IOSR Journal of Nursing and Health Science (IOSR-JNHS)
e-ISSN: 2320–1959.p- ISSN: 2320–1940 Volume 9, Issue 6 Ser. VI (Nov. – Dec. 2020), PP 60-71
www.iosrjournals.org

Early Detection of Myocardial Infarction and Management of Door-To-Balloon Time in Patients with Acute Myocardial Infarction in Saudi Arabia: A Retrospective Cross-Sectional Study

Nadiya Hussain Alsomali
MSc of Science in Nursing (Advanced Practice) BSN.RN
Capstone Research Submitted for the Master of Science in Nursing: Advanced Practice
Dublin City University School of Nursing and Human Sciences
Reviewed by: Dr Catherine Corrigan DNP MSc, Advanced Nurse Practitioner, Certified Nurse Educator, BSc RGN RCN RM

Date of Submission: 10-12-2020 Date of acceptance: 25-12-2020

I. Introduction

Background

Sudden cardiac arrest tops the list of the leading causes of death around the globe, presenting a major public health issue in both developed and developing countries (Zaman and Kovoor, 2014). Myocardial infarction (MI) is a major contributor of cardiac arrests. Persons with a history of MI are four to six times more likely to have a cardiac arrest than members of the general population (Zaman and Kovoor, 2014, p.2426). Globally, the number of deaths resulting from cardiovascular disease in 2008 was 17.3 million, 7.3 million of which resulted from MI (Aljefree and Ahmed, 2015, p.1). In the US, between 350,000 and 400,000 deaths are caused by sudden cardiac arrests annually (Zaman and Kovoor, 2014, p.2426). The number of deaths resulting from coronary heart disease in Saudi Arabia in 2017 was 23,624, which represented almost a quarter of all deaths (World Health Rakings, 2017). In Saudi Arabia, chronic heart disease has a 5.5% prevalence rate (Aljefree and Ahmed, 2015, p.3). An observational study conducted in Taif City Province in Saudi Arabia found an estimated prevalence of MI to be 1.4% (Alzahrani et al., 2018, p.1830). An ageing population, rising obesity rates, stress and poor diet were among the leading factors contributing to the high prevalence (Alzahrani et al., 2018). Consequently, the prevention, correct diagnosis and management of MI are critical to reducing cardiac arrests and reduce related mortality.

There are two types of MI: non-ST-elevation myocardial infarction (NSTEMI) and ST-elevation myocardial infarction (STEMI) that can be diagnosed by the heart tracings on an electrocardiogram (ECG) – a non-invasive test for patients with chest pain to measures the electrical activity of the heart. The latter is caused by blockages in the major arteries and leads to elevation of ST segments that are notably different from normal. On the other hand, NSTEMI patients show no elevation of ST segments (Lux, 2015). Patients presenting with acute coronary syndrome but showing no elevation of ST segments are grouped as either having unstable angina or NSTEMI. The distinction between the two is done by checking for biomarkers of myocardial necrosis, whereby the presence of these biomarkers confirms NSTEMI (Sheridan and Crossman, 2002). Caring for patients presenting with MI symptoms is critical to ensuring that they do not suffer cardiac arrest. One approach to care is a primary percutaneous coronary intervention (PPCI) that is conducted on STEMI patients to lower the high risk of death (Ellahham et al., 2015). PPCI is an invasive procedure used to unblock a coronary artery to restore normal blood flow to the heart. It is done during emergency cases to reduce the level of damage to heart muscle during a heart attack. The procedure involves the puncturing through the skin in the groin area using a needle to access the femoral artery and a catheter threaded through it up to the aorta using x-ray capability. The catheter is then advanced to the affected coronary artery and a balloon is used to unblock it (balloon angioplasty). In some instances, a stent may be placed to keep the artery patent (Torpy et al., 2004). On the contrary, NSTEMI patients, although having chest pain, are monitored for several hours and cardiac enzymes are conducted to determine the presence or absence of acute infarction (Lux, 2015).

In the majority of the cases, the time it takes for STEMI patients once they arrive in the emergency department (ED) to the start of the PPCI procedure (door-to-balloon time) is within the recommended time by the American College of Cardiology and the American Heart Association of ≤90 minutes (Nestler et al., 2009, p.508). However, there are instances where delays occur which can increase the risk of cardiac damage and

mortality. For instance, a cross-sectional study by Tra et al. (2015, p.1) found that over 78% of patients in PPCI centers in the Netherlands were treated within this recommended time. However, the remainder of the patients experienced delays ranging from 47 to 82 minutes (Tra et al., 2015, p.4). Factors attributed to delays in conducting PPCI include deviating patient routes and the extent of the infarction. Notably, patients for whom the first ECG is done by a general practitioner in the community or in-hospital, as opposed to in the emergency departments (ED), are highly likely to experience delays. Similarly, patients requiring interhospital transfers and those with acute heart failure at the time of admission are likely to experience door-to-balloon times longer than the recommended maximum of 90 minutes (Tra et al., 2015).

Door-to-balloon time delays are a major issue witnessed in the healthcare systems of multiple countries, making it a global issue. Most national healthcare systems are unable to conduct PPCI on STEMI patients within the recommended 90 minutes (Mehta, 2012). System and non-systems factors have all been cited as contributing to these delays (Mehta, 2012). Delays in administering PPCI continue to be a major issue in the treatment of MI in most countries, although major improvements have been noted (Foo et al., 2016). For instance, in Australia, the door-to-balloon time was reduced from 95 minutes in 2006 to 75 minutes in the 2010 (Brennan et al., 2014, p.471). The percentage of STEMI patients that achieved a door-to-balloon time of ≤90 minutes increased to 67% from 45%. While this increase is significant, it implies that one-third of the patients did not meet the ≤90 minutes guideline (Brennan et al., 2014, p.471). In the US, the door-to-balloon time was reduced from 96 minutes in 2005 to 64 minutes in 2010 (Krumholz et al., 2011, p.4). The patients with a door-to-balloon time of ≤90 minutes increased from 44.2% to 91.4% within that period (Krumholz et al., 2011, p.4). Despite the significant increases in the percentage of STEMI patients recording a door-to-balloon time of ≤90 minutes in both studies, delays remain a challenge.

The adoption of the international PPCI guidelines (Nestler et al., 2009) in Saudi Arabia, and the Gulf region at large, remains a major challenge in the health sector. Consequently, the country's national system records poor achievement of recommended door-to-balloon time of ≤90 minutes. Alyahya et al. (2018, p.173) reported that only 46% of STEMI patients undergo PPCI according to the Gulf registry of coronary events. Of these patients, only 29.5% have a door-to-balloon time of 90 minutes or less. In Saudi Arabia, the challenge is largely attributed to the low PPCI capability of hospitals. A total of 30 hospitals in the country have PPCI capability but only four of them offer the service fulltime (Alyahya et al., 2018, p.173). STEMI patients admitted during off-duty hours are more likely to receive poor services than those admitted during regular hours. A prospective observational study (N=2825) conducted in Saudi Arabia established that off-duty hours patients are likely to present with heart failure and STEMI than regular hour patients. However, they are less likely to undergo PPCI. The door-to-balloon time of patients during off-duty hours was 122 minutes, which is higher than the recommended 90 minutes (AlFaleh et al., 2012, p.366).

Delays in performing PPCI may also result from the ambiguity of MI symptoms and the existence of comorbidities, which makes it difficult to make a correct diagnosis in good time. A study by Ängerud et al. (2016) established that diabetic patients who experience MI are highly likely to experience delays than those without diabetes. The difference between the two groups exceeded one hour, with the majority of those with diabetes exceeding two hours. Although the reasons for delays are unclear, differences in the presentation of symptoms is a likely contributor factor. For instance, patients with diabetes are more likely to report shoulder pain and tiredness during MI than those without diabetes. Since these symptoms are not necessarily associated with MI, diagnosis may be delayed (Ängerud et al., 2016).

