality, safe patient care efficient TAT by working as a team provides a way to accomplish this. Operational efficiency and Optimum quality thus hold increasing importance to Cath labs Identifying inefficiencies and reducing supply expenses in Cath lab care delivery can save time, maximize production and minimize costs .

**Recommendations & Conclusions:** Depending on the available in-hospital facilities and using plan do study act quality tool the goal for patients with STEMI should be to achieve a Door-To-Needle Time within 30 minutes (for thrombolysis) and a Door-To-Balloon Time within 90 minutes (for PCI) and Turn Around Time to be 20 minutes. Organizations with higher staff satisfaction and commitment have better patient outcomes and organizational outcomes so proper distribution of resources and work in a proper hierarchal manner may reduce the workload, staff satisfaction, operational efficiency and ultimately achieving the mission of providing high and effective quality of care reducing all performing gaps and gaining and working on all opportunity gaps as mentioned in congruence model.

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### Introduction:-

Acute Coronary Syndrome, the major cause of heart diseases continues to be a serious public health problem in industrialized countries and is becoming an increasingly significant burden in the developing world. As per World Health Organization (WHO), coronary artery disease (CAD) accounts for 7.2 million deaths/year, or 12% of all deaths worldwide. Although CAD-related mortality rates worldwide have declined over the past four decades, it remains responsible for approximately one-third or more of all deaths in individuals over age 35. STEMI comprises 25% to 40% of presentations of acute MI (Myocardial Infarction), within-hospital and 1-year mortality rates at 5%-6% and 7%-18% respectively. Despite developments in management and education on cardiac risk behaviors, MI remains a serious health burden on society.

Cardiac catheterization can be either a diagnostic or a therapeutic procedure. The procedure is done in the evaluation and the treatment of the following conditions. Coronary artery disease, the hemodynamic measurement of the heart, especially the left ventricular function, evaluation and treatment of cardiac arrhythmias. Assessment of pericardial diseases and congenital heart diseases like valvular heart disease and cardiac catheterization labs.

Cath lab represent a significant capital investment for many hospitals. To meet the challenges and maintain fiscal health, hospitals are pursuing strategies to improve throughput, maximize equipment utilization and increase efficiency. Inefficient use of this limited resource increases costs and can compromise patient care. The core business principle in which organization strive to deliver **high quality care (goods and services)** in a cost effective manner. It is **operational efficiency**. This concept has become increasingly relevant to cardiac catheterization laboratories, as insurers move away from fee-for-service reimbursement and toward payment determined by **quality measures** bundled per episode of care. The importance of achieving efficiency is paramount in the current environment of rapidly increasing health care expenditures, as private insurers and government payers have placed more emphasis on quality over quantity of care, reducing procedural volumes, and limiting expenses

This article is focused to review, and analyze data. Data was derived from published materials, such as published articles, government publications, international publications and journals, press releases, online portals, implemented intervention project and relevant keyword searches. The result obtained were evaluated on basis of significance of various quality tools and indicators in Cath lab workflow, turnaround time, employee and patient satisfaction, door to needle and door to balloon time. Various strategies and models are also studied for the measurement and minimization of the same and result in high quality care and increasing operational efficiency

Quality has emerged as an important metric to determine reimbursement, equally as essential to the financial sustainability of providers are considerations of cost. Economic realities underlie the ability of every Cath lab to care for its patients, and many institutions are desperate for guidance on how to provide high-quality care efficiently. Quality healthcare is defined as doing the right thing (getting the health care services you need), at the right time (when you need it), in the right way (using the appropriate test or procedure), to achieve the best possible results. Quality measurement in health care is the process of using data to evaluate the performance of health plans and health care providers against recognized quality standards. According to Institute of Medicine, health care quality is defined by six attributes: **Safety** (patients should not be harmed by the care), **Patient-Centered-Care** (based on individual needs), Reduction in **Timely waits** (delays in care should be reduced), **Effective-Care** should be evidence-based, **Efficient**-reduce waste **Equitable** -care should be equal for all people

**TABLE 1** Definitions of Productivity, Cost, Efficiency, Quality, and Value as They Relate to Cath Lab Operations

	Definition
Productivity	Volume of cath lab cases in a period of time (i.e., output).
Cost	Total sum of resources spent per episode of care (i.e., input). Includes time, money, and any other scarce resource that could be used elsewhere.
Efficiency	The ratio of cath lab productivity to costs. Can be viewed in terms of specific costs (e.g., time, money, or nursing resources).
Quality	Delivery of optimal patient outcomes and avoidance of complications. Judged by adherence to ACC/AHA practice guidelines. Monitored by national registries (e.g., ACC NCDR CathPCI, AHA Get With the Guidelines).
Value	A subjective measurement of worth. Cath labs that provide high-quality, efficient care can be considered to be providing high-value care. Given its subjectivity, use of the term "value" is limited in our discussion.

ACC = American College of Cardiology; AHA = American Heart Association; NCDR = National Cardiovascular Disease Registry.

