Predictors of acute left ventricular failure and mortality in patients with acute STEMI treated with primary percutaneous coronary intervention

Dissertation submitted in partial fulfillment of the requirements for the degree of Master of Medicine

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Summary

Author’s name and surname: Tania Susan Varghese

Research Title:

Predictors of acute left ventricular failure and mortality in patients admitted with acute ST-segment elevation myocardial infarction treated with primary percutaneous coronary intervention.

Aim:

To determine predictors of acute left ventricular failure and mortality in patients admitted with acute ST-segment elevation myocardial infarction treated with primary percutaneous coronary intervention.

Objectives:

1. Risk factors, co-morbidities which influence mortality and the development of acute LVF, in patients with STEMI and treated with primary PCI.
2. Logistic parameters (chest pain duration, time till primary PCI (reperfusion therapy) and delay till primary PCI.
3. Impact of previous treatment on primary PCI effectiveness.
4. Outcomes (as acute LVF or and mortality) by different reperfusion strategies and also compare and contrast primary PCI of culprit lesion with multiple vessel PCI strategies.

Methodology:

In compiling a systematic review of relevant literature in terms of the research objectives, resources, and LSMU library website where searches were conducted using several databases: Medline (PubMed), Science Direct publications and Up To Date were scanned for suitable articles and papers for inclusion. Using a Boolean additive equation, the major keywords entered into the resource sites were: acute LVF, STEMI, mortality, TIMI flow, primary PCI, multi-vessel PCI, CABG. 70% of the chosen articles were published within the last ten years. Once selected, the articles were evaluated for their methodological details according to the present study’s rationale, and a review was formularized under relevant categories.
Results:

Some significant risk factors which influence the development of acute LVF and mortality in patients with STEMI, treated with primary PCI are age >65 and LVEF<30%. Comorbidities that have an effect on the occurrence of acute HF after STEMI in patients treated with primary PCI are diabetes and systemic hypertension. However, predictors of 30-day mortality are HT, diabetes, anterior infarct, higher Killip class, TIMI flow<2, repeat reperfusion therapy, reinfarction, cardiogenic shock, older age, LVSD.

Biomarkers have the potential to provide accurate prognostic information beyond that of conventional risk factors. High levels of serum creatinine, high sensitivity C-reactive protein, BNP, and glucose levels are a strong indicator of poor outcome/prognosis in STEMI patients. Non-invasive testing also identifies patients who are at risk of major adverse cardiac events. Angiographic parameters like myocardial blush grade, TIMI flow grade, help describe the effectiveness of myocardial reperfusion and independent predictors of mortality in relation to the infarct size, LVEF, and the extent of possible ST-segment resolution.

System delays and door to balloon delays are strongly associated with mortality in STEMI patients treated with primary PCI. Pretreatment with high loading doses of atorvastatin and clopidogrel compared to their traditional dosage prior to primary PCI in STEMI patients has shown to be both safe and effective in reducing the incidence of 30-day mortality. In many randomized control trials, prasugrel and ticagrelor have shown to have better angiographic results than clopidogrel. Coronary reperfusion grade improves in terms of pre and post-PPCI-TIMI flow grade and ST-segment resolution with a longer pretreatment time interval (at least 60 minutes prior to PPCI) with these newer P2Y12 inhibitors (ticagrelor or prasugrel). Pretreatment with heparin has shown to reduce the risk of no perfusion and definite thrombus significantly.

Primary PCI is the reperfusion of choice in patients with STEMI. Multi-vessel PCI is preferred over the culprit only PCI as it has reduced the risk of death, reinfarction, and future revascularization and is associated with no higher risk of complications compared to the culprit only PCI. However, as of the current European Society of Cardiology guidelines, it is recommended against PCI on the non-infarct related artery at the time of primary PCI in patients with STEMI, who are hemodynamically stable.
Conclusion:

Acute LVF and mortality is a common complication and consequence in patients with acute STEMI treated with primary PCI. This systematic literature review has determined the critical predictors that can help with the clinical diagnosis and treatment strategy of this frequent complication.

Practical recommendation

It is recommended to carry out an adequate history taking and clinical examination as it is an essential tool in the evaluation and recognition of ventricular dysfunction after acute MI.

Using a risk stratification score of significant predictors would make a great impact on the diagnosis, clinical decision making, treatment strategy, and hospital cost.

The reperfusion therapy decision should be based on current guidelines, individual patient features, their disease characteristics, and should also depend on the risk-benefit ratios of these treatment strategies.
Acknowledgment

I thank God from the bottom of my heart for giving me the strength, knowledge, ability and opportunity to undertake this research and complete it to the best of my abilities and gifting me with the blessing of a wonderful supervisor Dr. Olivija Gustienė.

I would like to express my sincere and deepest gratitude to my dear supervisor Dr. Olivija Gustienė who agreed to be my dissertation supervisor despite her other academic, professional commitments and busy work schedule, without whom this work would not have been possible. I am greatly thankful to her for her expertise, relentless support, valuable advice, tireless guidance, and patience. Her admirable wisdom, knowledge, and dedication to her patients, students, her work is to be praised and acknowledged. Her unwavering work ethic and humility makes me aspire to be like her one day. I am so happy to be able to work under her guidance for my research. Her clarity and precision in handling situations and her commitment to the highest standards inspires me a lot. Thank you, dearest Dr. Olivija, for your constant motivation. I am forever indebted to you.

I also would like to thank my beloved parents and my brother for their support and love.

Conflict of interest

The author reports no conflict of interest.
Abbreviations

1. CAD- Coronary Artery Disease
2. NSTEMI- Non-ST- Elevation Myocardial Infarction
3. STEMI- ST-Elevation Myocardial Infarction
4. TIMI flow- Thrombolysis in Myocardial Infarction flow
5. PPCI/Primary PCI- Primary Percutaneous Coronary Intervention
6. HF- Heart Failure
7. LVF- Left Ventricular Failure
8. MI- Myocardial Infarction
9. LVEF- Left Ventricular Ejection Fraction
10. %- the percentage
11. AMI- Acute Myocardial Infarction
12. LAD- Left Anterior Descending Coronary Artery
13. Non-LAD- Non-Left Anterior Descending Coronary Artery
14. EF- Ejection Fraction
15. Post MI HF- Post Myocardial Infarction Heart Failure
16. ACS- Acute Coronary Syndrome
17. i-TIMI- initial-TIMI
18. UA- Unstable Angina
19. CRP-C- Reactive Protein
20. BNP- B-type natriuretic peptide
21. hs-CRP- high sensitivity CRP
22. LVSD- Left Ventricular Systolic Dysfunction
23. AF- Atrial Fibrillation
24. HRT- Heart Rate Turbulence
25. TWA- T wave Alternans
26. MBG- Myocardial Blush Grade
27. TRI- TIMI Risk Index
28. CHF- Congestive Heart Failure
29. MVO- Micro Vascular Obstruction
30. ce CMR- contrast-enhanced Cardiac Magnetic Resonance
31. SCD- Sudden Cardiac Death
32. MMVT or PMVT- Programmed ventricular stimulation
33. PVC- Premature Ventricular Contractions
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<tr>
<td>34.</td>
<td>CMR- Cardiovascular Magnetic Resonance</td>
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<tr>
<td>35.</td>
<td>MR- Magnetic Resonance</td>
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<td>36.</td>
<td>DBT- Door to Balloon Time</td>
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<td>37.</td>
<td>t-PA- tissue-type plasminogen activator</td>
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<td>38.</td>
<td>RCTs- Randomized Controlled Trails</td>
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<td>39.</td>
<td>MACE- Major Adverse Cardiac Events</td>
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<td>40.</td>
<td>IRA- Infarct-Related Artery</td>
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<tr>
<td>41.</td>
<td>PIT- Pharmaco- Invasive Therapy</td>
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<td>42.</td>
<td>IPC- Ischemic Post Conditioning</td>
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<td>43.</td>
<td>MVD- Multi-Vessel Disease</td>
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<tr>
<td>44.</td>
<td>MV-PCI- Multi-Vessel Percutaneous Coronary Intervention</td>
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<tr>
<td>45.</td>
<td>COR- Culprit Only Revascularization</td>
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<tr>
<td>46.</td>
<td>MVCD- Multi-Vessel Coronary Disease</td>
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<tr>
<td>47.</td>
<td>S-PCI- Staged- Percutaneous Coronary Intervention</td>
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<td>48.</td>
<td>CABG- Coronary Artery Bypass Grafting</td>
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<td>49.</td>
<td>ESC- European Society of Cardiology</td>
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<tr>
<td>50.</td>
<td>TNK- Tenecteplase</td>
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<tr>
<td>51.</td>
<td>ECG- Electrocardiogram</td>
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<tr>
<td>52.</td>
<td>SPECT- Single-Photon Emission Computed Tomography</td>
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<tr>
<td>53.</td>
<td>PET- Positron Emission Tomography</td>
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1. Introduction

Coronary artery disease remains one of the significant causes of mortality and morbidity in both developed and developing countries and contributes a significant proportion to the overall disease burden and costs. CADs are responsible for more than one-third of all deaths among individuals above the age of 35 years. In determining the major coronary syndromes, there are four major types; CAD with stable angina, unstable angina, NSTEMI, and STEMI [1]. The STEMI represents an acute thrombotic occlusion of an epicardial coronary artery and requires prompt recognition, triage, and reperfusion. The reperfusion strategies include pharmacological means such as fibrinolytic therapy and also mechanical reperfusion, mostly including primary PCI. While both treatment methods have their set of parameters, limitations, and scope, PCI remains the most effective means of treatment following STEMI. The pre-hospital management of STEMI patients is based on regional networks designed to deliver reperfusion therapy expeditiously and effectively, with efforts made to make PPCI available to as many patients as possible. Among patients with STEMI and undergoing reperfusion therapy, TIMI flow grades remain one of the most significant prognostic assessment of outcomes and PPCI is the preferred reperfusion strategy in patients with STEMI within 12h of symptom onset, provided it can be performed expeditiously. However, despite best efforts by practitioners and health care providers, a significant proportion of patients with STEMI, who undergo PPCI or other treatment methods eventually develop HF, which increases the odds of adverse outcomes and also mortality. In this study, various factors implicated in the entire process right from the initial symptoms and presentation of STEMI, treatment using PCI, assessment using TIMI flow, pretreatment with antiplatelets, and also various biochemical, radiological, physical, healthcare system and time-based parameters which determine treatment outcomes, as well as prognosis, were explored.
1. **Aim**

To determine predictors of acute left ventricular failure and mortality in patients admitted with acute ST-segment elevation myocardial infarction treated with the primary percutaneous coronary intervention.