Research Aim, Question, and Rationale

The proposed research study will investigate the early detection of MI and the management of door-to-balloon time in patients with MI in Saudi Arabia. The study sets out to determine how these measures compare with international standards. To achieve this aim, the research will answer the question: How does the early recognition of MI and the management of door-to-balloon time in Saudi Arabia compare to international standards? It will focus on the differences in the existence, causes and extent of delays.

The proposed research is highly relevant to nursing given the significance of the problem that it seeks to address. Notably, the research seeks to determine how the MI-related clinical practices compare with those of other national healthcare systems. It will then relate these variances with local differences in the achievement of door-to-balloon time of ≤90 minutes. By identifying the possible causes of delays in door-to-balloon time, the research will propose initiatives in which the healthcare outcomes of persons presenting with STEMI can be improved. In particular ways reducing of myocardial damage and mortality resulting from MI will be proposed. The role of nurse practitioners (NPs) and their impact in early detection of MI cases will be discussed. The research findings will highlight variances in the process of early diagnosis of MI and door-to-balloon time, from which recommendations can be made in an effort to improve patient outcomes. The implementation of a well-organized institutional plan can accelerate the delivery of care to those patients identified to have STEMI upon arrival in ED. Lastly, the research can help the Saudi healthcare system to meet the American College of

Cardiology and American Heart Association recommendations of door-to-balloon time <90 minutes (Nestler et al., 2009, p.508).

II. Literature Review

The literature is primarily sourced from peer-reviewed journal articles and scholarly books. Studies published within the past five years form a large part of the review to ensure that the most relevant information is presented. The journal articles used to complete the literature review were sourced from CINAHL, PubMed and Google Scholar databases. Only peer-reviewed articles published in English were considered. The literature included in the review is dated no earlier than 2005, with the majority of works published within the past five years (2014-2019). The literature was obtained using the key words: 'myocardial infarction', 'door-to-balloon time', 'percutaneous coronary intervention', 'delays in door-to-balloon time', and 'Saudi Arabia'. The use of these keywords and their combinations yielded 31 articles and books. The literature was grouped into five subheadings: early detection of MI, causes of door-to-balloon delays, improving door-to-balloon time, role of NPs in the ED and impact of NPs in the early detection of MI in the ED.

Early Detection of MI

MI commonly known as heart attack is among the leading causes of death and disability in the world (Kränkel et al., 2016). The situation is complicated by the high risk of death within the first few hours following the onset of chest pain, meaning that rapid intervention paramount in saving lives. The effective treatment and improved health outcomes require an early and accurate detection (Kränkel et al., 2016). The early detection of MI often takes place in the ED considering that the majority of those reporting chest pain visit EDs. Although only 15-20% of those reporting chest pain have MI (Neumann et al., 2017, p.2), the early recognition and treatment of these patients is essentially a matter of life or death. Cullen et al. (2017) indicated that there is a burden on the healthcare staff associated with assessing patients displaying symptoms related to MI in the ED which causes a large strain on ED resources. Having an efficient process in place for the early detection of potential MI can help to reduce the associated pressure on ED resources.

The early detection of MI is based on clinical symptoms and the results of several tests. ECG (that measures the electrical activity of the heart) and echocardiogram (cardiac tissue imaging) findings determine whether a patient's symptoms are related to a potential MI (Kränkel et al., 2016). The measurement of cardiac troponin (a cardiac enzyme) is usually the major diagnostic criterion for distinguishing between MI and non-MI patients (Neumann, et al., 2017). However, the use of this method is marred by some accuracy challenges since troponins are often released as a result of other diseases such as myocarditis. Besides, chest pain can be misunderstood and diagnosing it can be difficult (Kränkel et al., 2016). Although the uses of invasive methods like PPCI have proven highly effective, such therapy is expensive and may lead to complications (Neumann et al., 2017). Clinicians are faced with the challenge of identifying and treating those with a pending MI and discharging those whose chest pain is not cardiac-related. MI has diverse symptoms that may require multiple tests during its detection. In fact, the use of clinical exam alone is limited in the detection of MI (Cullen et al., 2017). The challenges involved in the early diagnosis of MI may limit the effectiveness of healthcare professionals in reducing the mortality and morbidity associated with it. The possibility of MI disguising itself as other illnesses makes early detection challenging and sometimes expensive.

These challenges have led to patients presenting symptoms of potential MI encountering delays at the ED. The patient flow in the ED triage when dealing with patients presenting MI-like symptoms continues to be slow regardless of the experience of the medical professionals assigned to the unit (Sanders, 2017). The large number of patients visiting the ED presenting with symptoms similar to that of an MI is resulting in increased delays. A contributory factor to these delays is a high-patient-nurse ratio that is a global problem because of the shortage of nurses worldwide (Haddad and Toney-Butler, 2019). The resulting lengthy waiting times may increase the risk of patients developing complications related to MI before they are accurately diagnosed and treated.

The difficulties encountered in diagnosing MI have led to healthcare professionals taking extra precautions before discharging patients presenting with MI-like symptoms. Consequently, they commit patients to a short hospital admission or hold them in the ED for observation in addition to the diagnostic investigation (Gray et al., 2016). The increased awareness that the prompt presentation of patients with chest pain might be life-saving has led to the routine admission of patients with chest discomfort. The move is necessitated by diagnostic uncertainties for MI. Even then, the majority of these patients have a non-ischemic ECG on presentation (Gorenberg et al., 2005). Hospitals such as the Northern General Hospital in the UK have dedicated a special unit – the chest pain unit – to the provision of care to patients presenting with acute chest pain but whose initial clinical assessment, ECG and chest radiography have failed to diagnose their conditions. Such high utilization of hospital resources is attributed to diagnostic uncertainties (Goodacre et al., 2005). Improvements in the early detection of other chest pain related conditions can help to minimize the admission time for non-MI

patients. It would also help in the management of the disease by preventing the discharge of patients with pending MI without proper treatment.

Causes of Door-to-Balloon Delays

Door-to-balloon time refers to the interval between when a patient presenting with STEMI arrives at a hospital to the time of stent deployment that reopens the affected coronary artery (Foo et al., 2016). Door-to-balloon delays are caused by a combination of system and patient-related factors. In a retrospective study involving 1268 patients undergoing PPCI in south-east Asia, Sim et al. (2017, p.1) established that hold-up in the ED, atypical clinical presentation, and the requirement of patient stabilization or imaging were the leading causes of 202 patents experiencing delay (Sim et al., 2017, p.4). Other factors that contributed to delays included difficulties in conducting the PPCI procedure due to poor vascular access and issues with consent. In this study, system factors were the most critical, with delays in the ED contributing to 39% of the delays (Sim et al., 2017, p.4). Difficulties in diagnosing MI are also reported to have a significant contribution in delays. While the sample size used was appropriate data was only collected from a single center, which exposes the study to selection bias (Sim et al., 2017). In another observational study involving 2034 patients transferred for PPCI in a regional center, Miedema et al. (2011, p.1640)) established that awaiting transportation (26.5%) and ED delays (14.3%) were the leading causes of door-to-balloon time delays. Non-system factors also attributed to increased door-to-balloon delays; notably diagnostic dilemmas were found to increase the time to PPCI. Non-diagnostic initial ECGs also contributed to the time spent before the PPCI procedure could be conducted on a patient because they increased the steps taken before administering the PPCI. However, the results of this study may not be generalizable to other settings because the study was conducted at a single site and the patients were transferred for long distances, which may not be the case in other settings (Miedema et al., 2011).