### Quality of Care for Heart Patients

Among various specialties within hospitals, cardiac care is one of the most complex sections which is at high risk on one hand but highly rewarding and patient satisfying division on the other hand. Patient comes usually in emergency, with an environment and perception that he may lose life and in highly painful condition or at discomfort but with successful intervention through Cath lab likely to get improved life. Thus the offer of quality patient care becomes most important, some of the concerns are discussed as follows:-

#### Credibility of the operator and other staff;

Quality control of equipment and emergency back-up for the operator and other staff (the quality of the study must be optimal for precise diagnosis and appropriate referral for surgery or catheterization laboratory intervention, as well as for diagnosis to exclude important cardiac disease. Major concerns have been raised about some of the newer catheterization settings-mobile laboratories, for example because it is often difficult to plan for emergency back-up. Most radiography equipment was adapted for use in these new settings rather than specifically designed for this setting, and quality control procedures vary widely

#### Risk Stratification and Risk Benefit Ratio

Risk stratification before catheterization to ensure that candidates are screened appropriately to reliably identify those who may undergo certain studies in a nontraditional setting at low risk

Risk-benefit ratios (many patients in the newer settings are less symptomatic and may have a better prognosis than those who are severely symptomatic, so risk-benefit may be less favorable. Because risks were assessed largely in the more symptomatic patient populations studied in traditional settings, it may not be appropriate to compare them with studies in less traditional settings)

Timely access to the emergency or urgent cardiac surgery, vascular surgery, cardiac anesthesia, cardiovascular radiology etc is important in quality care of patients

#### Staff Support and Documentation

There are some ethical concerns include self ownership of laboratories, Self-Referral of Patients to Laboratories Cardiologists who also operate catheterization laboratories are in a unique position: they can refer patients seen in clinical settings to their own catheterization laboratory practices. It is not unusual for the cardiologist who makes the initial clinical assessment, which includes diagnostic studies such as the electrocardiogram (ECG), echocardiogram, and stress test, to also recommend further diagnostic testing, such as catheterization. This same cardiologist might then perform the catheterization and make further recommendations for, or even perform, therapeutic catheterization procedures such as percutaneous transluminal coronary angioplasty (PTCA)

The assumption of responsibility in the event of an emergency by the nontraditional laboratory operator, the hospital providing holding area support, or the hospital providing surgical back-up. Lack Laboratory Service Development

The number of patients and the kinds of resources of Definitions and Indications There is confusion about. Lack of General Guidelines for Catheterization required to justify development of cardiac catheterization laboratories, particularly newer nontraditional laboratories, have not been defined. This lack of guidelines may lead to unnecessary growth of services

There is usually a lack of Documentation for Cost-Containment Justification. It is also concern about the lack of published, objective data to support the claim of a substantial difference in cost between cardiac catheterizations in traditional laboratories and less traditional settings.

### Various models used for cath lab efficiency improvement

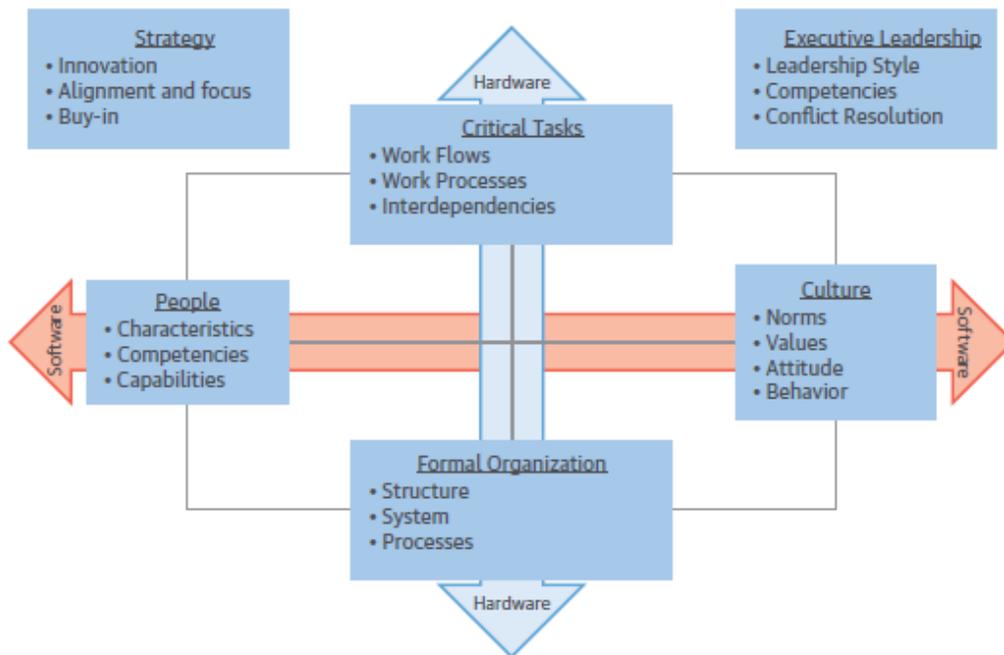
#### The congruence model

Nadler-Tushman congruence model for improving Cath lab efficiency. The performance of an Organization is measured and evaluated through the lens of several elements that encompass all aspects of a company's operations and are considered interconnected to one another.[3]

The first step in forming a congruence model is to study these elements, the interrelationships between elements, the term "hardware" is synonymous with the technical-structural dimension, and "software" encompasses the social aspects that shape values, behavior, and culture determining performance. The greater alignment between elements, the greater the Cath lab performance and efficiency.

B

#### Detailed Components of a Congruence Model



In a congruence model, managers examine the 6 essential elements of their organization and how they are interrelated with regard to specific processes of production illustrating the performance gaps.

