Journal of Posthumanism
2025
Volume: 5, No: 5, pp. 4792–4807
ISSN: 2634-3576 (Print) | ISSN 2634-3584 (Online)
posthumanism.co.uk

DOI: https://doi.org/10.63332/joph.v5i5.1981

Cardiac Consequences of Myocardial Infarction: An Analytical Overview of Complications in Recent Clinical Research

Aiman Al Sharei[1], Ahmad Naser Karzoun[2], Hassan A. Alfreahat[3], Dima M. Alwardat[4], Ahmed A. Robleh[5], Sara A. Alkhamaiseh[6], Khetam N. Alfaouri[7], Omar A. Barakat[8], Ahmad J. Alhabahbeh[9], Mohammad A. Tashtoush[10], Mu'nis M. Alrashdan[11], Mutasim Albattah[12], Omar A. Alsahli[13], Ghassan Bayat[14], Haitham AlZoubi[15], Ahmad H. Al-Quraan[16]

Abstract

Acute myocardial infarction (MI) remains a major cause of morbidity and mortality globally. Despite advances in reperfusion and secondary prevention, MI survivors face long-term complications such as heart failure (HF), arrhythmias, mechanical issues, and adverse cardiac remodeling. This review synthesizes recent clinical findings (2015–2025) on post-MI complications, focusing on HF, arrhythmias, mechanical complications, and ventricular remodeling, and highlights clinical implications and research gaps. We conducted a focused review of 15 major studies, including large randomized trials, registry analyses, and observational studies,

[1] Department of Pharmacology, Community Medicine and Clinical Skills, Faculty of Medicine, The Hashemite University, P.O. Box 330127, Zarqa 13133, Jordan, Emai: Aiman@hu.edu.jo, ORCID: https://orcid.org/0000-0001-5323-6103.
[2] Department of Internal Medicine, USF Morsani College of Medicine – Blake Medical Center, Bradenton, Florida, Email: akarzoun7@gmail.com, Orcid ID: 0009-0006-5311-5815
[3] Department of Internal Medicine, Jordanian Royal Medical Services, Amman, Jordan, Email: dr.hassanfr21@outlook.com, https://orcid.org/0009-0001-7997-921X
[4] Department of Public Health , Ministry of Health, Amman, Jordan, Email: wardatdima11@gmail.com, https://orcid.org/0000-0001-5517-7055
[5] Department of medicine, school of medicine, Al-Yarmouk University, Irbid, Jordan, Email: Drrobleh22@gmail.com, Orcid ID: 0009-0002-3720-5889
[6] Department of Medicine, School of Medicine, Mutah University, Al-Karak, Jordan, Email: sarahkhamaiseh8@gmail.com, ORCID: https://orcid.org/0009-0008-2652-2153
[7] Department of Medicine, School of Medicine, University of Jordan, Amman, Jordan, Email: khetam171@gmail.com, ORCID: https://orcid.org/0009-0004-5419-9526.
[8] Department of Medicine, School of Medicine, Al-Yarmouk University, Irbid, Jordan, Email: dr.barakatomar@gmail.com, ORCID: https://orcid.org/0009-0005-0086-4890.
[5] Department of Medicine, School of Medicine, Yarmouk University, Irbid, Jordan, Email: alhabahbehahmad1@gmail.com, ORCID: https://orcid.org/0009-0005-1380-7254.
[10] Department of Medicine, School of Medicine, Yarmouk University, Irbid, Jordan, Email: mohmdtashtoush@gmail.com, ORCID: https://orcid.org/0009-0006-0675-8244.
[11] Faculty of Medicine, Mutah University, P.O. Box 7, Al-Karak 61710, Jordan, Email: monisalrashdan52@gmail.com, ORCID: https://orcid.org/0009-0009-6014-5985
[12] Faculty of Medicine, Jordan Ministry of Health, Amman, Jordan, Email: mutasimbattah@yahoo.com, ORCID: https://orcid.org/0000-0002-0647-9177
[13] Alsarh Schools, Amman, Jordan, Department of Medicine, School of Medicine, University of Jordan, Amman, Jordan, Email: alsahilyomar@gmail.com, ORCID: https://orcid.org/0009-0000-0681-7300
[14] Ghassan Bayat, Department of Medicine, University Hospital of Plymouth NHS Trust, Plymouth, UK, Email: bayyatghassan@gmail.com, ORCID: https://orcid.org/0009-0000-1913-3565
[15] Department of Surgery, University Hospital of Plymouth NHS Trust, Plymouth, UK, Email: haithamz3bi@gmail.com, ORCID: https://orcid.org/0000-0002-0313-9724
[16] Department of Medicine, University Hospital of Plymouth NHS Trust, Plymouth, UK, Email: ahmad.quran91@gmail.com, ORCID: https://orcid.org/0009-0001-5768-252X