2. **Objectives**

1. Risk factors, co-morbidities which influence mortality and the development of acute LVF, in patients with STEMI and treated with primary PCI.
2. Logistic parameters (chest pain duration, time till primary PCI (reperfusion therapy) and delay till primary PCI.
3. Impact of previous treatment on primary PCI effectiveness
4. Outcomes (as acute LVF or and mortality) by different reperfusion strategies and also compare and contrast primary PCI of culprit lesion and multiple vessel PCI strategies.

3. **Review of Literature**

To provide better structure to the ‘Review of Literature’ chapter, and also adhere to the objectives of the study, the review was divided into five major categories in terms of risk factors, comorbidities, logistic parameters, essential pretreatment prior to PCI and outcomes of different reperfusion strategies and they were:

1. **Risk factors, co-morbidities which influence the development of acute LVF, in patients with STEMI and treated with primary PCI.**

This section included studies that were directly linked to the major research objectives in terms of the specific progression of HF, particularly LVF, only among STEMI patients treated with PCI. This section sheds some light on the nature of the progression of the disease, and also the various risk factors, comorbidities, and conditions that are relevant and implicated in the treatment process.

Heart failure is defined as a clinical syndrome resulting from any structural or functional cardiac disorder that impairs the ability of the ventricle to fill or eject blood Yancy et al. [2]. HF, which includes LVF remains one the most common consequence of MI across all settings and is the major determinant of adverse prognosis after MI (Cahill et al.) [3]. For patients with STEMI, LVF is often most implicated and determines the overall prognosis following PCI. Chen and colleagues (2016) [4] conducted a retrospective study to review a total of 553 patients of STEMI, who underwent PPCI in order to determine the clinical and angiographic predictors for reduced LVEF in STEMI patients. The decreased LVEF following acute MI, usually impacts cardiac prognosis, even after PPCI. Among the various studies taken for consideration, they found that culprit arteries of STEMI were
315 in the LAD system and 238 in the non-LAD system. In comparison with the non-LAD group, post-MI LVEF was significantly reduced in LAD related STEMI group. Furthermore, the analysis also revealed that age (>65 years), time to hospital and proximal occlusion were some factors most closely associated with reduced LVEF among acute MI patients.

Ezekowitz et al. [5] examined the long-term incidence of HF in elderly patients with MI among a population-based cohort of 7,733 patients who were 65 years of age and hospitalized for a first MI. They were without a prior history of HF and were inducted between 1994 and 2000 in Alberta, Canada, and followed up for five years following treatment. During the course of the initial intervention, according to the index MI hospitalization, 2,831 (37%) MI patients were diagnosed with new HF, among which 1,024 (13%) died. Among patients who survived and who did not have HF during their index hospitalization, an additional 3,040 patients (71%) developed HF by five years, 64% of which occurred in the first year. In total, 5,871 (76%) elderly patients who survived their first MI developed HF over the following given years.

In a study by Gerber et al. [6], a community cohort of patients with the incident (first-ever) MI were evaluated to explore the association of angiographic CAD with subsequent HF and the prognostic role of CAD according to HF subtypes (reduced EF and preserved EF). A total of 1922 residents from Olmsted County, Minnesota, with incident MI, diagnosed between January 1, 1990, and December 31, 2010, were taken for the study. They found that during the average follow up period of 6.7 (5.9) years, 588 patients (30.6%) developed HF. With death and recurrent MI taken as competing risks, the cumulative incidence rates of post-MI HF among patients with 0 or 1, 2, and 3 diseased vessels were 10.7%, 14.6%, and 23.0% at 30 days; and 14.7%, 20.6%, and 29.8% at 5 years, respectively. They concluded that the extent of angiographic CAD is a major indicator of post-MI HF regardless of HF type and independent of recurrent MI.

A study conducted by Lewis and the Cholesterol And Recurrent Events (CARE) group [7] looked at the risk of developing HF in 3,860 stable MI patients without a previous history of HF, with a median period of 10 months post MI, in order to determine the predictors of HF development in long-term survivors of MI. It was found that a total of 243 patients (6.3%) had developed HF in a linear pattern of almost 1.3% per year. The development of HF markedly increased the risk of death. Fifty-seven patients (23.5%) who developed HF had a recurrent MI between enrollment and the onset of HF, increasing the risk fivefold. The main predictors/ risk factors of HF were found to be age and LVEF. Other significant predictors/ risk factors included diabetes, history of HT, previous MI, and baseline heart rate. It was also found that moderate exercise three or more times per week was independently associated with a 30% lower risk of HF.
In a cohort study conducted by Gho et al. [8], a total of 1459 patients with first STEMI were taken, in order to determine the incidence, risk factors and prognosis of HF after STEMI using the arrhythmia genetics study in the Netherlands. Follow-up was done for 1360 (93.2%) patients who had received STEMI treatment, and the average follow-up time was 6.7 years. 1232 (90.6%) patients had been treated with PPCI. A total of 85 patients (6.3%) developed HF during follow-up. The participants who had HF were significantly higher in age (59.9 vs. 57.2 years, \( P<0.001 \)) and more commonly had a history of atrial fibrillation (6.1% vs. 1.4%, \( P=0.001 \)) than the others without HF. Overall, the study found a relatively low long-term contemporary incidence of HF after a first coronary treatment in the current PCI era in comparison with other cases.

In another study which sheds light on the immediate prognosis following MI, and during primary ongoing treatment, Zornoff et al. [9] evaluated clinical profiles and adherence to treatment recommendations in a retrospective study of 172 patients with acute MI. Among the patients, 68 percent were white, 97 percent were over 60 years old. The main risk factor for coronary atherosclerotic disease and HF was systemic blood HT (63%). In terms of the clinical variables taken for consideration reperfusion therapy, smoking, HT, cardiogenic shock, and age were the predictors of 30-day mortality.

Torabi et al. [10] also explored the various predictors of demographic and clinical variables that affect the prognosis of HF following MI. Out of the 896 patients who were recruited; they were first divided into three age groups, below 65 years, between 65 and 75 years and above 75 years. It was found that 311, 297 and 288 were aged < 65, 65–75 and >75 years, among which 24%, 57%, and 82% had died respectively by the following year. Out of the decease rates, 24 (8%), 68 (23%), and 107 (37%) occurred during the index admission, many associated with acute HF. A further 37 (12%), 63 (21%) and 82 (29%) developed HF that persisted until discharge, of whom 15, 44 and 62 subsequently died. Overall, death was preceded by the development of HF in 35 (70%), 93 (91%) and 107 (85%) in aged < 65 years, 65–75 years and >75 years.

A study by Solomon et al. [11] assessed the risks and time course of sudden death in high-risk patients who were survivors of acute MI. In the study, 14,609 patients with left ventricular dysfunction, HF, or both after MI were taken, and the prevalence and timing of sudden unexpected death or cardiac arrest with resuscitation in relation to LVEF were investigated. It was found that out of 14,609 patients, 1067 (7%) after acute MI: 903 had a sudden death, and 164 were resuscitated after cardiac arrest. The risk of mortality is the highest in the first 30-days. Patients with a LVEF of 30% or less were at highest risk in this early period. Also, 19% of all sudden deaths or episodes of cardiac arrest with resuscitation occurred within the first 30 days after MI. Thus, the study concluded
that the risk of sudden death is highest in the first 30 days after MI among patients with left ventricular dysfunction, HF, or both.

Halkin et al. [12] developed a risk score from the 2082 patients in the Controlled Abciximab and Device Investigation to Lower Late Angioplasty Complications (CADILLAC) for predicting the mortality after PCI for AMI. Logistic regression and jackknife procedure was used to select the correlates of one-year mortality. 3 sets of risk were defined as low risk; score 0 to 2, medium risk; score 3 to 5 and high risk; score >/= 6 with excellent prognostic accuracy for survival (c statistics= 0.83 and 0.81 for 30-day mortality and 0.79 and 0.78 for one-year mortality). Measurement of LVEF is found to be an important predictor of survival.

A prognostic assessment was formulated by De Luca G et al. [13] according to 30-day mortality rates in 1791 patients undergoing PCI from 1994 to 2001. Significant predictors of the Zwolle index include age, location of the infarction- anterior infarction, Killip class, and time to reperfusion-ischemic time, post-procedural TIMI flow and the number of diseased vessels (Figure 1). This is a useful risk stratification after primary angioplasty for STEMI and has a significant impact on clinical decision making and in hospital costs.

![Fig 1. Zwolle Risk Score for STEMI. TIMI flow post indicates post-procedural TIMI flow. RR and 30-D indicate relative risk and 30-day, respectively (De Luca G et al. [13])]
A cohort study was conducted at University Hospital Centre of Tirana (UHCT) and 587 consecutive patients presenting with acute MI were followed up, and their prognosis was tracked (Myftiu, et al.) [14]. HF was identified in 156 patients (26.6%) and a Killip class ≥ 2 was the main diagnostic criterion of HF during hospitalization. It was found that the subgroup with HF had significant differences when compared with the rest of the group with regard to age, sex (male), heart rate upon admission, systolic blood pressure on admission, previous episodes of AMI, hyperglycemia on admission, previous antihypertensive treatment, previous history of symptom escalation and diffusion, previous revascularization procedures, peripheral vascular disease, chronic renal disease, ejection fraction, anemia, and atrial fibrillation presence.