In the retrospective study conducted in the US using data from Catheterization laboratory (Cath lab) PPCI Registry, the researchers investigated the non-system causes of delay among 82,678 STEMI patients (Swaminathan et al., 2013, p.1688). Similar to the study by Sim et al. (2017), MI patients requiring intubation before PPCI could be conducted was the most influential non-system factor causing delay. Of all the patients experiencing non-system delays, 37.4% of cases were affected by needing intubation (Swaminathan et al., 2013, p.1691). Difficulties in obtaining vascular access were also reported as a major cause of delay (8.4% of all cases of delay). Difficulties in crossing the culprit lesion led to even more cases of delay (18.8%) than difficulties in obtaining vascular access (Swaminathan et al., 2013, p.1692). Delays in the consenting process were also found to be a major non-system aspect resulting in door-to-balloon time delays. Although the study used a large sample size, thus eliminating selection bias, the registry includes information of all STEMI patients meaning that it was difficult to account the effects of the demographic characteristics of the participants, such as age. Since it is a retrospective study, there is a possibility that unmeasured confounding factors influenced the study findings (Swaminathan et al., 2013).

In a study to determine the factors that may contribute to the achievement of door-to-balloon time of not more than 90 minutes, Levis et al. (2010) found that all activities from the time a patient is heading to the hospital to the time they are at the cath lab are all important factors in influencing door-to-balloon time. In particular, they found that the actions of the emergency medicine physician such as promptness in activating the cath lab can influence the delay time. The activation of the cardiac cath lab staff, for instance is effective in eliminating delay. Similarly, having the required staff on site such as an attending cardiologist is associated with less door-to-balloon time. A team-based approach when attending a STEMI patient also reduces delays. The researchers note that most delays are attributed to poor patient flow at the ED (Levis et al., 2010). Lacking a smooth flow of processes from the time the patient is being rushed to the hospital to the time the PPCI procedure is conducted may be associated with delays.

Improving Door-to-Balloon Time

The high risk of death as a result of MI can be reduced by administering PPCI in a timely manner (Ellahham et al., 2015). The recommendation for administering this intervention is a maximum of 90-minute interval between the time a patient walks into a hospital and the intracoronary balloon inflation – commonly referred to as door-to-balloon time (Ellahham et al., 2015, p.1). A retrospective study conducted in a large (3000-bed capacity) tertiary hospital in Taiwan affirmed that MI-related outcomes improve as the door-to-balloon time reduces (Chen et al., 2017, p.2). The authors reported that patients that received PPCI with door-to-balloon time of not more than 60 minutes had better thrombolysis in MI flow, reduced 30-day MI recurrence, and lower 30-day mortality rates (Chen et al., 2017, p.4).

However, these findings were contradicted in a study conducted in Australia over a five-year period (N=470) (Martin et al., 2015, p.37). In their study, Martin et al. reviewed PPCI undertaken for STEMI in a tertiary hospital for five years. The change of the process used at the ED led to the reduction in the door-to-balloon time from 109 to 72 minutes (Martin et al., 2015, p.39). However, the reduction in this time had no

significant impact on the patient's length of stay, unplanned readmissions, and 12-month mortality rates. On the contrary, reduced 12-month mortality and improved uptake of inpatient cardiac mortality was realized through the timely treatment of the illness. Consequently, the authors conclude that timely treatment has a larger bearing on the health outcomes of STEMI patients than the door-to-balloon time. These findings might have been compromised by the nonrandomization of participants and the difficulties in blinding data to control for confounding variables (Martin et al., 2016).

The healthcare team involved in caring for patients presenting with MI play a critical role in the reduction of door-to-balloon time. Ellahham et al. (2015) investigated the impact of having a multidisciplinary team implementing the Lean Six Sigma methodology to reduce the door-to-balloon time in the ED of a tertiary hospital in Dubai, UAE. They found that the proportion of patients that achieved the recommended ≤90 minutes door-to-balloon time increased from 73% to 96% following the implementation of the intervention (Ellahham et al., 2015, p.3). The high success rate was attributed to the use of Lean Six Sigma and multidisciplinary team building. Getting the right people in the healthcare team and improved team communication were considered important factors influencing the success of this approach. However, the simultaneous implementation of changes related to staffing at the ED and Lean Six Sigma makes it difficult to determine the contribution of individual changes (Ellahham et al., 2015). Nurses play a critical role in reducing the time to PPCI. In India, a prehospital nurse-led program that seeks to enhance the response time to cardiac arrest patients has been proposed as an effective approach to reducing the mortality rate of cardiac arrest patients as a result of delays at the ED. The program facilitates rapid identification and treatment of cardiovascular disease (Ramesh et al., 2018).

Role of NPs in the ED

The increasing demand for healthcare services has led to major healthcare reforms, targeted at increasing the responsibilities of nurses. In an Australian study that discussed the extension of nursing roles in EDs, Hudson and Marshall (2008) found that an increasing demand of care services, coupled with the shrinking healthcare workforce, has led to the expansion of the nurses' roles in the healthcare setting. One of the changes that have been witnessed is the introduction of NPs in EDs in an effort to save costs and improve the performance indicators like patient safety and quality of care. Although the authors agree that this move has addressed the issue of workforce shortages in Australia and other countries, it has led to an increased confusion and uncertainty regarding the role of NPs. NPs who practice in the ED sitting use their experience, skills, and clinical knowledge to bridge the workforce and skill gap between nurses and doctors that has existed for a long time. Competences for NPs globally are based on a scientific and information literacy foundation and include practice inquiry, independent clinical decision making, developing safe practice and quality care; professional values and ethics; leadership and collaboration with the multidisciplinary team (Hudson and Marshall, 2008). However, confusion about their role has made it difficult to assess their impact, in particular, in the ED (Hudson and Marshall, 2008).

Woo et al. (2017) reported similar confusion when explaining the changing roles of NPs and their increased involvement in the ED; nevertheless, these authors found that nurses had a positive impact on the delivery of service. In a systematic review conducted by Woo et al. to determine the impact of the role of NPs in the healthcare setting, the authors found that the rising prevalence of chronic illnesses has led to a growing demand for healthcare services where NP can be very valuable. In particular, the demand for services in emergency and critical care services has grown significantly in recent year. Despite this increase, there is a forecasted shortage of physicians, which has led to the formulation of strategies that support the increased engagement of nurses in advanced practice in patient care. The involvement of NPs in EDs has led to improved patient outcomes related to length of stay, waiting time, and patient satisfaction (Woo et al., 2017). Patients that were treated by NPs waited for less time before consultation and received services of equal value to that of a physician. Services provided by NPs had better health outcomes than those provided by physicians (Woo et al., 2017).

The most common NPs working in the ED are acute care nurse practitioners (ACNPs) or emergency nurse practitioners (ENPs), although a wide variety of NPs practice in the ED even though it often falls outside their traditional work settings. Campo et al. (2016) defined ENPs as NPs possessing the necessary competence to provide care to patients in ambulatory, urgent and emergent care settings. The scope of practice for ENPs involves the comprehensive management of patients – assessment, differential diagnoses, decision making, and treatment. Assessment involves the collection of data on their medical history, identification of risk factors, a physical exam and conducting the necessary tests. The subjective and objective data is then used to formulate a list of differential diagnosis. Following the development of differential diagnoses, ENPs make a final diagnosis through the analysis of patient data and critical thinking. Medical decision-making involves the synthesis and analysis of subjective and objective data. The NP uses clinical practice guidelines to execute the plan for care for the patient. The treatment/management involves ordering and interpreting laboratory/radiology tests for

instance; recommending non- pharmaceuticals therapies; prescribing pharmaceuticals if indicated, and providing patient/family education. ENPs may also refer patients for further care when necessary (Campo et al., 2016).