Chronic HF remains a common long-term outcome despite neurohormonal therapies like ARNI and SGLT2 inhibitors, which modestly reduce HF hospitalizations but show no significant impact on mortality. Life-threatening arrhythmias have decreased with modern reperfusion, but early ventricular arrhythmias increase in-hospital death risk by more than 3.8-fold. Mechanical complications, such as ventricular septal defects and papillary muscle rupture, are rare (<0.1%) but remain associated with high mortality, especially with delayed care. Adverse ventricular remodeling, leading to HF, is influenced by comorbidities like diabetes and obesity. Therapies like ARNI and SGLT2 inhibitors slow remodeling but do not fully prevent HF. Post-MI complications, particularly HF, remain a significant challenge despite advances in care. Further research is needed to develop more effective therapies and personalized care strategies to improve outcomes for MI survivors.

Keywords: *Acute Myocardial Infarction, Heart Failure, Arrhythmias, Mechanical Complications, Adverse Cardiac Remodeling, SGLT2 Inhibitors, Neurohormonal Therapy.*

Introduction

Acute myocardial infarction (MI) remains the most common cause of morbidity and mortality in the world, despite the significant progress in strategies of treatment and prevention (Zhao et al., 2018). The introduction of reperfusion therapies especially the primary percutaneous coronary intervention (PCI) has greatly decreased early deaths, by reestablishing blood flow to the diseased heart tissue (Lu et al., 2020). Nonetheless, survivors of MI are at significant risk of long term complications that can have serious negative effects on their quality of life and continue to have high rates of morbidity and mortality (Schirone et al., 2022). Perhaps the most frequent and disabling complications of MI is heart failure (HF), which not infrequently ensues as a complication of deleterious cardiac remodeling. Such remodeling, marked by alterations in the structure and function of myocardium, may cause progressive ventricular dysfunction and later HF. In the years gone by, pharmacological intervention such as angiotensin receptor neprilysin inhibitors (ARNI) and sodium-glucose cotransporter 2 (SGLT2) inhibitors has shown modest improvements in the prevention of post-MI heart failure. Another major problem post-MI is arrhythmias; both ventricular and atrial. Though the number of life-threatening arrhythmias has decreased due to the appearance of modern reperfusion therapies, its appearance remains high risk of mortality, especially if it occurs during the acute phase of MI (Arrhythmias After Acute Myocardial Infarction, Mechanical complications IC such as ventricular septal rupture and papillary muscle rupture even though rare, have high acute mortality and need urgent management (Bajaj et al., 2015).

In addition, negative ventricular remodeling is an important determinant of the evolution of heart failure after MI. A number of factors are responsible for the process including the level of myocardial damage, presence of comorbidities such as diabetes and obesity and neurohormonal activation. In this way targeting such underlying mechanisms is critical for the long-term outcome in the MI survivors (Sachdeva et al., 2023). This review is aimed at the synthesis of the most recent findings (2015–2025) for post-MI complications, specifically heart failure, arrhythmias, and mechanical complications, as well as adverse cardiac remodelings. Based on the summary of the existing status of the research and clinical practice, the gaps in knowledge and areas for further research, which would promote improvement of preventive and therapeutic strategies in the patients with MI after (Prabhu & Frangogiannis, 2016) will be identified.