In another review study conducted by Minicucci et al. [15], they explored various factors of complications in MI leading to HF including recurrent myocardial ischemia, infarct size, mechanical complications, and hibernating myocardium influence the appearance of LVSD after MI. They specified these risks as increasing the chances of death, following HF by at least 3- to 4-fold. Minicucci emphasized the priority to be given to the identification of the mechanisms involved in HF after MI since it can determine the treatment. They also specified the role of an adequate history and clinical examination as the most essential tools in the evaluation of ventricular dysfunction after an acute MI.

Hellerman et al. [16] conducted a study using an experimental design to test the hypothesis that the incidence of post-MI HF was declining over time among MI incidence cohort of 1,537 patients with no prior history of HF, from Olmsted County, Minnesota. The mean follow-up period was 7.6 years (sd=5.5 years), and it was found that 36% of patients experienced HF during the study period. When factors related to post MI, HF was adjusted, (age, HT, smoking, and biomarkers), it was found that the incidence of HF declined by 2% per year (relative risk = 0.98, 95% confidence interval: 0.96, 0.99; p = 0.01). It was also found that the administration of reperfusion therapy within 24 hours after MI was associated with a lower risk of post-MI HF and accounted for most of the temporal decline in HF. The study suggested that improved survival after MI is unlikely to be a major contributor to the HF epidemic.

In a study from West Pomerania, Poland (Dryja et al. [17]), medical researchers evaluated treatment methods of STEMI by comparing two major reperfusion strategies: PPCI and thrombolytic therapy, in terms of their early and long-term prognosis and outcomes. The study made use of medical records of 961 STEMI patients treated between 1st January and 31st December 2003. In the study group, 69.9% of the patients received reperfusion (44.6% primary PCI, 25.3% thrombolysis) with the mean age being 62 years. Patients referred for PCI were also younger compared to the thrombolysis group. It was found that 79 patients (8.3%) died in the early (30-day) period with a
mean age at the time of death being 73 years. Also, significantly higher mortality was observed in the conservative treatment group (12.7%) compared to patients treated with reperfusion. The group of thrombolytic therapy tended to have higher mortality (7.9%) than PCI patients (5.5%); the difference, however, was not significant. Early mortality was influenced by older age, female gender, low ejection fraction, and previous MI. The long-term prognosis was worsened by older age, low ejection fraction, diabetes mellitus, and smoking.

2. Logistic parameters (chest pain duration, time till Primary PCI (reperfusion therapy) and delay till primary PCI.

This section mostly dealt with information from relevant studies related to the exact course and nature of disease state (for STEMI), biochemical markers, angiographic markers and assessment procedures, and also patient characteristics like chest pain duration, time of symptom onset to balloon time, system delay like door to balloon time that eventually lead to interventions using PCI. It mostly dealt with factors and details associated with how medical professionals make decisions to go ahead with PCI, compared to other treatment options.

The treatment of associated symptoms and improvement of outcomes remain important parameters in terms of determining the course and treatment and also its duration and intensity. The management of ACS includes various subsets of acute MI, such as STEMI, NSTEMI, as well as unstable angina diagnoses (Kingsbury, 2013) [18].

A clinical study done by Suleiman et al. [19] aimed at studying the relationship between CRP, obtained between 12 and 24 hours of symptoms onset, and long-term risk of death and HF in survivors of acute MI, among a sample of 1044 patients admitted with acute MI and discharged from hospital in stable condition. It was found that during a median follow-up of 23 months (range, 6 to 42 months), 113 patients died and 112 developed HF. Using a multivariable Cox regression model adjusting for clinical variables and pre-discharge ejection fraction, it was found that the hazard ratios for death progressively increased with higher quartiles of CRP. The study highlighted the role of CRP, as a marker of long-term development of HF and mortality in patients with acute MI and it has the potential to provide accurate prognostic information beyond that provided by conventional risk factors and the degree of LVSD and could significantly help in input during the post-discharge period and long term treatment.

Jones et al. [20] conducted a consolidated analysis of treatment records and epidemiological evidence, which showed mean survival rates in chronic HF of 80–90%, 50–60%, and 30% at 1, 5, and ten years respectively following MI. However, they also stressed the complexity of a patient’s disease and their comorbidities, which makes it difficult to generalize the population results to
specific individuals. Among the myriad of factors implicated during the post-MI phase, the authors pointed out the significant effect of increasing age, LVSD, elevated natriuretic peptides, and other markers of vascular or renal disease as best predictors of poor prognosis.

Seo et al. [21], investigated whether the plasma B-type natriuretic peptide levels on admission can predict or not the myocardial perfusion status in patients with STEMI after PPCI. 102 patients with STEMI who had PPCI performed within 12 hours of symptom onset were enrolled in the study. Patients were grouped according to the BNP levels: high BNP group (> or = 80Pg/ml, n=43) and low BNP group (<80pg/ml, n=59). The group with high BNP levels had significantly lower ST-segment resolution, lower MBG, and high short term mortality. The patients with STEMI who had high BNP levels on admission observed to have insufficient myocardial tissue perfusion after PPCI. Hence, the study concluded that plasma BNP levels on admission could be a strong predictor of tissue perfusion after PPCI in patients with STEMI.

Grabowski et al. [22], study not only predicts BNP levels obtained on admission as a powerful and independent tool of short term mortality but also provides information on the success of PPCI as well as the no-reflow phenomenon can be predicted in patients with high serum BNP levels on admission for STEMI. High levels of BNP are observed in patients with TIMI < 3 after PPCI than those with TIMI 3. The study summarizes that BNP levels on admission can be used as an independent predictor for death, angiographic success (TIMI grade after PCI) and for the prediction of the no-reflow phenomenon.

The study by Jeong et al. [23] identifies BNP values on the initial presentation can predict the angiographic no-reflow phenomenon after the primary drug-eluting stent implantation for STEMI, and it may be very useful in identifying patients at high risk of the no-reflow phenomenon after primary stenting. In this study, the no-reflow phenomenon is defined as an angiographic outcome of TIMI grade < 3 without coinciding mechanical factors. It showed no-reflow patients were older, had greater symptom onset to balloon time and higher TIMI risk score. Also, BNP, hs-CRP, serum creatinine levels were higher in no-reflow patients compared to normal reflow patients. On admission BNP levels (> or = 90 pg/ml) is shown to have 80% sensitivity and 70% specificity.

BNP levels have shown to be an independent predictor of new-onset AF in STEMI patients treated with PPCI (Asanin et al.) [24].

In a study of the identification of risks following MI, Exner et al. [25] from the REFINE study sought to determine whether the combined assessment of autonomic tone plus cardiac electrical substrate could identify patients at risk of serious events after MI. They also compared the assessment of risks at 2 to 4 weeks versus 10 to 14 weeks after MI on a group of 322 MI patients with an EF <
0.50 in the initial week after MI and they were followed up for a median of 47 months. They found that mean EF significantly increased over the initial 8 weeks after MI. The assessment carried out two to four weeks after MI did not reliably identify patients at risk, whereas testing at 10 to 14 weeks did. They concluded that parameters such as impaired heart rate turbulence, abnormal T-wave alternans, and an EF < 0.50 beyond 8 weeks after MI could reliably identify patients at risk of serious events.

In a study done by Rasoul et al. [26], patient characteristics and their outcomes of 30-day mortality were evaluated using the clinical data of 4732 patients who were treated with PCI for STEMI during an 11 year study period. 219 patients (4.6%) patients died at the 30-day follow up. Mortality was prominent in older, higher risk profile patients. Significant predictors of 30-day mortality in patients treated with PCI were found to be the multi-vessel disease, anterior MI, in-hospital reinfarction, ischemic time, and pre TIMI flow less than 3. The other strong predictors for 30-day as well as one-year mortality are previous MI, diabetes, Killip class >2, post-PCI TIMI flow < 3 and LVEF < 30%.

The degree of left ventricular dysfunction (Macić-Džanković et al. [27]) is interlinked with the extent of acute ischemia/infarction. Hemodynamic instability is seen when impairment involves 20 to 25% of the left ventricle, and cardiogenic shock or death occurs with involvement left ventricular muscle of 40% or more. Pulmonary congestion and S3 and S4 gallops are the most common physical findings. Early recanalization (via thrombolytics, PCI, or CABG) is the most effective therapy to reduce infarct size, ventricular dysfunction, and associated HF. In patients with severe HF and shock, PCI or surgical revascularization can improve survival. HF grade can be defined according to Killip classification (Table 1). The TIMI-risk score has a higher prognostic value, especially in the estimation of one- and six-months survival (Table 2).
A study was undertaken at the hospital De Weezenlanden, Zwolle, the Netherlands where researchers studied 777 patients who underwent PPCI during a 6-year period and investigated the value of angiographic evidence of myocardial reperfusion (MBG) in relation to the extent of ST-segment elevation resolution, infarct size, left ventricular function, and long-term mortality (van Hof, et al.) [28]. They found that the patients after reperfusion therapy, the MBG, as seen on the coronary angiogram, can be used to describe the effectiveness of myocardial reperfusion and is an independent predictor of long-term mortality.
Myocardial reperfusion in STEMI patients who are undergoing PCI is usually evaluated using the angiographic TIMI flow grade. The TIMI risk index is a simple bedside score that predicts 30-day mortality in patients with STEMI.