Apart from ENPs who specialize in emergency care; other NPs are also involved in caring for patients in the ED. For example family nurse practitioners (FNPs) and ACNPs while reviewing the education, licensing, and scope of practice to determine those best prepared to work in EDs, Hoyt and Proehl (2015) noted that NPs are qualified and certified to work in a variety of settings that include EDs where they provide quality care services to diverse populations. The authors found that family and acute care nurse practitioners, as well as adult NPs have educational background to practice in non-traditional settings such as the ED. A substantial proportion of NPs can offer comprehensive care services in the ED as long as they are competent in the core competencies of basic emergency medicine (Hoyt and Proehl, 2015).

Impact of NPs in the Early Detection of MI in the ED

Nurses play a critical role in the detection, diagnosis, and management of MI. Based on the secondary analysis of observational field notes, Deaton et al. (2017) found that the role of nurses in caring for patients with non-ST elevation MI is complex and evolving. These roles can still be classified under the broad traditional nurses' roles including assessment, triage, coordination of care, and patient education (Deaton et al., 2017). NPs in the ED are used as a service model, providing all types of services in the department. They work to the full scope of their roles while operating in the ED (Roche et al., 2017).

The involvement of NPs reduces the rehospitalization rate of patients with ST elevation MI, non-ST elevation MI, and heart failure by half (Deaton et al., 2017, p.55). NPs provide continuity in the provision of cardiac care, meaning the follow through of patients with cardiac conditions, which leads to the improved clinical outcomes. Another factor that has been attributed to better outcomes is the involvement of NPs in the multidisciplinary team. The involvement of NPs leads to improved professional collaboration, better patient education delivered by nurses, and higher expertise within the team in particular with the holistic approach to patients that is the focus of NPs. However, there is still confusion about the roles that NPs should play in the detection and management of acute MI. In most clinical settings, the roles appear restricted to making up for shortages of physicians and intervening in cases where dispute arises during the delivery of care (Deaton et al., 2017).

ED nurses and NPs play a critical role in the early detection of MI in the ED. They often act as first-line managers in the care of patients and triage them directly to their treatment trajectory based on the patient's clinical presentation. In countries such as the US, chest pain is the second leading cause of ED visits. Unfortunately, timely and appropriate management can be challenging and nurses often fail to detect acute coronary syndrome, which leads to MI. Such occurrences are a leading cause of legal suits related to malpractice in healthcare institutions (Abid et al., 2015). Considering that they are the frontline providers in the ED, NPs must be proficient with the existing clinical guidelines involving the determination of the clinical risk and the timely initiation of treatment to patients presenting with chest pain with no known etiology (Abid et al., 2015).

The increased use of NPs in the ED puts them in the first line of defense in the early detection of MIs. Roche et al. (2017) carried out a longitudinal study (N=61) between November 2014 and February 2016 to determine the effectiveness of ENP service in managing patients with chest pain in the ED. The use of these NPs led to improvements in waiting time, length of stay, patient satisfaction, and adherence to clinical guidelines. The diagnostic accuracy of the model involving ENPs was 91.7% when compared to 82.8% for the standard practice (delivered and coordinated by a medical officer) (Roche et al., 2017, p.5-6). The involvement of ENPs also reduced the occurrence of unplanned readmissions, especially chest pain, within a week likely because of thorough patient education. The proportion of patients that were satisfied with the services was also high at the 88.5% and improved to 93.2% at the follow-up evaluation (Roche et al., 2017, p.11). Although there was no baseline adherence rate to compare the findings of the study with, the authors classified the 64% adherence rate achieved in the study as good (Roche et al., 2017, p.8).

Winkler (2014) outlined the role played by NPs in the early detection of MI in an article describing the electrocardiographic monitoring for cardiovascular dysfunction. He explains that the NPs and staff nurses play a critical role in deciding which patients need to be monitored following presenting symptoms that suggest potential MI. Appropriate investigations for such patients includes the establishment of appropriate cardiac enzymes and ECG monitoring for conditions such as cardiac arrhythmias and drug overdose (Winkler, 2014).

NPs are qualified to make both nursing and medical diagnoses. Consequently, they can act at the same capacity as physicians and still achieve equal or higher levels of effectiveness (Treas and Wilkinson, 2014). Taking the case of an MI, for instance, the nursing diagnosis can be the denial of a patient to accept that they might be at risk of a heart attack. Nurses rely on data such as the time taken to visit the ED and the patient's perception of the illness. On the other hand, the medical diagnosis involves the validation of an illness based on the symptoms presented and the results of medical tests. For instance, diagnosing a patient with myocardial

infarction is a medical diagnosis. These roles were traditionally reserved for doctors; however, NPs are now qualified and licensed to carry them out in many countries (Treas and Wilkinson, 2014).

NPs have been proven highly effective in the prevention of reinfarction and death in the patients with MI. Based on a cohort study (N=65) conducted in a large Canadian community hospital targeted at developing a secondary prevention intervention for patients with MI, Harbman (2014) established that the involvement of NPs improved clinical outcomes. In the randomized controlled trial, patients being cared for using an NP-led patient-centered secondary prevention intervention in an inpatient and outpatient setting resulted in reduced attrition rates at three-months follow-up. Adherence to the clinical guidelines for secondary prevention of MIs – American Health Association and American College of Cardiology Foundation guidelines – was a major mediating factor in the nurse-patient relationship. However, it is important to note that the study had a very short follow-up period (three months), which might be one of the explanations for the significantly lower attrition rate when compared to studies with lengthier follow-up periods (Harbman, 2014).

Broers et al. (2009) performed an open-label feasibility study to determine the effectiveness of a NP-led intervention program in the management of non-high-risk post-MI patients in the Netherlands. A comparison between pre- and post-intervention outcomes revealed that the involvement of NPs in the management of non-high-risk post-MI patients led to reduced hospital stays (6.2 vs 11.1 days) (Broers et al., 2009, p.64). There were no significance differences between the two periods for other clinical outcomes – mortality and reinfarction rates (Broers et al., 2009).

The high effectiveness of nurse-delivered care as compared to physician-delivered care to improve the health outcomes of people with cardiac illnesses is an illustration of NPs high effectiveness in the diagnosis and management of MI. In a randomized controlled trial comparing NP-led personalized care treatment to standard physician-led care, Barley et al. (2014, p.5) found that the former improved care outcomes by 19%. The proportion of patients that no longer reported having chest pain was higher in the personalized care group than the standard care group (37% vs 18%) (Barley et al., 2014, p.5). The personalized care group also reported higher improvements in illness perception and self-efficacy (Barley et al., 2014). Similarly, Smigorowsky et al. (2017) found studies suggesting that nurse practitioner-led care improved the health-related quality of life of persons with atrial fibrillation. In an effort to develop a study protocol to test this phenomenon, the authors examined the literature and found that NP-led care was associated with higher patient satisfaction, adherence to treatment plans, improved clinical outcomes, and cost savings (Smigorowsky et al., 2017).

Summary

The existing literature is addressing a combination of system and patient-related factors that can cause door-to-balloon time delays are presented. Moreover, the impact of the roles played by NPs in the early detection of potential MI in patients visiting the ED is detailed. There is consensus that MI is a leading cause of death and mortality around the globe, which makes its early detection a priority in reducing the burden of MI on public health. MI accounts for a large proportion of those visiting the ED and is one of the contributing factors to the increased demand for services at health care facilities. As the demand for ED services increase, the shortage of the healthcare workers is rising and putting a strain on the existing human resources. As part of the plan to address this issue, governments have opted to involve NPs more in the delivery of services in non-traditional fields. This move has increased the work of NPs in the ED. Considering that most patients with symptoms akin to those of MI present to the ED as the entry point to the hospital; the NPs become the first line of care for early detection and management of this condition.