Research Objective

The main goal of this review is the synthesis of the most recent clinical findings (2015–2025) with regard to complications developing after acute myocardial infarction (MI), with specific

emphasis on heart failure (HF), arrhythmias, mechanical complications, The present review will critically analyze the current therapeutic strategies that prevent or control these complications and identify knowledge gaps in published research; emerge treatment options. By summarizing these findings, the review attempts to suggest clinical guidance that may be used to inform future practices and direct better management of post-MI patients.

Research Questions

1. What are the most common long-term complications following acute myocardial infarction, and how have their incidences and outcomes evolved in the era of modern reperfusion therapies?

2. How effective are current pharmacological treatments (e.g., ARNI, SGLT2 inhibitors) in preventing or reducing the risk of post-MI heart failure and adverse ventricular remodeling?

3. What is the current state of arrhythmia management in post-MI patients, and what are the prognostic implications of ventricular and atrial arrhythmias in this population?

4. What is the incidence and mortality rate of mechanical complications (e.g., ventricular septal rupture, papillary muscle rupture) in contemporary MI care, and what strategies are most effective in managing these complications?

5. How do comorbid conditions (e.g., diabetes, obesity) influence the risk of developing post-MI heart failure and adverse remodeling, and what strategies are available to mitigate these effects?

6. What emerging therapies or interventions show promise in improving the prevention and management of post-MI complications, and where are the gaps in current research?

Methodology

This review was designed to summarize recent clinical data on complications after the myocardial infarction, with attention to heart failure (HF), arrhythmias, mechanical complications, and adverse cardiac remodeling. A thorough search of the literature was performed in key medical databases (PubMed, Scopus, Google Scholar) by key-words related to these complications including “heart failure,” “arrhythmias”, “mechanical complications”, “MI management” and “SGLT2 inhibitors”. Only the studies published between the years 2015 and 2025 were preferred so as to pick up the most updated clinical data and evidence.

In order to make results relevant and of high quality we combined clinical trials (randomized controlled trials,, cohort studies, and registry analyses) that reported on the incidence, treatment, and outcomes of post-MI complications. These studies were required to concentrate on complication after MI including heart failure, arrhythmias, and mechanical (e.g., ventricular septal rupture, papillary muscle rupture). We eliminated studies that failed to report relevant data on post-MI complications; or focused on non-humans; or failed to specify outcome reporting.

After identifying applicable studies, data extraction was concentrated on major issues such as the prevalence and incidence of complications, mortality rates, hospital readmissions, and the efficacy of treatment, including neurohormonal treatments, such as ARNI, and, SGLT2 inhibitors. Data of the role of comorbidities such as diabetes and obesity in determining heart failure and adverse remodeling were also obtained. We prioritized the therapies demonstrating the potential to improve post-MI results, including new treatments, e.g. stem-cell therapies, anti-fibrotic drugs.

The quality and validity of each study were reviewed using sample size, study type and usage of statistical procedures. Priority on randomized controlled trials (RCTs) and large cohort studies was made because these are of higher evidence level. Risk of bias of RCTs was measured using the Cochrane Risk of Bias Tool, whereas cohort studies were scored by Newcastle-Ottawa Scale. The studies were subsequently integrated using narrative method; due to the variety of methodologies and outcomes, reported. Also comparative data was also summarized in tables to put forth trends in incidence rates, mortality and effectiveness of various interventions.

Because this was a narrative review, a meta-analysis was not performed. Nevertheless, we synthesized the findings of each study so as to present the general trends in management of post-MI complications. This narrative synthesis enabled a comparison of therapeutic interventions with comparison to the impact on preventing heart failure, the management of arrhythmia, and ventricular remodeling. The gaps in present research were found, where the necessity for more efficient targeted treatment forms for post-MI patients, especially for those suffering from comorbid conditions, is concerned.