A study by Truong et al. [29] reported on the results of the TIMI 2 trial in which 3,153 patients (mean age = 57 years) were randomized to either invasive or conservative methods of post fibrinolysis, and with a median follow up of up to 3 years. The TIMI risk index for this study was divided into 5 groups. The primary point of analysis was whether or not mortality occurred, whereas the secondary analyses included recurrent MI, congestive heart failure. It was found that the mortality in group 5 was more than 5-fold higher than group 1 and was also higher in group 4 and 3. Group 5 also had the highest risk for CHF and the highest risk for composite death over group 1. The study highlighted the utility and effectiveness of the simple TRI score based on TIMI, which can successfully predict increased long-term mortality, CHF, and composite death.

In another study by Schaaf et al. [30], they assessed the impact on infarct size of initial –TIMI (i-TIMI) flow in the culprit coronary artery, as well as on microvascular obstruction (MVO) incidence and size using contrast-enhanced cardiac magnetic resonance (ce-CMR) using a prospective, multi-centre design. The population of the study included a total of 140 patients presenting with STEMI referred for PPCI. It was seen that there was no significant difference in final post-PCI TIMI flow between the groups. In the i-TIMI flow 1 group, infarct size was significantly larger, MVO was significantly more frequent, and MVO size was significantly larger compared to the i-TIMI 2 patient group. The final takeaway of the study was that the initial angiographic TIMI flow in the culprit coronary artery prior to any PCI could be used in predicting final infarct size and MVO size.

In a retrospective study by Kammler et al. [31], data from “real world patients” database of patients undergoing PPCI were analyzed to determine differences in clinical and angiographic patterns in patients with or without restoring TIMI flow 3. The study included 500 patients who underwent PPCI for STEMI between 2001 and 2006. Among 430 patients, post-interventional TIMI flow 3 could be established, and in-hospital mortality was significantly lower, LVEF was better and pre-hospital fibrinolytic therapy, cardiogenic shock and use of intra-aortic balloon pump were all more unlikely compared to patients with TIMI flow ≤ 2. Also, in patients with post-interventional TIMI flow ≤ 2, the left anterior descending coronary artery was significantly more often seen as the target vessel. Appropriate regression analysis revealed that predictors leading to such flow patterns were diabetes, pre-hospital fibrinolytic therapy, cardiogenic shock, and a 3-vessel disease. The authors concluded that post-interventional TIMI flow ≤ 2 is strongly linked with adverse outcome during hospitalization and after 6 months following hospitalization.
In exploring the incidence of sudden death among patients of acute MI, Dr. Umang Patel (2016) [32], in a compiled presentation on the topic of sudden cardiac death (SCD) following acute MI, highlighted several risk factors that predict SCD following acute MI. In his assessment, factors such as LVEF, programmed ventricular stimulation, functional class of HF, Holter monitor showing premature ventricular contraction (PVC) > 10 / hour, autonomic dysfunction and renal failure are most significant predictors of sudden death following MI. He also distinguished the nature of the intervention as primary or secondary in terms of the time period following the MI and the presence of the earlier mentioned criteria in determining the nature of PCI to follow and also the chances of SCD.

In a study conducted by Francone et al. [33] analyzed the extent and nature of myocardial damage by using cardiovascular magnetic resonance (CMR) by evaluating the infarct size and myocardial salvage in patients with STEMI in relation to a different time to reperfusion intervals. 70 patients with STEMI treated successfully with PPCI within 12 hours from symptom onset had CMR done 3+/-2 days after hospital admission. Patients were categorized into 4 symptom onset to balloon quartiles that is < or = 90mins, > 90mins to 150mins, > 150 to 360mins and > 360mins. T2 weighted short tau inversion recovery and late gadolinium enhancement were used to classify reversible and irreversible myocardial damage. They concluded that the patients treated for STEMI with PPCI, time from symptom onset to reperfusion controls the extent of reversible, and irreversible myocardial injury. Salvaged myocardium is significantly reduced when reperfusion is attempted > 90mins of the occluded artery.

Another study done by Aquaro et al. [34] comes to a differing conclusion where they explored the influence of pain to balloon time on infarct size assessed by delayed enhancement MR imaging. 60 patients with just AMI were treated within < 168mins, 168 to 222mins, 223 to 300mins and > 300mins and grouped respectively and also according to their severity of presentation at admission. MR imaging was done 6+/-3 days after PPCI. The study concluded that the patients with the worst presentation were transferred sooner for PPCI; hence, the shorter pain to balloon time does not decrease infarct size likely due to unavoidable delay to reperfusion.

A follow up study done on population-based Danish medical registries by Terkelsen et al. [35] of patients with STEMI has evaluated the association between system, treatment, patient, and door to balloon time (DBT) delays and mortality in patients with STEMI and their multivariable analysis adjusted for other predictors of mortality concluded system delay, pre-hospital system delay and DBT delay was associated with mortality in STEMI patients treated with PPCI, but there is no significant relationship between time from symptom onset to balloon inflation and long term mortality.
A cohort study conducted by McNamara et al. [36] evaluated the effect of the DBT on mortality for patients with STEMI treated with PCI. 29,222 STEMI patients treated with PCI within the 6-hour presentation participated in the National Registry of Myocardial Infarction (NRMI) - 3 and 4 from 1999 to 2000. DBT is strongly associated with mortality risk. Longer DBT is associated with increased in-hospital mortality. 121 to 150mins and >150mins had a mortality rate of 5.7% and 7.4% respectively. Patients with DBT > 90mins had increased mortality compared to those who had the DBT < or = 90mins. Also, regardless of the presence or absence of high-risk factors, increased mortality was seen with increased DBT regardless of symptom onset to door time.

The CADILLAC and HORIZONS-AMI [37] studied the impact of the DBT on mortality in 4548 patients based on time of presentation and clinical risk. They determined the one-year mortality rate was lower in a patient with short vs. long DBT (< or = 90 min vs.> 90min, 3.1% vs. 4.3% respectively). Short DBT showed low mortality rate in patients with the early presentation but less on late presentation. The absolute benefit with mortality rate reduction with short DBT was greatest for high-risk patients presenting early (5.7% vs. 7.4%, < or = 90mins vs.> 90mins respectively).

The prognosis of any form of acute MI remains poor compared to a host of other physical conditions. While there remains a range of in-hospital and immediate factors that determine mortality for the short term (less than 30 days), mostly in hospital settings, the scenario changes drastically when considering long term health and outcome of the patients who receive PCI. The overall health of patients is definitely compromised, and a significant proportion of patients either suffer another MI or mortality within the first year of the first acute MI and its treatment. Thus, it paints a grave picture of the overall prognosis of MI. Stone et al. [38] examined the predictors of in-hospital and 6-month outcome following an acute MI after different reperfusion strategies had been put in place. A total of 395 patients from 12 centers presenting within 12 hours of the onset of acute transmural MI were prospectively randomized to receive one of two types of treatment; tissue-type plasminogen activator or undergo primary angioplasty without antecedent thrombolysis. Sixteen clinical variables were examined with univariate and multiple regression analysis to identify the predictors of clinical outcome. The study found that in-hospital mortality was significantly higher in the elderly group, women, and patients with diabetes and patients treated with t-PA, as opposed to angioplasty. The authors concluded that in today’s reperfusion era, the two most powerful determinants of freedom from death, re-infarction, and recurrent ischemia after MI are young age and treatment by primary angioplasty.

Minicucci et al. [39] evaluated the predictors of systolic recovery after MI and following modern therapy methods, which included reperfusion, aggressive platelet antiaggregant therapy, angiotensin-converting enzyme inhibitors, and beta-blockers. In terms of evaluating the factors that lead to HF
following MI, it is also important to look at the alternate factors which predict a favorable prognosis. A total of 94 patients with MI and ST-segment elevation were taken for the study and follow up echocardiograms were performed during the in-hospital phase and after 6 months. It was found that patients with ventricular dysfunction had larger infarct size (assessed by the measurement of total and isoenzyme MB creatine kinase enzymes) than patients without ventricular dysfunction. Moreover, 24.5 percent of patients that initially had systolic dysfunction showed recovery within 6 months after MI. Among the recovery group, they had smaller infarct sizes, but larger values of ejection fraction and E-wave deceleration time than patients without recovery.

Contractor (2011) [40] conducted a meta-analysis of results from various studies on prognosis post-MI was analyzed the relative effective sizes for 48 randomized trials in which the outcomes of exercise-based rehabilitation was contrasted with treatment involving usual medical care. The meta-analysis showed an aggregate reduction of 20% in total mortality and 26% in cardiac mortality rates when exercise-based rehabilitation techniques were employed in recuperation following MI and subsequent coronary based interventions.

2. Impact of pretreatment on primary PCI effectiveness (TIMI).

In a study done by Jung et al. [41], compares the pretreatment of clopidogrel before PPCI with high loading dose vs. low loading dose. 171 patients with STEMI were given clopidogrel as a pretreatment before PPCI. 73 patients were given 600 mg, and 98 patients were given 900mg of a loading dose of clopidogrel. The main endpoints: mortality in 30-days, recurrent MI, stroke or repeat revascularization, and safety endpoints were evaluated. The primary endpoints were lower in patients treated with 600mg of clopidogrel (1 of 73 (1.4%)) compared to the low dose 300mg (11 of 98 (11.2%)). Safety outcomes were similar in both groups. Pretreatment with a 600mg loading dose of clopidogrel before PPCI is both effective, safe and reduces adverse events like 30-day mortality, recurrent MI, stroke, and revascularization compared with the standard 300mg loading dose.

Larson et al. [42] study found similar results to the above study. His study has a larger population. 2,014 STEMI patients were treated with clopidogrel before PCI. The study found that patients receiving a loading dose of 600mg of clopidogrel had less ischemic complications without major bleeds or deaths.