#### Continuous Quality Improvement in Cath lab

The purpose of continuous quality improvement for Cath lab is to promote and sustain their presence on the cutting edge of optimal patient care. If patient outcomes and satisfaction are at center of improvement strategies and processes, the end result is up to the mark. This article is designed to define continuous quality improvement, practical applications for cardiac Cath lab, tools for implementing high- caliber quality improvement programs, and sample processes and projects that can enhance the effectiveness of Cath lab performance and outcomes

CQI includes a wide array of concepts such quality control, key performance or quality indicators, resource management, value added processes and improvements leading to an optimum quality assurance. For an effective CQI program, positive patient outcomes and satisfaction as an end result ,Cath lab should constantly review and retool practices to reach certain goal. Focusing on 2 critical and fundamental indicators:

1. Performance indicators such as meeting door-to balloon times
2. Patient outcomes such as reductions in post procedural complication rates

In the Cath lab it is the responsibility of every team member, as well as management staff to improve quality other indicators include improving cost containment and implementing best current practices, each lab has different structure , scopes of practices and different types of patients. Even the equipment, logistics and staff experience levels may vary widely from lab to lab.

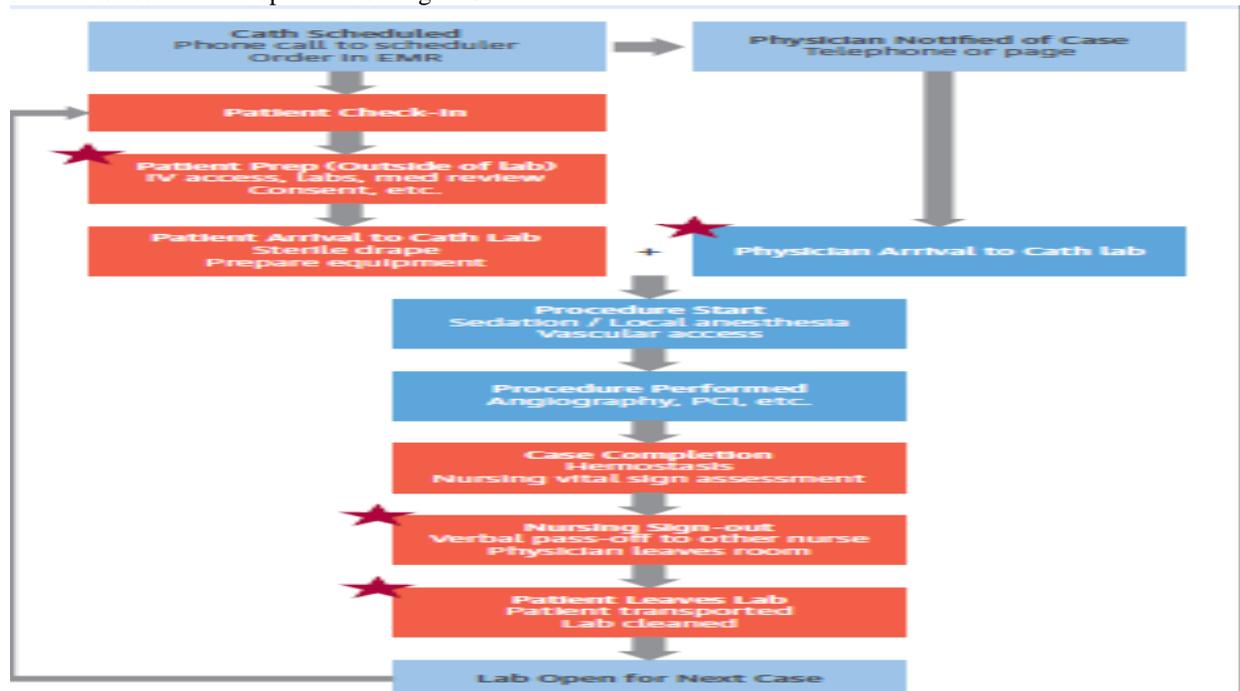
### Significance of DMAIC in Cath Lab

To make implementation recommendations for the overall CCL system involved two phases. Phase I included the five stages of the six-sigma approach consisting of the DMAIC methodology to identify potential areas of improvement and to suggest recommendations aiming at an overall process improvement,[9] shown as follows:

1. Define: Study and understand the existing CCL system
2. Measure: Develop process maps and conduct time studies and collect all relevant system related data
3. Analyze: Analyze the collected data by statistical tests
4. Improve: Use Industrial and Systems Engineering tools such as cause-effect diagram and value stream maps to identify potential causes of delay in the existing and make recommendations for continuous process improvements
5. Control: Ensure that the recommendations are implemented and followed methodically. This was achieved by discussing with subject matter experts after the recommendations had been implemented one after another.
6. Phase II deal with result quantification using discrete event simulation, which included the following steps: 1) Development and validation of a baseline discrete event simulation model which reflects the existing CCL system, 2) Testing of alternate scenarios and measurement of performance outcomes, and 3) Suggesting the best and most feasible solution.

### Workload Flowchart and distribution of work in Cath Lab –

Efficient and effective workflow of Cath lab staff and proper distribution of resources and work in hierarchal manner is essential for optimal working in Cath lab.



**Efficiency Based Outcome Indicators In Cath Lab**

**Turn Around time:-**

**Turnaround times** defined as the **time** that one patient leaves the procedure room until the **time** the next patient enters the same room.[10]

In the cardiac Cath lab, one area that may provide an opportunity for cost savings is **maximizing patient throughput**.