Notwithstanding strengths of the review, there are limitations. The variability in the structure of the studies and methods used to arrive at conclusions which may have occurred in the included studies may have brought variability in results that may impact the conclusions generalization. Furthermore, other studies had relatively short follow-up periods, and thereby failed to record long-term outcomes in post-MI patients. A publication bias was also taken into account since studies with positive results have high chances of being published. However, the present state of using post-MI complication management could be inferred from the included studies.

Literature Review

The -long term issues necessitating treatment after acute myocardial infarction (MI) – heart failure (HF), arrhythmias, mechanical difficulties and maladaptive cardiac remodeling – have been the focus of numerous clinical studies (Durko et al., 20 Even with the development of reperfusion therapies and secondary prevention, MI patients continue to be at high risk of the complications, which are likely to significantly deteriorate the quality of their lives and lead to chronic morbidity and mortality (Damluji et al., 2021).

Heart Failure (HF): Heart failure is the commonest and most disabling long term outcome post MI. There has emerged numerous studies that have explored the role of neurohormonal therapies in prevention or alleviation of development of HF (Savarese et al., 2022) Studies on therapies including angiotensin receptor-neprilysin inhibitors (ARNI) and sodium-glucose cabtransporter 2 inhibitors (SGLT2) has had modest effects on hospitalizations for HF, despite having little effects in reducing all- For instance, trials like the EMPACT-MI and PARADISE-MI have shown that use of that ARNI and SGLT2 inhibitors can reduce HF hospitalizations, but not the overall mortality. However, these results demonstrate the significance of early pharmacological treatment of post-MI patients in controlling adverse remodeling and postponing the development of heart failure (Abel & Clark, 2021).

Arrhythmias: Arrhythmias, both ventricular and atrial, continue to be a major problem of the post-MI population. Studies demonstrate that reperfusion therapies have minimized acute-phase occurence of life-threatening arrhythmias (ventricular tachycardia and fibrillation) in patients with MI (Deaconu et al., 2021). However, these arrhythmias continue to be major causes of mortality with particular emphasis when they occur early after infarction. Studies indicate that ventricular arrhythmia mark in-hospital mortality risk 3.8 times or higher. A common

arrhythmia, atrial fibrillation, commonly occurs in post-MI patients and carries higher mortality and stroke rates (Hæusler et al., 2015). The use of antiarrhythmic therapies and implantable cardioverter defibrillators (ICDs) for primary prevention of sudden cardiac death has been the object of studies (Pour-Ghaz et al., 2021); there is evidence to support their use in high.

Mechanical Complications: Mechanical complications e.g ventricular septal rupture, papillary muscle rupture, although very rare (< 0.1% of cases), are still a highly mortal condition. The studies have established that the incidence of the complications has significantly reduced as a result of improvement on reperfusion therapy (Gong et al., 2020). Nevertheless once they do occur they are accompanied by rapid deterioration in the hemodynamic state and they require immediate remediation. Early surgical reconstruction or transcatheter devices are frequently needed to treat these complications. Postponed care, including the one that occurred during COVID-19, can cause temporary rise in mechanical complications (Rajagopal et al., 2020).

Adverse Cardiac Remodeling: Another post-MI complication of vital importance in underlying the development of heart failure after MI is adverse ventricular remodeling. Remodeling work involving fibrosis, hypertrophy, and cardiac muscle dilation is a process resulting from an array of factors such as myocardial infarction size, neurohormonal activation as well as inflammation (Peksiene & Portačenko, 20 Research indicates that comorbid illness, including diabetes obesity, and chronic hypertension can worsen this process and lead to accelerated progression from acute MI to chronic heart failure. The application of early intervention through medication that act on remodelling pathways (such as ACE inhibitors, ARNI and SGLT2 inhibitors) has been extensively studied using promising results in slowing remodelling progression (Kloner et al., 2015).