Koul et al. [43] analyzed 7,433 STEMI patients. 5,438 who were pretreated with ticagrelor before undergoing PPCI and 1,995 were given ticagrelor in the cath lab only. The outcomes of the study were all-cause mortality, reinfarction, stent thrombosis at 30-days, and major in-hospital bleeding. They found that the groups did not differ in the primary endpoints, and neither was there any
significant difference among the groups regarding in-hospital bleeding. Even after adjusting baseline differences, no significant differences were seen concerning the endpoints. Hence the study concluded pretreatment with ticagrelor compared with ticagrelor given in the cath lab only did not improve the endpoints in STEMI patients undergoing PPCI.

Hibbert et al. [44] in their CAPITAL RELOAD study evidence show ticagrelor bolus following clopidogrel resulted in more rapid and profound platelet inhibition, demonstrating a positive pharmacodynamic interaction in patients referred for PPCI.

In a retrospective analysis conducted by Vos et al. [45] collected clinical information of 533 patients with STEMI, pretreated with either prasugrel or ticagrelor prior to PPCI. The primary endpoints of the study were flow grade of coronary reperfusion and ST-segment elevation resolution. The secondary endpoints are MACE and stent thrombosis at 30 days. It was found that the prehospital administration of both ticagrelor and prasugrel in STEMI is safe and no significant differences were seen in MACE and stent thrombosis between the two groups as well as no major bleeding were reported in the 30-day period. Similarly, neither any significant difference was found in pre-procedural and post-procedural coronary reperfusion (TIMI flow 3) and in ST-segment resolution among them.

In this observational study conducted by Pepe et al. [46] determines whether P2Y12 inhibitors such as ticagrelor and prasugrel has or has not improved the angiographic outcomes of PPCI and patient prognosis in relation to the time of their loading dose administration. 328 patients with STEMI referred for PPCI were chosen and divided into 3 groups depending on the interval of P2Y12 inhibitors administration to balloon time. Group 0 was given the loading dose at the moment of PPCI, group 1 within 60 min before PPCI, and group 2 included patients that received P2Y12 inhibitors at least 60 min prior to PPCI. Pre PPCI-TIMI flow grade improved with longer P2Y12 inhibitor loading dose administration time to balloon time. Pre PPCI-TIMI flow grade 0/1 was 74.5% in group 0, 65.5% in group 1 and 54.9% in group 2. Increase in ST-segment resolution was shown in patients with STEMI treated with longer pretreatment intervals. In conclusion, this study shows coronary reperfusion grade improves in terms of pre and post-PPCI-TIMI flow grade and ST-segment resolution with a longer pretreatment time interval.

In a randomized control study done by Mont’Alverne-Filho et al. [47] was to determine the effect of pretreatment with prasugrel (60mg) or ticagrelor (180mg) or clopidogrel (600mg) for patients with STEMI undergoing PPCI within 12hrs. Pre PPCI-TIMI flow grade 0/1 was found to be 97.7% in the clopidogrel group, 87.8% in the prasugrel group and 78.3% in the ticagrelor group. The post-procedural TIMI grade flow 3 and MBG 3 were 52.3% for clopidogrel, 80.5% for prasugrel, and
67.4% for ticagrelor (P=0.022). In conclusion, it was found that even though varying evidence was seen, prasugrel and ticagrelor are shown to have better angiographic results than clopidogrel.

In a double-blind, randomized, comparison study done by Zeymer et al. [48] conclude that the pre PCI administration of prasugrel in patients with STEMI undergoing PPCI was associated with significantly faster platelet inhibition compared with clopidogrel.

Tang et al. [49] did an assessment comparing the safety and efficacy of pretreatment with ticagrelor vs. clopidogrel in patients with STEMI prior to PPCI. Ticagrelor has shown to reduce the incidence of major cardiovascular and cerebrovascular events; stent thrombosis, recurrent MI, recanalization, stroke as well as fewer patients received GPIIb/IIIa inhibitors after PPCI compared with those receiving clopidogrel. However, no significant difference was seen among the two groups in terms of risk of bleeding.

In contrast, a large observational, non-randomized study conducted by De Backer et al. [50] shows excluding the patients in cardiac arrest or cardiogenic shock undergoing PPCI, that the pretreatment with newer P2Y12 inhibitors (prasugrel or ticagrelor) does not improve early coronary reperfusion as compared to the pre-hospital loading with clopidogrel in the PPCI.

A study done by Ma et al. [51] identifies RCTs assessing pretreatment with atorvastatin in ACS patients undergoing PCI. 17 RCTs, including 10072 patients, were studied. Clinical outcomes such as short term MACEs, changes in serum hs-CRP, peak CK-MB level, and TIMI grade 3 flow after PCI were studied. It was found that high-dose atorvastatin showed high benefits in reducing the incidence of short-term MACEs and hs-CRP levels but had no significant difference in terms of peak CK-MB and final TIMI flow grade 3 among ACS patients after PCI. It also had benefits of not increasing drug-induced hepatotoxicity in ACS patients after PCI.

A STATIN STEMI trial was conducted by Kim et al. [52] to determine the efficacy of high-dose atorvastatin in patients with STEMI undergoing PPCI. 171 patients with STEMI were randomized to a high dose of 80 mg atorvastatin and a low dose of 10 mg atorvastatin pretreatment before PCI. The primary endpoint of the study was the 30-day incidence of MACE, including death, recurrent non-fatal MI, and revascularization. MACE was observed 5 (5.8%) and 9 (10.6%) patients in 80 mg and 10 mg atorvastatin pretreatment respectively. The trial concludes there is no significant difference of MACE when compared regarding the dosage of atorvastatin, but did show immediate improvement to the coronary flow after PPCI with a high dose of atorvastatin (higher MBG and ST-segment resolution).
A study done by Hahn et al. [53] found no effect on the reduction of infarct size with pretreatment with high dose atorvastatin followed by further treatment for 5 days after the PPCI.

A large scale observational analysis was done by Karlsson et al. [54] aimed to study the effect of pretreatment with heparin on TIMI grade flow and thrombus burden before PPCI in patients with STEMI. Using multi-logistic regression analysis, it was found that pretreatment with heparin was associated with significantly reduced risk of no perfusion (TIMI 0 flow) and definite thrombus before PPCI.

4. Outcomes (as acute LVF or and mortality) by different reperfusion strategies compare primary PCI of culprit lesion and multiple vessel PCI strategies

This section included studies that mostly looked at the timeline following the initial presentation of MI symptoms and the primary methods of interventions (mostly PCI). The major focus of interest was on the factors related to short term and long term prognosis following MI and PCI treatment. Also dealt with the effectiveness and efficiency of various reperfusion strategies following STEMI, with particular reference to PCI and its comparison with other treatment methods. A major contrast was drawn between the two major intervention methods: pharmacological (fibrinolytic therapy), mechanical (PPCI) reperfusion and their different types of mechanical reperfusion like multi-vessel PPCI, culprit only PPCI and staged multi-vessel PCI in order to get a clearer idea regarding the scope and effectiveness of the treatment methods.

PPCI remains the reperfusion method of choice for most acute STEMI conditions as it achieves a high rate of TIMI flow 3 and also reduces the risks of bleeding and strokes and overall outcomes. In a brief commentary by Mullasari et al. [55], the authors highlighted the importance of coronary care units and early reperfusion therapy (Thrombolytic and Percutaneous Coronary Intervention) in substantially decreasing in-hospital mortality rates of patients in the acute phase of MI. They differentiated the complications arising out of acute MI into five types; mechanical, arrhythmic, ischemic, and inflammatory (early pericarditis and post-MI syndrome) sequelae, as well as left ventricular mural thrombus. Furthermore, they also pointed out right ventricular infarction and cardiogenic shock as other common complications associated with acute MI. The article also highlights the importance of paying attention to the explicit symptoms and physical manifestations following MI and stressed the importance of the post-infarction period and the role of physicians to evaluate and treat the complication appropriately.

In a research study by Dzankovic et al. [27], they compared two groups of patients following acute MI in a primary health setting. The first group of patients was treated with fibrinolytic and was hospitalized within six hours of the start of physical symptoms of MI. The second group included
patients who did not come within optimal time after MI and were treated with anticoagulants only. The patients were classified according to Killip-classification, shock-index, and TIMI-risk score after MI. The results of the study highlighted the stark differences in outcomes and provided evidence of benefits of fibrinolytic therapy, when done in optimal time, keeps both myocardial muscle mass and myocardial pump function as optimal.

Le May et al. [56] compared two methods of treatment of acute MI; tenecteplase (TNK)-facilitated angioplasty and TNK alone in patients presenting with high-risk STEMI. The study was based on previous trials where thrombolysis followed by immediate angioplasty for the treatment of STEMI did not seem to improve ischemic outcomes compared with thrombolysis alone. The researchers randomized 170 patients with high-risk STEMI to treatment with TNK alone (84 patients) or TNK-facilitated angioplasty (86 patients). The primary endpoints for analysis in the study were a composite of death, re-infarction, recurrent unstable ischemia, or stroke at a time period of six months. It was found that at six months, the incidence of the primary endpoint was 24.4% in the TNK-only group versus 11.6% in the TNK-facilitated PCI group. There was also a reduction in the rate of recurrent unstable ischemia a trend toward a lower re-infarction rate with TNK-facilitated angioplasty. Moreover, no significant differences were observed in the rates of mortality or stroke. The authors concluded that in patients with high-risk for STEMI, TNK plus immediate angioplasty (facilitated perfusion) decreased the risk of recurrent ischemic events compared with TNK alone and also was not associated with an increase in major bleeding complications.