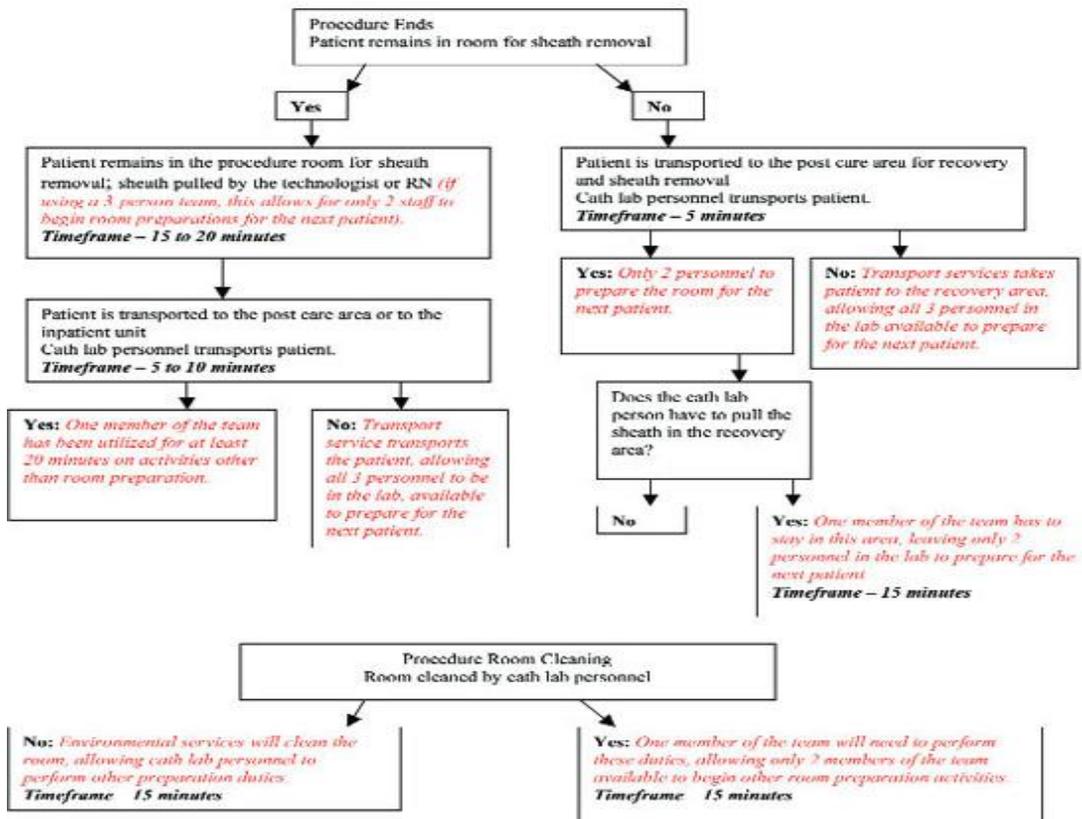
A well-defined throughput process can optimize lab utilization. Scheduling & getting each patient into and out of the procedure room in a timely manner can add minutes and maybe even hours to the daily schedules, allowing for the accommodation of a greater number of cases. Increasing the number of procedures performed per day or week can add to overall income.

In order to review and improve the throughput process, is conducting an in- depth review of all activities that must take place in order to get the patient in and out of the procedure room. There is no better way to identify problem areas within the process. By identifying road- blocks and determining if there are opportunities to expedite the process, turnover time can be reduced.

**Major focus on many factors affect the patient throughput process in the cardiac Cath lab like:-**

1. What occurs pre-, intra- and post- procedure is very important to the process.
2. Did the patient arrive in the suite on time?
3. Was all the appropriate documentation available, i.e., blood work results?
4. Were all the appropriate supplies needed for the procedure available?
5. Was the patient on the table at the scheduled time?

A negative response to any of these questions can delay the current procedure and definitely delays the start of the next case. Every Cath lab has its own ways of completing each step by analyzing and documenting to improve the processes and save time and money.



The crucial aspect to determine Cath Lab TAT is time period usually involve tasks such as transferring the patient off the procedure table, transporting them to a recovery bed or an inpatient room, sheath removal and groin management, and cleaning and preparing the procedure room to accept the next patient, you need to identify the key processes involved in preparing to accept the next patient and determine their effectiveness.

1. Firstly, in-depth review of every single step should be done outlining all the activities involved and monitoring the time it takes to complete each of the steps. Identify what takes place at the end of a procedure. List all the steps necessary to discharge the current patient from the procedure room and prepare the room for the next patient, up to when the next patient enters the room.
2. This may be done by documenting the processes in a work- flow diagram. A workflow diagram will provide a detailed overview of the activities associated with each step in the turnaround process. It will allow you to perform the review, scrutinizing each step to determine if it can be performed differently, performed in a more timely fashion or if it can be eliminated
3. Every institution has specific barriers that may prevent them from achieving ultimate procedure room turnaround times; however, there are some aspects that are universal and may apply to all, the quality tool used to study and evaluate the ideal TAT.