III. Conceptual Framework

The proposed study will be guided by the Donabedian model by Avedis Donabedian (Voyce et al., 2015). This is a theoretical framework that guides the assessment of the quality of nursing care. According to the model, the quality of care can be determined based on three factors: structure, process, and outcome. A positive correlation between each of the three factors is an indication of high quality of care (Voyce et al., 2015). Donabedian defined *structure* as the resources involved in the provision of care. They include professional (staff and staff training) and organizational resources (medicines, equipment). *Process* is used to refer to the actions cared out – to the patient during service delivery. They include referrals, laboratory tests, and interactions with clinicians. Lastly, *outcome* refers to the results after care has been provided. They include technical outcomes such as healing and interpersonal outcomes such as patient satisfaction (Ameh et al., 2017).

The Donabedian model was selected because this study seeks to assess the process aspects of care delivery and how it correlates with the structure and outcome constructs. The research aims to study in depth the *process* in the provision of care to STEMI patients from the time they enter the ED to the time the PPCI procedure is administered. The author is keen to determine how the structure (for instance, ED personnel and availability of necessary equipment) determines the process involved in preparing a patient for PPCI procedure. Besides, it seeks to determine how the two interact to influence *outcome* (door-to-balloon time of ≤90 minutes).

From a larger perspective, it will also highlight how broader outcomes such as minimal heart tissue damage, morbidity, and mortality are influenced by the interaction between the structure (NPs) and the process (getting the patient to the PPCI).

IV. Research Design and Methodology

Setting

The proposed study will be conducted in a hospital in Riyadh, Saudi Arabia. It is a government-owned tertiary care center for medicine and surgery that has been in operation since 1956. The hospital has international recognition as a center for training in medicine and surgery for all members of the healthcare team. The hospital has a bed capacity of 1,400 beds, with 199 of them being in the intensive care unit. Despite the hospital being in operation for over half a century, its cardiac catheterization laboratory was established in late 2017. The choice of this hospital is based on its large size and its high potential for treating STEMI patients. Given that it is a large government hospital, the standard procedures used in treating STEMI patients are likely to be representative of the standard procedures in other government hospitals in Saudi Arabia. The choice of this hospital is also informed by the research design, meaning the large number of PPCI cases. The study will rely on historical hospital records, implying that its credibility is dependent on the accuracy of the data provided. Being an internationally recognized healthcare institution, this hospital is likely to keep accurate and detailed data.

Research Design

This study will employ the retrospective cross-sectional research design. A retrospective study is common in medical research that assesses historical data to test exposure to certain factors in relation to an outcome. A cross-sectional study is a study that assesses the data from a population at a specific point in time. In a retrospective cross-sectional study, data of a particular historical point in time is assessed to understand phenomena. This research design offers several advantages when used in nursing research. Notably, it provides large volumes of data that would be costly and time-consuming if obtained from primary sources such as interviews (Polit and Beck, 2008; Creswell, 2014).

The use of a retrospective cross-sectional research design is based on the type of data that will be used in the proposed study. The study will rely on data obtained from the hospital database from January 1, 2018 to December 31, 2018. The year 2018 was selected as the year of choice since it is the only complete calendar year since the cath lab has been in operation in the hospital under study in Riyadh. The door-to-balloon time is the specific measure that will be compared with international standards.

Research Approach

The proposed study will be a descriptive study using quantitative data. This type of research relies on numerical data and employs a positivist research philosophy. Positivism is a research philosophy that posits that factual knowledge can only be obtained through the use of quantifiable observations and measurements. In quantitative research, the researcher participates passively. Findings from this research are highly credible since they are free of the researcher's biases (Willis and Jost, 2007). The use of quantitative research approach and the positivist approach is based on the type of data to be collected. The proposed research seeks to obtain numerical data from the hospital's database. The measurement and analysis of the data will have no interference from the researcher.

Ethics

The proposed research will aim to collect biomedical data from patients. Consequently, the biomedical ethics related to research with human subjects will be applied. The three basic principles of ethics in biomedical and behavioral research as stipulated in the Belmont Report – respect for persons, beneficence, and justice – will be adhered to (Dresser, 2012). The principle of respect for person posits that all individuals should be treated as an autonomous being. In the case that the autonomy of such a person is diminished, efforts should be made to protect that person (U.S. Department of Health, Education, and Welfare, 2014). To ensure that this principle is upheld, approval to conduct the research will be sought from the institutional review board of the hospital. Permission to access the data will be sought from the hospital ethics committee. The hospital policy on ethical standards for research studies will also be followed to include the completion of an ethics application form and the anonymization of patient information.

The beneficence principle requires that all persons be treated in an ethical manner, is based on the concept of 'first do no harm' thus ensuring that maximum benefits and minimal harm apply to each participant (U.S. Department of Health, Education, and Welfare, 2014). To meet the requirements of this principle, the confidentiality of data will be observed. The names and any other patient-related data that may lead to the identification of the persons whose records will be used in the research will not be disclosed. Apart from ensuring anonymity, the data will be kept in a safe location with access being limited to the researchers only.

After the completion of the research, the data will be kept for one year in a locked drawer within the researchers' office, or a password protected work computer after which time it will be destroyed. At no point during this period will this data be handed to a third party.

The final principle is justice. It requires that all people obtain the benefit that they are entitled to without bearing any burdens unduly imposed in the study (U.S. Department of Health, Education, and Welfare, 2014). To meet this principle, the research will not require any additional data from any person for whose data will be used. Besides, the research findings will be availed to the public to enhance societal benefits. Since the report can guide the implementation of best practices at in the early detection of MI and the management of door-to-balloon time in the hospital in which it is conducted, as well as other similar contexts in Saudi Arabia, the participants stand to benefit from improved service delivery and better health outcomes.

Data Collection Procedure

Data will be collected by chart reviewing of all cases of PPCI for STEMIs performed at the hospital from January 1, 2018 to December 31, 2018. All door-to-balloon times will be recorded and broken down to the time taken to complete each step of the process. They include the time of the patient arrival at the ED, the time that the patient is seen by a nurse and ED doctor, the time of ECG and blood draws for cardiac enzymes, the time the cath lab is activated, the time the patient is transferred to cath lab, the time of preparing the patient inside cath lab, and the puncture time (Based on the process of diagnosing and treating STEMI in the ED described in Kosowsky et al. (2009)). Data will also be collected about the qualifications and number of healthcare personnel manning the process. Inclusion/exclusion criteria will be used to determine the participants to include in the study. Male and female STEMI patients aged above 18 who underwent PPCI will be included in the study. Patients below 18 years have been excluded because this study focuses on the adult population only.

Data Analysis

The proposed research will rely on numerical data collection, particularly the times taken in different steps of the process of getting the patient from the ED to the cath lab. Consequently, descriptive statistical analysis will be used. Descriptive statistical analysis describes and summarizes the characteristics of a sample. Unlike inferential statistical analysis, descriptive methods do not infer something about the population; rather the analysis describes the basic features of the data such as measures of central tendency (Goodwin, 2010). Data will be collected from a sample of adult patients who underwent PPCI (both male and female) following MI. Specifically data will be collected for all cases of PPCI for STEMI patients attended the hospital from 1/1/2018 and 30/12/2018.