In another review study by Cimato (2015) [57], the author concluded that patients who sustain recurrent MI could be regarded as a particularly high-risk group for the development of HF. Despite the tremendous improvements in treatment methods for MI, ranging from thrombolytic therapy to PCI, HF occurs in roughly 10% of patients in the first year after first MI, and 3 years after their first MI. Also, 40% of subjects with prior MI develop HF within six years according to longitudinal studies that have kept track of prognosis of thousands of MI patients in primary health settings. He also highlighted complete revascularization by PCI at the time of ST-segment elevation, as an emerging treatment approach to prevent HF and could significantly improve prognosis results of a large section of patients from different age and profile groups.

A study by Mehta et al. [58] sought to assess the impact of post-PCI, TIMI flow grades in the infarct-related artery in patients with STEMI, and cardiogenic shock. Among a sample of 4,731 STEMI patients with cardiogenic shock undergoing PCI at 567 hospitals included in the American College of Cardiology–National Cardiovascular Database, it was found that post-PCI TIMI flow grades 0 to 2 in the infarct-related artery were present in 14.7% of patients. In comparison with patients with TIMI flow grade 3, patients with TIMI flow grades between 0 and 2 were more likely
to undergo CABG surgery after PCI and also develop renal failure, cardiac tamponade and bleeding requiring a blood transfusion. The unadjusted mortality was more than two times higher with TIMI flow grades 0 to 2 versus TIMI flow grade 3. It was also seen that there was a graded inverse relationship with TIMI flow in the IRA and the adjusted mortality for TIMI flow grades 0/1 and for TIMI flow grade 2 compared with TIMI flow grade 3. The study concluded that the lack of procedural success (post-PCI TIMI flow grades 0 to 2) after PPCI among patients with cardiogenic shock was associated with a much higher risk of mortality compared to patients with normal post-PCI TIMI flow grade 3.

In another study by Timmer et al. [59], they aimed to investigate whether elevated glucose was associated with impaired TIMI flow before PPCI. Usually, reperfusion before PPCI in patients with STEMI is associated with an improved outcome whereas hyperglycemia in the same patients is associated with an adverse prognosis. For this study, a total of 460 patients with STEMI treated with PPCI were included. It was found that hyperglycemia was observed in 70% and TIMI flow grade 3 before PPCI in 17% of the patients. Patients with hyperglycemia less often had TIMI flow grade 3 before PPCI. It was also found that hyperglycemia was a strong predictor of the absence of reperfusion before PPCI.

In another study by Zeymer et al. [60], they sought to investigate whether TIMI 3 flow obtained with fibrinolysis before PCI was associated with a clinical outcome comparable to that in patients with spontaneous TIMI 3 flow. The study included a total of 1617 patients with STEMI <6 hours enrolled in treatment using PCI. To test the hypotheses, patients were divided into three groups according to the TIMI flow of the infarct vessel before PCI: TIMI 0/1, TIMI 2, and TIMI 3. Among the 1617 patients, 861 had TIMI 0/1, 279 had TIMI 2, and 477 TIMI 3 flow with rates of TIMI 3 flow after PCI being 84.6, 89.7, and 95.6%, respectively. Among the TIMI 3 flow group, complete ST resolution was observed most often, and the incidence of cardiogenic shock and 90-day mortality were also lowest in this group. It was also found that the 90-day mortality in patients with TIMI 3 before PCI was identical in the facilitated and the PPCI groups.

Another paper reported on the national registry in France for acute ST-elevation myocardial infarction (FAST-MI) and included 223 centers and 1714 patients over a 1-month period at the end of 2005 (Danchin et al.) [61]. Among the patients, 60 percent underwent reperfusion therapy, 33% with PPCI, and 29% with intravenous thrombolysis (18% pre-hospital). At baseline, the global registry of acute coronary events score was found to be similar in thrombolysis and PPCI patients. Time to initiation of reperfusion therapy was significantly shorter in thrombolysis than in PPCI. After thrombolysis, 96% of patients had coronary angiography, and 84% had subsequent PCI (58% within 24 hours). In-hospital mortality was 4.3% for thrombolysis and 5.0% for PPCI. One-year
survival was 94% for thrombolysis and 92% for PPCI. The study concluded that when used early after the onset of symptoms, a pharmacoinvasive strategy that combines thrombolysis with liberal use of PCI yields survival rates that are comparable to those of PPCI.

In a meta-analysis done by Siddiqi et al. [62] compared the safety and efficacy of using pharmacoinvasive therapy (PIT) on patients with STEMI presenting to the non-PCI capable hospitals that need to be transferred to PPCI providing centers. It is known that increased time to revascularization increases the chances of in-hospital deaths. Total ischemic time is an important determinant in the outcome of acute MI. PIT can be a possible alternative over PPCI in patients requiring a transfer. PIT is defined as administration of fibrinolysis followed by immediate PCI only when thrombolysis has failed. It was found that combined results of RCT and observational studies demonstrated that compared with PIT, PPCI significantly increases the chances of cardiogenic shock whereas significantly decrease the chances of re-infarction, but there is no crucial difference in short term or long term mortality, stroke, TIMI-3 flow or major bleeding. It shows that the PIT approach is beneficial in patients where very long delays to PPCI are expected (>60 minutes). Cardiogenic shock is found to be the leading cause of death in hospitalized patients with acute MI complicating about 5% to 8% of STEMI cases. Delays in reperfusion are a known risk factor of cardiogenic shock, and early reperfusion is the key to prevent this complication.

Zhenhua et al. [63] did a systemic review and meta-analysis to evaluate the outcomes of post-ischemic conditioning on patients with STEMI who underwent PPCI. PPCI is a first line therapy and is known to be effective in restoring blood flow. Ischemic post conditioning (IPC) is an experimental technique which refers to a series of repetitive brief interruptions of blood flow before sustained reperfusion is applied to the site of ischemia, which results in reduced reperfusion injury or infarction at the myocardium. Reperfusion injury can be identified using cardiac biomarkers, single photon emission CT, and ECG. IPC is safe and cost-effective without additional costs. Similar meta-analysis has demonstrated a reduction of the insult to the cardiomyocytes due to IPC. The RCT showed no reduction in the incidence of HF compared with traditional PPCI, as well as it did not reduce all causes of mortality, cardiac death, MI and MACE over a mean follow up of 20 months.

Lee KL et al. [64], performed a comprehensive analysis of the relation between clinical data and 30-day mortality from the large population of the GUSTO-I trial candidates receiving thrombolysis therapy for acute MI. 41021 candidates took part in the randomized trial, which was examined using both univariate and multivariate analyses. It was found that a total of 2851 patients (7.0%) died within 30 days of the trial enrollment. 1125 (39%) of the deaths occurred within 24 hours, more than half (55%) occurred within 48 hours of the trails and the most significant factor influencing the 30-day mortality in the youngest age group (<45 years) at the rate of 1.1% and the oldest (>75 years) at
20.5\% is age. The other significant factors that influence the 30-day mortality were low systolic blood pressure, higher Killip class, elevated heart rate, and anterior infarction. They make 90\% of the most important prognostic details from the initial assessment data after acute MI.

In a meta-analysis done by Bangalore et al. [65], compared several randomized controlled trials in patients with STEMI and multi-vessel disease following their PPCI strategies:

1) Single- procedure multi-vessel PCI;
2) Staged multi-vessel PCI;
3) Culprit only PCI.

Their safety and efficacy outcomes were evaluated. The primary efficacy outcomes were the risk of death or re-infarction, and the secondary efficacy outcomes include death, MI, and repeat revascularization. Safety outcomes were contrast-associated acute kidney injury, stroke, and major hemorrhage.

3,150 patients were enrolled in 11 trials. In direct comparison meta-analysis, single-procedure multi-vessel PCI was associated with reduced risk of death or re-infarction compared with culprit-only PCI. However, staged multi-vessel PCI did not drastically reduce death or MI compared with culprit-only PCI. Hence the meta-analysis concluded suggesting that single procedure multi-vessel PCI may be preferred over staged multi-vessel or culprit only PPCI strategies in patients with STEMI and MVD.

In another meta-analysis done by El-Hayek et al. [66] proved similar outcomes, where the RCT comparing the multi-vessel PCI (either at the time of the PPCI or as a staged procedure) versus culprit vessel only revascularization during PPCI in patients with STEMI and multi-vessel coronary disease. Four RCTs were selected. Among them, 566 patients underwent MV-PCI, and 478 patients underwent COR. The follow up showed a significant reduction in all-cause mortality, cardiac death, significantly lower risk of re-infarction and future revascularization with MV- PCI. Furthermore, with regards to their safety outcomes MV-PCI was not associated with a higher risk of complications, including major hemorrhages, strokes, or contrast-induced kidney injuries.

In another systematic review and meta-analysis done by Bainey et al. [67], they contradicted the meta-analysis of the RCTs done by Bangalore S et al., where single procedure MV- PCI is preferred over staged MV-PCI. Bainey used 26 studies of randomized as well as non-RCTs of 46,324 patients, out of which 7886 were MV-PCI and 38,438 were COR. They found there is no major difference in hospital mortality with multi-vessel PCI vs. culprit-only PCI. However, amongst MV- PPCI and
MV-PCI performed in a staged manner, the former showed to have increased in-hospital mortality, and the latter had lower short and long term mortality and repeat revascularization.

In the study done by Hannan EL et al. [68], 3521 patients underwent culprit vessel PPCI. 259 of them underwent staged PCI during initial admission, and 538 patients underwent staged PCI within 60 days of the index procedure. It was found that patients without hemodynamic instability had lower in-hospital mortality, when COR was performed during index admission rather than MV-PCI during index procedure whereas patients undergoing staged multi-vessel PCI within 60-days after the index procedure had a significantly lower 1-year mortality rate than patients undergoing COR only.