**Figure 3:-Quality Tool- Plan-Do- Check –Act Cycle**

<p><b>Plan</b> the change :</p> <p>What are we testing and who is conducting the test?</p> <ul style="list-style-type: none"> <li>• Who are we testing the change on?</li> <li>• When are we testing?</li> <li>• Where are we testing?</li> </ul> <p>Predictions:- What do we expect to happen?</p> <p>Data:- What data do we need to collect? Who will collect the data?</p>	<p><b>Do</b></p> <ol style="list-style-type: none"> <li>1. Test (carry out the cha</li> <li>2. Collect Data</li> <li>3. Begin analysis</li> </ol> <p>What was actually tested?</p> <p>What happened?</p> <p>Observations:</p> <p>Problems:</p>	<p><b>Check:-</b></p> <p>Complete analysis of data</p> <p>Summarize what was learned</p> <p>Compare data to predictions</p>	<p><b>Act:-</b></p> <p>What changes should be made before the next test cycle?</p> <p>What will be the next test cycle be ?</p> <p>Are we ready to implement the change?</p>
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**Barriers to TAT Efficiency**

The “top three factors” that were barriers to TAT efficiency according to Et al Luann Hallahan, RN, BSN, BC, UPMCPassavant Pittsburgh, Pennsylvania

**Barriers to TAT Efficiency**

The “top three factors” that were barriers to TAT efficiency[12]are as follows:-

1. Physicians: Arrival time in the morning may affect the first case of the day and subsequent cases starting on time. The variables were to case start time, including if the physician was called after patient is prepped, or delays due to the physician leaving the procedural area to assess their patients and address new consults.

2. Anesthesia: Every Cath Lab procedure must have anesthesia consent; however, the assigned anesthetist when paged are usually occupied with cases in the OR. Also, there was confusion between CRNAs and the CCL team as to optimum patient sedation levels and end results of ablation procedures.
3. Housekeeping: Housekeeping staff communication are not in proper hierarchy. To review with the aim of eliminating minutes from turn-around time is procedure room cleaning, trained housekeeping staff is responsible for cleaning the procedure room between cases safely and maintain. Sometimes on busy days, the staff cleaned and wet mopped the room themselves.

**Certain Barriers** in that may prevent them from achieving ultimate procedure room turnaround times;

For instance, at the end of a diagnostic procedure, is the patient moved to a recovery area where the sheath is pulled or is this done in the procedure room immediately after the case?

Who is responsible to pull the sheath?

If the patient remains in the procedure room to have their sheath pulled could add minimum, 15 to 20 minutes to turnaround time frame. If sheath pulling is the responsibility of the Cath lab staff, even when the patient is in the recovery area, that staff member will be unavailable to assist with room preparation for the next patient.

If a member of the Cath lab team has to leave the suite to transport a patient to the recovery area, they will be unavailable to help set up the room for the next patient. Utilizing the entire team to prepare the procedure room can slash minutes from your turnaround time. , certain trained ward boy or escort service may be available to transfer patient to respective wards/C.C.U.

#### **Door to Needle time:**

Time between arrival of patient of acute myocardial infarction to emergency department (ED) and the administration of thrombolysis (thrombolytic therapy).

Jordan M, Caesar J.(2016) in 131- bedded district hospital in New Zealand promoted early ST-segment elevation myocardial infarction (STEMI) recognition and treatment algorithm that increased the awareness of the staff and brought down the door to needle time. The fundamental approach to the management of STEMI in New Zealand includes early recognition, appropriate and timely delivery of reperfusion therapy and implementation of secondary preventions and recommendations. Furthermore, commencement of appropriate secondary prevention medications, to reduce the risk of further myocardial infarction (MI) was variable.[14]

Most cases of ACS are caused by coronary artery plaque rupture and thrombus formation. When thrombosis leads to total occlusion of blood flow within an epicardial artery, acute STEMI is often the clinical outcome. STEMI is a clinical syndrome defined by characteristic symptoms of myocardial ischemia in association with persistent ECG ST elevation and raised biochemical markers of myocardial necrosis

1. The New Zealand branch of the Cardiac Society of Australia and New Zealand have produced guidelines on the management of acute coronary symptoms since 2005. These have been developed by clinicians throughout New Zealand with the aim to improve quality of care. They focus on the most effective strategies based on evidence from clinical trials. The evidence is graded and the recommendations are patient focused. Patients should be informed of the risks and benefits of treatment and share in decision making.
2. The guidelines specify patients with acute STEMI should receive coronary reperfusion therapy in shorter duration of time with either primary percutaneous coronary intervention (PCI) or thrombolysis.[15]

A number of factors that contributed to suboptimal implementation of STEMI guidelines and delay in door to needle time:-

1. The need for refreshed awareness amongst nurses and junior doctors that rapid reperfusion therapy is recommended within 30 minutes of arrival.
2. The co-ordination of initial nursing triage to subsequent junior doctor and consultant assessments of the STEMI patient was inconsistent.
3. The need for an updated and easily accessible local trust STEMI protocol and the fact that initiation of reperfusion therapy overnight requires senior clearance. In the absence of on-site registrars, decision to thrombolysis is the responsibility of the on-call physician, who may be at home outside normal working hours
4. Uncertainty existed amongst junior doctors regarding the necessary out-of-hours escalation pathways to trigger senior support and send electronic ECG traces to on-call physicians overnight for review prior to thrombolysis.

Consultant travel time from home to hospital was often between 15-20 minutes and without swift initiation of the thrombolysis pathway, treatments were frequently delayed and door-to-needle time.

#### **Door to balloon time:-**

This short duration from the time a patient arrives at the hospital to the time the angioplasty balloon is inflated in the blocked artery of the patient is known as the “door-to-balloon” time.