A comparison between the hospital data (medical records) and the international standards will then be made. Analysis will determine the correlation between the data obtained from the hospital records and international standards and the reasons for delays that makes the door-to-balloon time greater than 90 minutes. The correlation will be done through regression, which will be done using SPSS software. This is a software that offers wide range of tools to conduct statistical analysis on both numerical and textual data (Wagner, 2010). Consistent with the proposal by Fisher (the proposer of the p-value), 0.05 will be used as a threshold of significance (Panagiotakos, 2008, p.97). The p-value is the "probability of obtaining a result at least as extreme as the one that was actually observed in the study, given that the null hypothesis is true" (Panagiotakos, 2008, p.97). The American College of Cardiology/American Heart Association recommendations of door-to-balloon time <90 min will be used as the benchmark. Consequently, the analysis will seek to determine areas of delay within the process of preparing STEMI patients for PPCI.

V. Discussion

This paper proposes a research project to investigate early detection of MI and the management of door-to-balloon time in patients with MI in Saudi Arabia. The study seeks to compare data from a tertiary hospital in Riyadh with the international guidelines of door-to-balloon time of ≤90 minutes. The findings of this study will inform the organization of delays in giving the PPCI procedure to STEMI patients. As estimated that door-to-balloon time in this hospital is higher than the internationally recommended time. Further research to identify how the causes of delays can be improved upon is recommended.

The results of this study are estimated to be consistent with the existing literature, meaning that delays can be found to be mostly in the time between arrival and first contact with a doctor and in transferring patients to the cath lab. The absence of NPs at the ED is expected to be one of the variables that can contribute to the prolonged door-to-balloon time. The existing literature has established that NPs play a critical role in the early detection of MI (Deaton et al., 2017; Abid et al., 2015; Roche et al., 2017). The absence of NPs in EDs in Saudi Arabia is expected to have an adverse impact on early detection of MI, which can be one of the reasons for delays in getting the patient to their PPCI procedure in less than 90 minutes.

However, the study has several limitations. First, the proposed research will be a single-site study, which limits the generalizability of the findings. The use of a single setting poses the challenge of selection bias. Factors in the chosen context such as the organizational culture can influence the findings, leading to bias. In future, a study comparing the door-to-balloon time in other hospitals in Saudi Arabia should be conducted to determine if delays are found in the same section of the process as in this study location.

VI. Implication to Findings

The findings of the proposed study are likely to impact future policymaking, interventions, and practice interventions in the Saudi healthcare sector. In terms of policymaking, the international standards of door-to-balloon time of less than 90 minutes could be adapted by all Saudi hospitals as a quality standard practice. In practice, the handling of patients presenting with MI-related symptoms would need to be adjusted to reflect adherence to this policy. The findings will likely have the implication that nurses and NPs should be more involved in the treatment and management of MI-related symptoms at the ED, which would align with previous studies (Abid et al., 2015; Deaton et al., 2017; Roche et al., 2017). ED nurses and NPs play a critical role in the early detection of MI in the ED. They often act as first-line managers in the care of patients and triage them directly to their treatment trajectory based on the patient's clinical presentation (Abid et al., 2015). Nurses play a critical role in the detection, diagnosis, and management of MI. In particular, NPs have been observed to be highly effective in the management of the condition (Deaton et al., 2017). The involvement of NPs reduces the rate of the rehospitalization of patients with ST elevation MI, non-ST elevation MI, and heart failure by half (Deaton et al., 2017, 55). NPs provide continuity in the provision of cardiac care, which leads to the improved clinical outcomes (Deaton et al., 2017).

NPs and staff nurses play a critical role in deciding which patients to be monitored after coming to the hospital presenting symptoms that suggest potential MI. Appropriate care for such patients includes the establishment of appropriate ECG monitoring for conditions such as cardiac arrhythmias, and drug overdose. While tests are aimed at finding evidence of cardiac dysfunction, NPs assist in setting the standards to guide the monitoring of ECG readings (Winkler, 2014). Such findings have implications on the operations of EDs in hospitals in Saudi Arabia. The inclusion of NPs to act as the first life of defense can enhance the early detection of MI at the ED. This would facilitate better management of door-to-balloon time to achieve the recommended time of not more than 90 minutes.

Reflection

This proposal has taught me lots of things about research and nursing practice. In particular, I have learned more about the roles of NPs and how they have been used in other countries to improve outcomes, especially in the ED. In particular, when reviewing the literature, I learned more about the practices that have been implemented in different national health systems to improve the door-to-balloon time, most of which included the expansion of the role played by nurses in the ED and the use of NPs.

I have also learned that the Saudi healthcare system still has a long way to go to achieve high levels of efficiency in the delivery of cardiovascular care. Notably, the high rates deaths attributed to MI and the delays in the giving PPCI to STEMI patients, as established in the literature review, presents a gap that can be filled. I have also learned of the different ways to practice that would bring Saudi on a par with other national healthcare systems, especially by eliminating the major causes of delays. I plan to use this knowledge to improve my effectiveness as an NP. I will engage further in research on the topic with the aim of identifying gaps in the delivery of care in Saudi Arabia and possible ways that can be used to make improvements.

The proposal has also improved my research skills. Through the proposal, I have familiarized myself with different research methods and designs that can be used to conduct different types of research. When proposing the methodology, I engaged in extensive research about these approaches before finding the most appropriate one. I have also improved my skills in finding credible information on the internet, particularly by discovering databases that contain credible nursing and healthcare-related topics. I will use these skills to further my research activities. These skills will be of major benefit to me in my continuing education and as I develop as a NP.

VII. Conclusion

This paper presents a research proposal for a research titled, "Early Detection of Myocardial infarction and Management of Door-to-Balloon Time in Patients with Acute Myocardial Infarction in Saudi Arabia." It proposes a quantitative research to be conducted using medical records at a Riyadh tertiary hospital through a retrospective cross-sectional research design. Given the nature of the data to be collected, statistical software such as SPSS will be used in the analysis of the data. The findings of the study are expected to inform the management of door-to-balloon time in the hospital in Riyadh. These findings will likely inform other organizations within Saudi healthcare system. The study has the potential to improve healthcare outcomes for

persons presenting with MI at the ED. The research will be important as it may guide the implementation of the introduction of NPs in Saudi Arabia.

Acknowledgments

I would like to express my gratitude to my research advisor, Dr Catherine Corrigan, for giving me guidance throughout the research process and my research tutor, Dr. Mary Brigid Martin, for all the help in this journey. Secondly, I would like to express my special thanks to King Fahad Medical City, for the scholarship to study this Masters program. Lastly, I would like to thank my parents and friends who have always been supportive in my studies and all the help they rendered in completing this research project.

References

[1]. Abid, S., Shuaib, W., Ali, S., Evans, D.D., Khan, M.S., Edalat, F. and Khan, M. J. (2015) 'Chest Pain Assessment and Imaging Practices for Nurse Practitioners in the mergency Department', *Advanced Emergency Nursing Journal*, 37(1), pp. 12-22.

[2]. Aljefree, N. and Ahmed, F. (2015) 'Prevalence of cardiovascular disease and associated risk factors among adult population in the Gulf region: A systematic review', *Advances in Public Health*, 2015, pp. 1-23.

[3]. Al Faleh, H.F., Thalib, L., AlHabib, K.F., Ullah, A., AlNemer, K., AlSaif, S.M., Taraben, A.N., Malik, A., Abuosa, A.M., Mimish, L.A. and Hersia, A.S. (2012) 'Are acute coronary syndrome patients admitted during off-duty hours treated differently? An analysis of the Saudi Project for Assessment of Acute Coronary Syndrome (SPACE) study', *Annals of Saudi medicine*, 32(4), pp. 366-371.