In another meta-analysis of RCT’s done by Dahal et al. [69], Four RCTs were identified with around 840 patients. It showed that MV-PCI when compared with CV-PCI significantly reduced the risks of major adverse cardiac events, re-infarction, revascularization, and all-cause mortality. Staged PCI and MV-PCI has a similar risk of MACE, revascularization, and all-cause mortality. The meta-analysis concluded MV-PCI compared to CV-PCI lowers risk of MACE due to lower reinfarction and repeat PCI in patients with STEMI & MVD. Whereas S-PCI has shown to be superior in reducing overall MACE, MI, revascularization, and re-hospitalization when compared to CV-PCI.

A systematic review and meta-analysis did by Li et al. (2017) [70], compared 10 studies of 4 randomized and 6 non-randomized trials of which 562/820 patients had staged PCI, and 347/820 patients had one time, complete revascularization. When S-PCI (staged PCI) was compared to MV-PCI, a significant reduction in both short and long term mortality and also lower risk of MACE was observed. However, no difference in recurrent MI was observed amongst them. In conclusion, a staged strategy for non-culprit lesion seems to have better outcomes than MV-PCI.

However, as of current European Society of Cardiology/European Association of Cardio-Thoracic Surgery guidelines (Neumann et al. [71]), they recommend PPCI of the infarct-related artery (IRA) be done as an index revascularization procedure for patients presenting with STEMI. It is recommended against PCI on the non-infarct related artery at the time of PPCI in patients with STEMI, who are hemodynamically stable. However, it is recommended for patients presenting with cardiogenic shock, especially those with multi-vessel disease (MVD). Current data shows only 25% of the patients with MVD complicated by cardiogenic shock receive MV-PCI for STEMI during PPCI.

In a study conducted by Gu et al. [72] is aimed to determine the prevalence and clinical outcome of CABG performed in patients with STEMI within 30-days after initial presentation and to compare it with PCI, and their clinical outcome was assessed at both 30 days and one year. 1071 patients were enrolled in the randomized clinical trial of Thrombus Aspiration during Percutaneous coronary
intervention in Acute myocardial infarction Study (TAPAS) of which on 59 patients CABG was performed within 30 days of presentation. 13 (22%) of them were operated often within 24 hours, 8(14%) between one and three days and 38 (64%) of them between 4 and 30 days. Patients who were operated often had multi-vessel disease compared with the group who received PCI. The surgical group had 1.7% of cardiac mortality at 30-days and one-year, whereas the non-surgical group had 3.2% and 5.3% respectively. Thus the study concluded that patients with STEMI treated with CABG within 3 days after the presentation is at an increased risk of rethoracotomy. However, despite the increased risk of surgical complications and multiple high-risk features at presentation, surgical management during the acute and subacute phase is associated with excellent 30-day and one-year survival.

4. Methodology

In compiling a systematic review of relevant literature in terms of the research objectives, resources, and LSMU library website where searches were conducted using several databases: Medline (PubMed), Science Direct publications and Up To Date were scanned for suitable articles and papers for inclusion. Using a Boolean additive equation, the primary keywords entered into the resource sites were an acute LVF, STEMI, mortality, TIMI flow, primary PCI, multi-vessel PCI, CABG. 70% of the chosen articles were published within the last 10 years. Once selected, the articles were evaluated for their methodological details according to the present study’s rationale, and a review was formularized under relevant categories.

5. Results and Discussion

MI is the major cause of cardiac morbidity and mortality. Some of the serious complications of a debilitating MI are an acute LVF, cardiogenic shock, and stroke or in-hospital death. This systematic review has discussed some significant risk factors which may influence the development of acute LVF and mortality in patients with STEMI, treated with PPCI. Age >65 is one of the primary risk factors, and the other significant one is reduced LVEF, post-MI LVEF was significantly reduced in the left anterior descending artery related STEMI. Co-morbidities that have an effect on the occurrence of HF are a history of diabetes. Evidence shows that patients with hyperglycemia have 3 to 5 times increased risk of having an adverse prognosis after MI than patients with no diabetes. Systemic HT is another main co-morbidity that influence the happening of acute LVF after an MI. Predictors of 30-day mortality are HT, diabetes, elevated heart rate, anterior infarct, higher Killip class, TIMI flow < 2, repeat reperfusion therapy, reinfarction, smoking, cardiogenic shock, stroke, older age, LVEF<30%. They make 90% of the most important prognostic details from the initial assessment data after acute MI.
Another study identifies the importance of age taken as a strong predictor of mortality, especially age >75 because studies show death was preceded by the development of HF in >75 years of age.

However, some authors argue LVEF<30%, programmed ventricular stimulation, premature ventricular contraction (PVC>10/h), autonomic dysfunction and renal failure are the most significant predictors of SCD after an acute MI.

Various factors of complications in MI, leading to LVSD include anterior infarct, recurrent MI, infarct size, mechanical complications, and hibernating myocardium. They increase the risk of death following HF 3 to 4 times. When factors related to post MI and HF (age, HT, smoking, biomarkers) were adjusted, the incidence of HF declined by 2% per year. The development of HF marked the increased risk of death.

Patients who had a recurrent MI between index admission and the onset of HF had a 5-time increase in the risk of mortality, and studies show the risk of death is the highest in the first 30 days after MI among patients with left ventricular dysfunction, HF or both. Patients with LVEF < 30% is at the highest risk. Hence the measurement of LVEF is found to be an important predictor of survival. A great impact on the diagnosis and treatment strategy can be made if significant predictors are used to make a risk stratification – predictors include age, location of the infarction – especially anterior infarct, Killip class >2, ischemic time, post-procedural TIMI flow grade, number of diseased vessels, diabetes and HT. The angiographic evidence of the extent of the number of occluded vessels can be a major indicator of post-MI heart failure, regardless of the type of HF and independent of recurrent MI.

Biomarkers, like hs-CRP obtained between 12 and 24 hours of symptom onset can be used as markers for the development of HF and mortality in patients with acute MI. High BNP levels on admission can also be a strong predictor of tissue perfusion, mortality, angiographic success (TIMI grade) after the procedure and for the prediction of the no-reflow phenomenon after PPCI in patients with STEMI. Serum creatinine, hs-CRP, BNP, and glucose levels are high in patients with no-reflow phenomenon than in normal re-flow patients. BNP can also be used as an independent predictor of new-onset AF in STEMI patients treated with PPCI.

These biomarkers may have the potential to provide accurate prognostic information beyond that provided by conventional risk factors.

Electrocardiographic & electrophysiological parameters such as ST-segment resolution, impaired heart rate turbulence, abnormal T-wave alternans, along with LVEF < 50% could help identify patients who are at risk of major adverse cardiac events.
Angiographic parameters like MBG, TIMI flow grade in relation with infarct size, LVEF, and the extent of ST-segment resolution can help describe the effectiveness of myocardial reperfusion and are independent predictors of mortality. Post-interventional TIMI flow < 2 are associated with adverse outcome during hospitalization. Studies also show initial angiographic TIMI flow grade in the culprit coronary artery prior to any PCI could be used in predicting the final infarct size and microvascular obstruction.

Patients treated for STEMI, time of symptom onset to reperfusion controls the extent of reversible, and irreversible myocardial damage. Salvaged myocardium is significantly reduced when reperfusion is done > 90 mins.

System delay and DBT delays are strongly associated with mortality in STEMI patients treated with PPCI. In the presence or absence of high-risk features, increased mortality was seen with increased DBT time regardless of symptom onset to door time. However, the greatest benefit in the reduction of mortality was seen in high-risk patients with short DBT, that is < or = 90 mins.

Many randomized trials show a reduction in total mortality and cardiac mortality rates when exercise-based rehabilitation techniques are employed along with subsequent coronary interventions following MI.

Impact of pretreatment with anticoagulants, antiplatelets, and anti-lipids (heparin, clopidogrel, ticagrelor, aspirin, and atorvastatin) on PPCI effectiveness is a major discussion in today’s research field, many RCTs show pretreatment with high loading dose of atorvastatin reduces the incidence of short term major adverse cardiac events, higher MBG and ST-segment resolution proving improved immediate coronary flow, but no effect was found on the reduction of myocardial infarct size even after the administration of a further 5 days of treatment with a high dose of atorvastatin after PPCI. The high loading dose also did meet the safety endpoints by not increasing the drug-induced hepatotoxicity in patients with ACS after PCI.

Pretreatment with clopidogrel has shown compelling evidence with regard to it being both safe and effective in reducing the adverse events like 30-day mortality, recurrent MI, stroke, revascularization compared to the traditional 300mg loading dose without major hemorrhage or mortality.

On the other hand, pretreatment with ticagrelor compared with ticagrelor given only in the cath lab did not show any success in improving the primary endpoints like all-cause mortality, reinfarction, stent thrombosis at 30 days or in hospital bleeding in STEMI patients undergoing PPCI. Whereas, evidence show ticagrelor bolus following clopidogrel resulted in more rapid and profound
platelet inhibition, demonstrating a positive pharmacodynamic interaction in patients referred for PPCI.

Coronary reperfusion grade improves in terms of pre and post-PPCI-TIMI flow grade and ST-segment resolution with a longer pretreatment time interval (at least 60 minutes prior to PPCI) with P2Y<sub>12</sub> inhibitors.

In many randomized control trials, prasugrel and ticagrelor have shown to have better angiographic results than clopidogrel.

The pre PCI administration of prasugrel in patients with STEMI undergoing PPCI was associated with significantly faster platelet inhibition compared with clopidogrel.

Among ticagrelor and clopidogrel, the former has shown to reduce the incidence of major cardiovascular and cerebrovascular events; stent thrombosis, recurrent MI, recanalization, stroke as well as fewer patients received GPIIb/IIIa inhibitors after PPCI compared with those receiving clopidogrel.

Whereas among ticagrelor and prasugrel, neither has shown any significant difference in pre and post-procedural coronary reperfusion (TIMI flow grade 3), ST-segment resolution nor any significant difference were seen in MACE, in major bleeding and stent thrombosis between the two.