According to The New Zealand branch of the Cardiac Society of Australia and New Zealand have produced guidelines on the management of acute coronary symptoms since 2005. The following strategy was initiated as a quality indicator for the purpose of minimization of both Door to needle time and Door to balloon time [16]

**PDSA cycle 1:** Meeting was to raise awareness of STEMI diagnostic criteria and integrate the updated local protocol within hospital by recognition and management flow diagram.

**PDSA cycle 2:** The STEMI guideline was integrated into hospital practice and 6 months was allocated for staff familiarization with this intervention before further data collection on door-to-needle times occurred. The objective was to assess whether a more accessible, simplified flow diagram could change mean times to thrombolysis of STEMI patients in our hospital.

**Staff Education And Its Significance :** Educational STEMI awareness workshop on new STEMI guidelines of ACS aimed at CCU staff and junior doctors was held followed by group discussion.

#### **PDSA cycle 3.**

When exploring the reasons for inadequate door-to-needle times, clear delays between initial triage times by CCU nurses and subsequent medical assessments by both junior doctors and consultant physicians were noticed. The target time for first doctor assessment of the cardiac triage patient of < 5 minutes then an escalation pathway was initiated with a direct page to the on-call consultant, physician made via switchboard. This system operated in conjunction with a target time of < 20 minutes for thrombolytic therapy administration after first doctor assessment. We introduced laminated copies of the escalation protocol to be displayed on CCU

#### **PDSA cycle 4:**

We aimed to address this issue and improve overall door-to-needle times by promoting an out-of-hours remote electronic ECG interpretation system at night shifts as well.

#### **Staff Education Workshop 2:**

Awareness about The use of remote electronic ECG interpretation system, which allows off-site consultants to review patient ECGs on an encrypted tablet.

#### **PDSA cycle 5:**

Pharmacists conducted regular medication chart reviews to ensure appropriate prescribing of ACS medications and secondary prevention, ward pharmacists conducted regular medication chart reviews and liaised with the ward team to maximize STEMI management.

Depending on the available in-hospital facilities, the goal for patients with STEMI should be to achieve a door-to-needle time within 30 minutes (for thrombolysis) and a door-to-balloon time within 90 minutes (for PCI).

#### **Identification of sources of delay in the system**

Causes for delay in the system were identified using a Cause and Effect (C&E) diagram and Value Stream Maps (VSMs). [18]

The “causes” highlighted in red indicating potential areas for improvement in the process.

#### **Value stream maps**

VSMs were developed for the overall inpatient flow the total time covered in inpatient transfer process from the inpatient ward/floor would be longer than overall inpatient flow that observed in VSMs were not developed for emergency patients because it was observed that the overall process in sending such a patient into the procedure room

occurred in a very short period of time. and should be under 90 minutes according to the guidelines[19].Based once diagram, and VSMs, the following sources of delay in the system were identified:

#### Delayed start of procedure

1. First procedure for the day starts at 8:07 AM (on average).
2. Late arrival of physician to procedure room.
3. Inter-procedure delays.

#### Patient waiting time delays

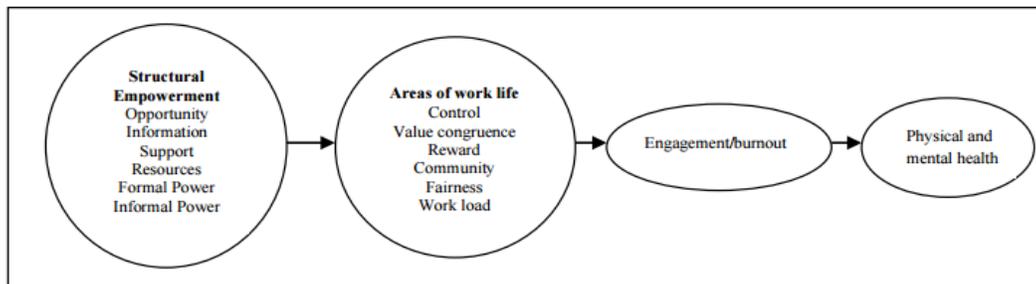
1. The time outpatients waiting in CACU between the pre-procedure documentation and being sent into the procedure room averages about 116minutes with a standard deviation of 45 minutes
2. Patients waiting in the inpatient ward or CACU for the physician's consent.
3. The consent is mandatory for a procedure to begin.

#### Delays in transferring patients to and from the procedure room

1. Unavailability of stretcher for transferring inpatients.
2. Lack of proper communication between the CCL staff and the ward nurse.
3. Patient waiting in the hallway in front of the CCL.

#### Employee Engagement and Satisfaction in Cardiac Catheterization Laboratory

A workplace climate that is empowering will most likely foster employee engagement. Increased employee engagement can result in employee's satisfaction with their workplace climate and therefore, have a deeper organizational commitment. The purpose is to determine the current state of workplace climate and staff engagement in the Cath lab setting, organizations with higher staff satisfaction and commitment have better patient outcomes and organizational outcomes.[21]Kanter's structural empowerment theory provides a framework to help leaders empower staff and, in turn, the staff will be more satisfied and productive.