[4]. Alyahya, A.A., Alghammass, M.A, Aldhahri, F.S., Alsebti, A.A., Alfulaij, A.Y., Alrashed, S.H., Faleh, H.A., Alshameri, M., Alhabib, K., Arafah, M., Moberik, A., Almulaik, A., Al-Aseri, Z. and Kashour, T.S. (2018) 'The impact of introduction of Code-STEMI program on the reduction of door-to-balloon time in acute ST-elevation myocardial infarction patients undergoing primary percutaneous coronary intervention: A single-center study in Saudi Arabia', *Journal of the Saudi Heart Association*, 30(3), pp. 172-179.

[5]. Alzahrani, N.J., ALotaibi, N.S., Margoushy, N.M. E. and Mougrabi, M.M. (2018) 'The prevalence of acute myocardial infarction (AMI) in Taif City Province and its participating factors', *The Egyptian Journal of Hospital Medicine*, 70(10), pp. 1826-1833.

[6]. Ameh, S., Gómez-Olivé, F.X., Kahn, K., Tollman, S.M. and Klipstein-Grobusch, K. (2017) 'Relationships between structure, process and outcome to assess quality of integrated chronic disease management in a rural South African setting: Applying a structural equation model', *BMC Health Services Research*, 17(1), pp. 229.

[7]. Ängerud, K.H., Thylén, I., Lawesson, S.S., Eliasson, M., Näslund, U. and Brulinm C. (2016) 'Symptoms and delay times during myocardial infarction in 694 patients with and without diabetes; an explorative cross-sectional study', *BioMed Central Cardiovascular Disorders*, (16), pp. 108.

[8]. Barley, E.A., Walters, P., Haddad, M., Phillips, R., Achilla, E., McCrone, P., van Marwijk, H.W.J., Mann, A. and Tylee, A. (2014) 'The UPBEAT Nurse-Delivered Personalized Care Intervention for People with Coronary Heart Disease Who Report Current Chest Pain and Depression: A Randomised Controlled Pilot Study', *PLoS One*, 9(6), pp. e98704.

[9]. Brennan, A.L., Andrianopoulos, N., Duffy, S.J., Reid, C.M., Clark, D.J., Loane, P., New, G., Black, A., Yan, B.P., Brooks, M., Roberts, L., Carroll, E.A., Lefkovits, J. and Ajani, A.E. (2014) 'Trends in door-to-balloon time and outcomes following primary percutaneous coronary intervention for ST-elevation myocardial infarction: an Australian perspective', *Journal of Internal Medicine*, 44(5), pp. 471-477.

[10]. Broers, C.J.M., Sinclair, N., van der Ploeg, T.J, Jaarsma, T., van Veldhuisen, D.J. and Umans, V. (2009) 'The post-infarction nurse practitioner project: A prospective study comparing nurse intervention with conventional care in a non-high-risk myocardial infarction population', *Netherlands heart journal : monthly journal of the Netherlands Society of Cardiology and the Netherlands Heart Foundation*,17(2), pp. 61-67.

[11]. Campo, T.M., Campo, T.M., Carman, M.J., Evans, D., Hoyt, K.S., Kincaid, K., Ramirez, E.G., Roberts, E., Stackhouse, K., Wilbeck, J. and Weltge, A. (2016) 'Standards of practice for emergency nurse practitioners', *Advanced Emergency Nursing Journal*, 38(4), pp. 255-258.

[12]. Chen, F., Lin, Y., Kung, C., Cheng, C. and Li, C. (2017) 'The association between door-to-balloon time of less than 60 minutes and prognosis of patients developing ST segment elevation myocardial infarction and undergoing primary percutaneous coronary intervention', *BioMed Research International*, 2017, pp. 1910934-6.

[13]. Creswell, J. (2014) *Research Design:Qualitative, Quantitative and Mixed Methods Approaches*. 4th edn. London:SAGE Publications Ltd.

[14]. Cullen, L.A., Mills, N.L., Mahler, S. and Body, R., (2017) 'Early rule-out and rule-in strategies for myocardial infarction', *Clinical Chemistry*, 63(1), pp. 129-139.

[15]. Deaton, C., Johnson, R., Evans, M., Timmis, A., Zaman, J., Hemingway, H., Hughes, J., Feder, G. and Cramer, H. (2017) 'Aligning the planets: The role of nurses in the care of patients with non-ST elevation myocardial infarction', *Nursing Open*, 4(1), pp. 49-56.

[16]. Dresser, R. (2012) 'Aligning regulations and ethics in human research', *Science*, 337(6094), pp. 527-528.

[17]. Ellahham, S., Aljabbari, S., Harold Mananghaya, T., Raji, S. and Al Zubaidi, A. (2015) 'Reducing Door to- Balloon- Time for Acute ST Elevation Myocardial Infarction In Primary Percutaneous Intervention: Transformation using Robust Performance Improvement', *British Medical Journal, Quality Improvement Reports*, 4(1), pp. u207849.w3309.

[18]. Foo, C.Y., Reidpath, D.D. and Chaiyakunapruk, N. (2016) 'The effect of door-to-balloon delay in primary percutaneous coronary intervention on clinical outcomes of STEMI: A systematic review and meta-analysis protocol', *Systematic Reviews*, 5(130), pp. 1-7.

[19]. Goodacre, S., Locker, T., Arnold, J., Angelini, K. and Morris, F. (2005) 'Which diagnostic tests are most useful in a chest pain unit protocol?', *BioMed Central emergency medicine*, 5(1), pp. 6-6.

[20]. Gorenberg, M., Marmor, A. and Rotstein, H. (2005) 'Detection of chest pain of non-cardiac origin at the emergency room by a new non-invasive device avoiding unnecessary admission to hospital', *Emergency Medicine Journal*, 22(7), pp. 486-489.

[21]. Gray, A.J., Roobottom, C., Smith, J.E., Goodacre, S., Oatey, K., O'Brien, R., Storey, R.F., Na, L., Lewis, S.C., Thokala, P. and Newby, D.E. (2016) 'The RAPID-CTCA trial (Rapid Assessment of Potential Ischaemic Heart Disease with CTCA) - a multicentre parallel-group randomised trial to compare early computerised tomography coronary angiography versus standard care in patients presenting with suspected or confirmed acute coronary syndrome: study protocol for a randomised controlled trial', *Trials*, 17(1), pp. 579.

[22]. Haddad, L.M. and Toney-Butler, T.J. (2019) *Nursing shortage*. Treasure Island: StatPearls Publishing.

[23]. Harbman, P. (2014) 'The development and testing of a nurse practitioner secondary prevention intervention for patients after acute myocardial infarction: A prospective cohort study', *International Journal of Nursing Studies*, 51(12), pp. 1542-1556.

[24]. Hoyt, K.S. and Proehl, J.A. (2015) 'Family nurse practitioner or acute care nurse practitioner in the emergency department?', *Advanced Emergency Nursing Journal*, 37(4), pp. 243-246.

[25]. Hudson, P.V. and Marshall, A.P. (2008)'Extending the nursing role in Emergency Departments: Challenges for Australia', *Australasian Emergency Care*, 11(1), pp. 39-48.

[26]. Kosowsky, J., Yiadom, M., Hermann, L., and Jagoda, A. (2009) 'The diagnosis and treatment of STEMI in the emergency department', *Emergency Medicine Practice*, 11(6), pp. 1-18.

[27]. Kränkel, N., Blankenberg, S. and Zeller, T. (2016) 'Early detection of myocardial infarction—microRNAs right at the time?', *Annals of Translational Medicine*, 4(24), pp. 502.

[28]. Krumholz, H.M., Herrin, J., Miller, L.E., Drye, E.E, Ling, S.M., Han, L.F., Rapp, M.T., Bradley, E.H., Nallamothu, B.K., Nsa,W., Bratzler, D.W. and Curtis, J.P (2011) 'Improvements in Door-to-Balloon Time in the United States: 2005-2010', *Circulation*, 124(9), pp. 1038-1045.