Pretreatment with heparin is related with significantly reduced risk of no perfusion (TIMI 0 flow) and definite thrombus before PPCI.

Current European Society of Cardiology (ESC) guidelines recommend that dual antiplatelet therapy (aspirin and P2Y12 inhibitor like clopidogrel) should be administered to STEMI patients at first medical contact or as early as possible even though no particular reference is given if it is in the ambulance setting, in the emergency department or the cath lab.

While comparing the outcomes and mortality with regards to different reperfusion strategies. PPCI remains the reperfusion of choice in this modern era of treatment with PCI, for patients with acute STEMI. It has shown to achieve a high rate of TIMI 3 flow grade, high MBG, and reduces the risk of bleeding, strokes, and all-cause mortality. However, that does not undermine the fact that fibrinolytic therapy, when done in optimal time, keeps both the myocardial muscle mass and the function of the ventricles optimal.

The PRAMI trial found that the complete revascularization for STEMI patients reduced cardiac-related mortality, HF, need for repeat revascularization along with a reduction in major adverse cardiac events compared to infarct-related artery PCI. Studies show post PCI TIMI flow grades 0 to
2 after PPCI for STEMI among patients with cardiogenic shock is associated with increased risk of death compared to patients with normal post PCI TIMI flow grade 3.

Pharmacoinvasive therapy (administration of fibrinolysis followed by immediate PCI if thrombolysis has failed) benefits patients with STEMI where very long delays to PPCI are expected (>60 minutes). RCTs and observational studies demonstrate that PPCI increases the chances of cardiogenic shock, whereas it significantly decreases the chances of re-infarction. However, no difference is found in short term mortality, stroke, TIMI-3 flow, or amongst safety outcomes like major bleeding.

Cardiogenic shock is found to be one of the leading causes of mortality complicating 5 to 8% of STEMI cases. Delay reperfusion is an indicator of developing cardiogenic shock, and early revascularization can help prevent this complication.

A few meta-analyses evaluated the outcome of ischemic post conditioning on patients with STEMI who underwent PPCI. Even though ischemic post conditioning is safe and cost-effective, no RCTs have shown a reduction in the incidence of HF compared with traditional PPCI. Neither did it show a reduction in MACE, mortality, and recurrent MI.

Different PCI strategies: single procedure multi-vessel PCI, staged multi-vessel PCI, infarct-related artery PCI are compared amongst each other in terms of their effectiveness and safety to understand which procedure brings better outcome and prognosis in the short and long term.

Multivessel PCI is preferred over culprit-only PCI since it is associated with reduced risk of death, reinfarction, and future revascularization. Moreover, their safety outcomes held a similar risk of complications compared to infarct-related artery PCI. However, among MV-PCI and MV-PCI did in a staged manner, the latter seems to be superior by having better outcomes with a significant reduction in both short and long term mortality and low risk of incidence of MACE.

However, as of the current European Society of Cardiology/European Association of Cardio-Thoracic Surgery guidelines, they recommend PPCI of the infarct-related artery is done as an index revascularization procedure for patients presenting with STEMI. It is recommended against PCI on the non-infarct related artery at the time of PPCI in patients with STEMI, who are hemodynamically stable. However, it is recommended for patients presenting with cardiogenic shock, especially those with multi-vessel disease.

Predicted surgical mortality, the anatomical complexity of CAD, and the anticipated completeness of revascularization are important criteria for decision-making with respect to the type of revascularization- PCI or CABG
CABG done within 3 days after the presentation of STEMI is associated with an increased risk of rethoracotomy. However, despite the increased risk of surgical complications and multiple high-risk features at presentation. CABG is linked with excellent 30-day and one-year survival.

6. Conclusion

In Conclusion;

1) Some significant risk factors which influence the development of acute LVF and mortality in patients with STEMI, treated with PPCI are age >65 and LVEF<30 %. Post MI, LVEF is significantly reduced in LAD artery related STEMI.

2) Co-morbidities that have an effect on the occurrence of acute HF after STEMI in patients treated with PPCI are diabetes and systemic hypertension. Patients with hyperglycemia have an increased risk of having adverse prognosis after MI.

3) Predictors of 30-day mortality are HT, diabetes, anterior infarct, higher Killip class, TIMI flow<2, repeat reperfusion therapy, reinfarction, cardiogenic shock, older age, LVSD. Patients who had recurrent MI between index admission and the onset of HF have 5-time increase at risk of death.

4) Biomarkers have the potential to provide accurate prognostic information beyond that of conventional risk factors. High levels of serum creatinine, high sensitivity CRP, BNP and glucose levels are a strong indicator of tissue perfusion, mortality and angiographic success after the procedure and it is also very helpful in the prediction of the no-reflow phenomenon after PPCI in patients with STEMI.

5) Non-invasive testing (electrocardiographic and electrophysiological) parameters like LVEF, ST-segment resolution, impaired heart rate turbulence and abnormal T-wave alternans help identify patients who are at risk of major adverse cardiac events after STEMI treated with PPCI.

6) Angiographic parameters like MBG, TIMI flow grade also help describe the effectiveness of myocardial reperfusion and independent predictors of mortality in relation with the infarct size, LVEF, and the extent of possible ST-segment resolution. Initial angiographic TIMI flow grade (i-TIMI) in the culprit coronary artery prior to any PCI could be used in predicting the final infarct size and microvascular obstruction.

7) Patients treated for STEMI, time of symptom onset to reperfusion controls the extent of reversible, and irreversible myocardial damage. Salvaged myocardium is significantly reduced when reperfusion is done >90mins.
8) System delays and DBT delays are strongly associated with mortality in STEMI patients treated with PPCI. The greatest benefit in the reduction of mortality is seen in high-risk patients with short (<or = 90mins) DBT.

9) Pretreatment with high loading doses of atorvastatin and clopidogrel compared to their traditional dosage prior to PPCI in STEMI patients has shown to be both safe and effective in reducing the incidence of 30-day mortality, recurrent MI, stroke, revascularization and in the short term MACE without increased hepatotoxicity and major bleeding. Pretreatment with ticagrelor compared with ticagrelor given in the cath lab only does not improve the endpoints in STEMI patients undergoing PPCI. Coronary reperfusion grade improves in terms of pre and post-PPCI-TIMI flow grade and ST-segment resolution with a longer pretreatment time interval (at least 60 minutes prior to PPCI) with P2Y12 inhibitors. In many randomized control trials, prasugrel and ticagrelor have shown to have better angiographic results than clopidogrel. The pre PCI administration of prasugrel in patients with STEMI undergoing PPCI was associated with significantly faster platelet inhibition compared with clopidogrel and among ticagrelor and clopidogrel, the former has shown to reduce the incidence of major cardiovascular and cerebrovascular events; stent thrombosis, recurrent MI, recanalization, stroke as well as fewer patients received GPIIb/IIIa inhibitors after PPCI compared with those receiving clopidogrel. Whereas among ticagrelor and prasugrel, neither has shown any significant difference in pre and post-procedural coronary reperfusion (TIMI flow grade 3), ST-segment resolution nor any significant difference were seen in MACE, in major bleeding and stent thrombosis between the two.

10) Whereas pretreatment with heparin has shown to reduce the risk of no perfusion and definite thrombus significantly.

11) PPCI is the reperfusion of choice in patients with STEMI. Complications like acute LVF and cardiogenic shock can be prevented with early revascularizations.

12) Traditional PPCI has shown to be superior to pharmacoinvasive therapy and IPC during PPCI.

13) Comparing the effectiveness of different PPCI strategies that can be used during the PPCI, multi-vessel PCI is preferred over the culprit only PCI as it has reduced the risk of death, re-infarction, and future revascularization and is associated with no higher risk of complications compared to the culprit only PCI. However, as of the current European Society of Cardiology/European Association of Cardio-Thoracic Surgery guidelines, they recommend PPCI of the infarct-related artery is done as an index revascularization procedure for patients presenting with STEMI. It is recommended against PCI on the non-infarct related artery at the time of PPCI on
patients with STEMI, who are hemodynamically stable. However, it is recommended for patients presenting with cardiogenic shock, especially those with multi-vessel disease.

14) CABG is linked with excellent 30-day and one-year survival if performed under clear indications or as an elective reperfusion therapy as per the current guidelines rather than a reperfusion strategy for acute MI unless indicated and necessary, so as to avoid unwanted complications since CABG done within 3 days after the presentation of STEMI is associated with an increased risk of rethoracotomy. Whether conservative therapy, PCI, or CABG is preferred should depend on the risk-benefit ratios of these treatment strategies against improvements in health-related quality of life, as well as long-term freedom from death, MI, or repeat revascularization.

8. Practical Recommendations

According to the results of this literature review, it can be easily determined with significant predictors which patients with STEMI treated with PPCI are at risk of death or developing acute LVF.

It is recommended to carry out an adequate history taking and clinical examination as it is an important tool in the evaluation and recognition of ventricular dysfunction after acute MI. Even though it might not provide as much specific information as invasive tests do, parameters of non-invasive tests (ECG, echo, SPECT, PET, stress echocardiography) and biomarkers do have the potential to provide accurate prognostic details compared to the traditional risk factors.

A risk stratification using significant predictors would make a great impact on the diagnosis and treatment strategy. Significant predictors used to make a risk stratification could be age, location of the infarction – especially anterior infarct, Killip class >2, ischemic time, post-procedural TIMI flow grade, number of diseased vessels, diabetes and HT.

The angiographic evidence of the extent of the number of occluded vessels can also be used as a major indicator of post-MI heart failure, regardless of the type of HF.

Whether conservative therapy, PCI, or CABG is preferred, the decision should be based on current guidelines, individual patient features, their disease characteristics and should also depend on the risk-benefit ratios of these treatment strategies.
References