**Fig 4:-**Kanter's theory linking structural empowerment to the six areas of work life.(Laschinger & Finnegan, 2005, p. 441)

A positive relationship between employing constructs that promote empowerment, collaboration and decision-making and nurses' perception of work climate. In this study there are eight work processes essential to a healthy work environment (HWE): (a) peers are clinically competent, (b) collaborative interdisciplinary relationships, (c) clinical autonomy, (d) educational support, (e) perception of adequate staffing, (for) supportive leadership,(g) control of nursing care (h)provision of safe patient centered care

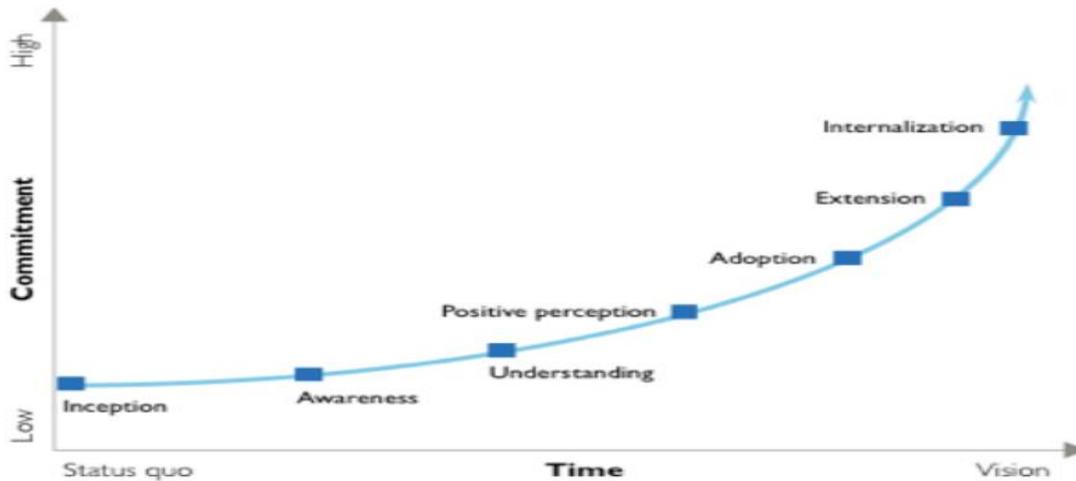


Fig 5:-Communication-Commitment graph (Philips Healthcare,2011)[25]

### Interventions that can be implemented in initiative

#### Patient Scheduling System

A patient scheduling and appointment system was designed and integrated into the work flow for the hospital. Before the intervention, as stated earlier, patients were scheduled for a specific day but were not given an appointment time for their procedure. According to the new scheduling system, patients were given an instruction sheet that outlined pre-procedure preparation steps and their appointment time. To incorporate the scheduling flexibility needed to allow for non-elective cases, our scheduling model divided the working day into five blocks.[20]

This design was similar to approaches used in other settings to improve catheterization laboratory patient flow.<sup>3</sup> A defined number of patients were scheduled according to each time slot, accounting for

1. The number of available beds in the patient care unit,
2. The average duration of each procedure type,
3. The expected length of stay after each procedure type and
4. The availability of hospital staff.

The proportion of diagnostic to therapeutic cases scheduled in each time slot was crucial in determining the schedule for two reasons.

After the 12 recovery beds assigned for the catheterization laboratory were occupied, the catheterization laboratory could not schedule any more procedures. Patients receiving diagnostic and intervention catheterizations are required to stay in bed for observation for six hours and overnight, respectively. Therefore, it was advantageous to schedule more diagnostic cases in the morning slots so that, by afternoon, beds could be reopened for other patients.

Second, the expected duration of the procedure was different for diagnostic and therapeutic cases, averaging less than 30 minutes and approximately 60 minutes, respectively. The defaulter and nonselective cases were also allowed when building the scheduling plans.

Approximately 15% of all catheterization laboratory cases were non-elective per day, so that scheduling at 85% of maximum capacity would accommodate the unexpected non-elective cases. Nevertheless, because many (up to 12%) of scheduled patients defaulted (that is, were “no shows”), we were able to schedule at 95% of maximum capacity within any given time slot.

#### Time Stamps

The laboratory technicians manually record the information, including the entries of total number of patients, the occupancy of each laboratory, procedure type, physician name, and duration of procedures in their register( time of wheeled-in of patient to time of wheel-out) were also recorded.

Time stamps were also collected for a purpose to obtain information related to patients' waiting time. A time stamp collection form to capture the arrival times of patients at various stations at the hospital.

1. On a patient's arrival at the registration department, a time stamp data recording form was attached to the medical record. The responsibility of Registration staff and nurses at subsequent stations for recording on this form the time that patients arrived: the inpatient care ward unit (admission), the pre-procedure waiting area (pre-procedure), and the procedure room (procedure).
2. At the end of each day, the collection forms would be collected by the catheterization laboratory administrative staff and enable the other Cath laboratory staff to continually monitor system performance with minimum extra effort, two databases were created—one for utilization and one for the time stamps.
3. After the data clerk entered the information from the logbooks and time stamp collection sheets into these databases at the end of each working day, the preset standard reports in the databases would provide all the needed data regarding utilization rates and waiting times.

The following four measures of patient waiting times were computed on the basis of the time stamps collected at the various stations[22]:

1. Registration-to-admission time (difference between time stamps recorded when the patients first arrived at the hospital registration department and when the patients were admitted to the inpatient care ward unit)
2. Admission to pre-procedure time (from the time patients were admitted to the inpatient care ward unit to the time patients were brought to the waiting room outside the catheterization laboratory)
3. Pre-procedure-to-procedure time (from the time patients arrived at the waiting room to the time the procedure began)
4. Total waiting time (from registration to the time at which the procedure began).