[29]. Levis, J.T., Mercer, M.P., Thanassi, M. and Lin, J. (2010) 'Factors Contributing to Door-to-Balloon Times of ≤90 Minutes in 97% of Patients with ST-Elevation Myocardial Infarction: Our One-Year Experience with a Heart Alert Protocol', *The Permanente Journal*, 14(3), pp. 4-11.

[30]. Lux, R.L. (2015) 'Non-ST-Segment Elevation Myocardial Infarction: A Novel and Robust Approach for Early Detection of Patients at Risk', *Journal of the American Heart Association*, 4(7). doi: 10.1161/JAHA.115.002279

[31]. Martin, L., Murphy, M., Scanlon, A., Clark, D. and Farouque, O. (2016) 'The impact on long term health outcomes for STEMI patients during a period of process change to reduce door to balloon time', *European Journal of Cardiovascular Nursing*, 15(3). doi: 10.1177/1474515115577294.

[32]. Mehta, S. (2012) *STEMI interventions: An issue of Interventional Cardiology Clinics*. Philadelphia: Elsevier Saunders.

[33]. Miedema, M.D. Newell, M.C., Duval, S., Garberich, R.F., Handran, C.B., Larson, D.M., Mulder, S., Wang, Y.L., Lips, D.L. and Henry, T.D. (2011) 'Causes of Delay and Associated Mortality in Patients Transferred With ST-Segment–Elevation Myocardial Infarction', *Circulation*, 124(15), pp. 1636-1644.

[34]. Nestler, D.M. Noheria, A., Haro, L.H., Stead, L.G., Decker, W.W., Scanlan-Hanson, L.N., Lennon, R.J., Lim, C., Holmes, D.R., Rihal, C.S., Bell, M.R., and Ting, H.H. (2009) 'Sustaining Improvement in Door-to-Balloon Time Over 4 Years: The Mayo Clinic ST-Elevation Myocardial Infarction Protocol', *Circulation: Cardiovascular Quality and Outcomes*, 2(5), pp. 508-513.

[35]. Neumann, J.T., Sörensen, N.A., Ojeda, F., Renné, T., Schnabel, R.B., Zeller, T., Karakas, M., Blankenberg, S. and Westermann, D. (2017) 'Early diagnosis of acute myocardial infarction using high-sensitivity troponin I', *PLoS ONE*, 12(3), pp. e0174288.

[36]. Panagiotakos, D. B. (2008) 'The value of p-value in biomedical research', *The Open Cardiovasc Medicine Journal*, 2(1), pp. 97-99.

[37]. Polit, D.F. and Beck, C.T. (2008) *Nursing research: generating and assessing evidence for nursing practice*. 8th edn. Philadelphia: Wolters Kluwer Health.

[38]. Ramesh, A., Vanden Hoek, T.L., LaBresh, K., Campbell, T., Murthy, K., Shetty, N., Begeman, R.M., Edison, M., Williams, P., Prabhakar, B.S. and Erickson, T.B. (2018) 'Development of an emergency nurse-paramedic motorcycle response system for acute STEMI and sudden cardiac arrest care in India', *Global Journal of Emergency Medicine*, 1(2), pp. 1-6.

[39]. Roche, T. E., Gardner, G. and Jack, L. (2017) 'The effectiveness of emergency nurse practitioner service in the management of patients presenting to rural hospitals with chest pain: A multisite prospective longitudinal nested cohort study', *BioMed Central Health Services Research*, 17(1), pp. 445.

[40]. Rogerson, P. (2001) *Statistical methods for geography*. Thousand Oaks: SAGE Publications.

[41]. Sanders, S. (2017) 'Care delays in patients with signs and symptoms of acute myocardial infarction', *Emergency Nurse*, 25(6), pp. 31-36.

[42]. Sheridan, P.J. and Crossman, D.C. (2002) 'Critical review of unstable angina and non-ST elevation myocardial infarction', *Postgraduate Medical Journal*, 78(926), pp. 717-726.

[43]. Sim, W.J., Ang, A.S., Tan, M.C., Xiang, W.W., Foo, D., Loh, K.K., Jafary, F.H., Watson, T.J., Ong, P.J.L. and Ho, H.H. (2017) 'Causes of delay in door-to-balloon time in south-east Asian patients undergoing primary percutaneous coronary intervention', *PLoS One*, 12(9), pp. e0185186.

[44]. Smigorowsky, M.J., Norris, C.M., McMurtry, M.S. and Tsuyuki, R.T. (2017) 'Measuring the effect of nurse practitioner (NP)-led care on health-related quality of life in adult patients with atrial fibrillation: Study protocol for a randomized controlled trial', *Trials*, 18(1), pp. 364-8.

[45]. Swaminathan, R.V., Wang, T.Y., Kaltenbach, L.A., Kim, L.K., Minutello, R.M., Bergman, G., Wong, S.C. and Feldman, D.N. (2013) 'Nonsystem reasons for delay in door-to-balloon time and associated in-hospital mortality: A report from the National Cardiovascular Data Registry', *Journal of the American College of Cardiology*, 61(16), pp. 1688-1695.

[46]. Torpy, J.M., Lynm, C. and Glass, R.M. (2004) 'Percutaneous Coronary Intervention', *JAMA*, 291(6), pp. 778.

[47]. Tra, J., van der Wulp, I., de Bruijne, M.C. and Wagner, C. (2015) 'Exploring the treatment delay in the care of patients with ST-elevation myocardial infarction undergoing acute percutaneous coronary intervention: a cross-sectional study', *BMC Health Services Research*, 15(1), pp. 340.

[48]. Treas, L.S. and Wilkinson, J.M. (2014) *Basic nursing: Concepts, skills, and reasoning.* Philadelphia: F.A. Davis Company.

[49]. U.S. Department of Health, Education, and Welfare (2014) 'The Belmont Report: Ethical principles and guidelines for the protection of human subjects of research', *Journal of the American College of Dentists*, 81(3), pp. 4-13.

[50]. Voyce, J., Gouveia, M.J.B., Medinas, M.A., Santos, A.S. and Ferreira, R.F. (2015) 'A Donabedian model of the quality of nursing care from nurses' perspectives in a Portuguese hospital: A pilot study', *Journal of Nursing Measurement*, 23(3), pp. 474-484.

[51]. Wagner, W.E. (2010) *Using SPSS for social statistics and research methods*. 2nd edn. Thousand Oaks: Pine Forge Press.

[52]. Willis, J.W. and Jost, M. (2007) *Foundations of qualitative research: Interpretive and critical approaches*. Thousand Oaks: SAGE.

[53]. Winkler, C. (2014) Electrocardiographic monitoring for cardiovascular dysfunction. In Booker, K.J. (eds.) *Critical care nursing: Monitoring and treatment for advanced nursing practice.* Ames: Wiley Blackwell, pp. 57-72.

[54]. Woo, B.F.Y., Lee, J.X.Y. and Tam, W.W.S. (2017) 'The impact of the advanced practice nursing role on quality of care, clinical outcomes, patient satisfaction, and cost in the emergency and critical care settings: a systematic review', *Human Resources for Health*, 15(1), pp. 63-22.

[55]. World Health Rakings (2017). *Coronary heart disease in Saudi Arabia.* Available at: https://www.worldlifeexpectancy.com/saudi-arabia-coronary-heart-disease (Accessed 3 May 2019).

[56]. Zaman, S. and Kovoor, P. (2014) 'Sudden Cardiac Death Early After Myocardial Infarction: Pathogenesis, Risk Stratification, and Primary Prevention', *Circulation*, 129(23), pp. 2426–2435.