The percentage of patients arriving at hospital registration for a catheterization laboratory procedure within each hour of the day are also recorded.[23]

#### **Patient satisfaction table [Figure 5][24]**

The following are recommended techniques for enhancing patient Satisfaction in the cardiac catheterization laboratory (CCL) from the Society for Cardiovascular Angiography and Interventions:

<b>Pre-procedure</b>
<ul style="list-style-type: none"> <li>• Prompt easy scheduling for outpatients</li> <li>• Minimize or eliminate NPO period before procedure (some institutions allow clear liquids until 2 hours before procedure, or no longer require NPO)</li> <li>• All outpatient suite and CCL personnel introduce themselves by name</li> <li>• Update patients when delays are anticipated</li> <li>• Emphasize comfort and privacy, including of family members</li> <li>• Respect confidentiality</li> </ul>
<b>Intra-procedure</b>
<ul style="list-style-type: none"> <li>• Careful attention to adequate sedation and pain control during the procedure</li> <li>• Time out with introduction of all team members to the patient</li> </ul>
<b>Post-procedure</b>
<ul style="list-style-type: none"> <li>• Full explanation of results of procedure to patients and when appropriate family</li> <li>• Prompt food and drink when tolerated after procedure</li> <li>• Discuss follow-up plans, provide instructions for emergency help after discharge, and provide appointment before discharge</li> <li>• Follow-up call to answer questions and identify post-procedural problems</li> </ul>

Source: Adapted from Naidu S, et al. *Catheter Cardiovasc Interv.* 2016 Apr 24 [Epub ahead of print]. Available at: [www.scai.org](http://www.scai.org).

### Recommendations

By working on the above aspects and following the below mentioned procedures, the evaluation of throughput process for minimizing and maintaining ideal TAT:

1. As mentioned in Fig-2 one method of informal flowcharting of procedure room turnaround activities. There are other ways that turn around activity can be outlined, such as documenting the roles and responsibilities of each team member in a flow diagram
2. . Another popular method that can the throughput process is the quality be utilized when analyzing improvement model, Plan-Do-Check- Act (PDCA) cycle as mentioned in Fig-3. This model has been used extensively in the health care field. The cycle consists of small-scale tests of planned actions, followed by procedure room turnaround time) and have identified changes that you can make to help achieve this goal, the PDSA cycle can test these changes.[13]
3. TAT involves a detailed study of each step of the process and the role of each member involved. As communication improves, an appreciation and respect occurs between the team members, enabling efficient workflow to occur. Small steps to cut off minutes become impressive in the end result. Also important to note is that staff members in all roles take pride in providing high-quality, safe patient care — efficient TAT by working as a team provides a way to accomplish this

### Good Cath lab practice results:–

A 30-35 minute turnaround time was reduced to approximately 20 minutes which is an ideal turnaround time for cardiac catheterization by reducing the burden of Cath lab staff and recruiting trained environmental staff person was assigned to the lab and holding area decreasing times spent in cleaning the rooms, an inventory person who checks and orders all the supplies for the lab daily

One Cath lab staff assigned each day as a lead, a position that rotates through all staff on a daily basis. This person makes staff assignments and takes care of sending for patients, pre-medicating patients and arranging for beds after procedures. The leader is also responsible for adjusting staffing when emergencies come in and he is in constant touch with the nursing supervisor and leads on the nursing units to keep the flow of patients moving.

The tasks of crash cart check, narcotics check, quality analysis on O2 sat machines and ACT machines, and temperature logs for contrast and refrigerated meds are usually done by the nurse assigned to the room.

### Recommendations for reducing the delays

The recommendations towards process improvements are broadly classified as qualitative and quantitative.

#### Qualitative Approach

Unavailability of stretchers causes delays in transferring an inpatient from the floor some medical supplies for the cardiac catheterization procedures were stocked in the hallway, leading to multiple congestions.[20]

#### Lean 5S principle is to be implemented to solve the above issue:-

Sort: As part of sorting, the existing lead apron stand, occupying one third of the hallway width, was replaced with a wall-mountable version. This reduced the congestion in the hallway. The board displaying the patients and doctors for a particular day was also moved to a much better position.

#### Set in order:

1. In addition to the lead apron stand, the hallway was further congested by the stocking of medical supplies (e.g., catheters). The nursing assistant room was not properly utilized ,being close to the procedure room would-be ideal for storing the medical and lab supplies in order.
2. Re-allocation of rooms for nursing assistants and the nurse manager were also suggested.
3. Shine: The entire area was cleaned regularly, especially the room where the supplies were stocked including procedure room table for the next procedure in an orderly manner and to further improve the process, available technologists were suggested to be responsible for arranging the supplies on the table without affecting the hygiene.
4. Standardize: The supplies are now moved directly into the new room identified. A standard practice of two technologists preparing procedure room tables has been implemented.
5. Sustain: This is the most important part of the 5S principle. Periodic reviews and measurements of various parameters would help in gauging the process before and after the recommendations were in effect.

## Conclusions:-

Depending on the available in-hospital facilities and using plan do study act quality tool the goal for patients with STEMI should be to achieve a Door-To-Needle Time within 30 minutes (for thrombolysis) and a Door-To-Balloon Time within 90 minutes (for PCI) and Turn Around Time to be 20 minutes. Organizations with higher staff satisfaction and commitment have better patient outcomes and organizational outcomes so proper distribution of resources and work in a proper hierarchical manner may reduce the workload, staff satisfaction, operational efficiency and ultimately achieving the mission of providing high and effective quality of care reducing all performing gaps and gaining and working on all opportunity gaps as mentioned in congruence model.

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