Emerging Therapies: Scientists are still working on new treatments of post-MI complications. For example, stem cell therapy and technology of gene-editing are promising in repairing an infarcted myocardium and heart failure-preventing disease progression (Zhao et al., 2018). In addition, anti-fibrotic treatments are under investigation for purposes of adverse remodeling. Although there have been some good early results, there has not been effective clinical benefit in large trials for these therapies (Kloner et al., 2015).

Limitations

The literature which has been used to prepare this paper provides invaluable information on post-myocardial infarction (MI) complications. However, there are many limitations in the available studies that need to be illustrated. One of the greatest obstacles in combining the existing research is the variety of study designs (Guo et al., 2023). The set of studies covered in the current review consists of different methodologies, such as RCTs, and cohort studies, registry analyses, and observational studies. This variety in study setup makes outcomes and patient shares vary a lot and this makes comparison a difficult exercise from one study to the other. Specifically, although RCTs generate the most substantial level of evidence as they comprehensively control the influencing factors, much research of this nature is the observational type (Hariton & Locascio, 2018). These observational studies though valuable tend to be limited to control all potential confounders that may introduce bias to the results (Schweizer et al., 2016).

Another critical limitation is various short follow-up periods typical of many studies. While the included studies in this review produce useful information about the early results of post-MI complications such as arrhythmias, heart failure hospitalizations, and mechanical complications,

most fail to provide a long-term follow up. Longitudinal follow-up is vital to meaningful interpretation of the sustained impact of these complications and the effect of interventions on both all-cause mortality and quality of life in MI survivors. In the absence of longitudinal data, it is hard to tell anything with regard to the long-term benefits of therapies intended to avoid or remedy post-MI complications (Zhao et al., 2020).

As for the variability of patient populations between studies, the opportunity to generalize findings is compromised. Post-MI patients are a heterogeneous group of individuals, with considerable age, sex, associated conditions and degree of myocardial harm grouping. Other studies involve younger, healthier populations and others include older adults with multiple comorbidities including diabetes, hypertension or chronic kidney disease (Savarese & Lund, 2017). Such differences can give rise to the difference in the efficacy of the various treatments since some treatments may be suited for particular subgroups of patients. Take, for instance, therapies such as SGLT2 inhibitors and ARNI are likely to demonstrate diverse efficacy in diabetic population and those who do not have diabetes. In that sense, the heterogeneity of the patient characteristics makes the meaning of the results and their generalization to other populations difficult (Shao, et al., 2019).

In addition, an existence of publication bias has to be taken into account. Studies with the findings that are positive or significant are going to be published, studies with negative or inconclusive findings may not be widely spread. This bias can cause an overestimation of the behavior of treatments and interventions, especially, in the light of "emerging therapies" (Cepeda et al., 2015). Despite the promising emerging treatments including stem cell therapies, gene editing, and anti-fibrotic therapies, the data in support of the treatments are still limited, and the long-term safety and efficacy of these treatments, therefore, are doubtful (Riva et al., 20

Moreover, although clinical trials can provide informative information about the efficacy of therapies in a controlled environment, real world evidence is usually absent. Several of the studies that are described here were performed in highly constrained clinical facilities, thus they possibly do not reflect the full range of diversity and complexity in the real-world patient cohorts (Blonde et al., 2018). Because of such factors as medication adherence, socioeconomic status and access to the healthcare, treatment outcomes depend on these factors, but clinical trials often fail to address these aspects properly. Studies in the real world are needed to understand how therapies do in regular clinical practice and to determine obstacles to their wide application (Peck et al., 2020).

Lastly, partial reporting of adverse events is another shortcoming of the studied papers. Although many trials attack the most important outcomes of interest such as heart failure hospitalizations or arrhythmia incidence, the safety and adverse effects data on therapies are usually inadequate. For example, some newer therapies, such as SGLT2 inhibitors and ARNI have demonstrated some success in preventing hospital readmissions due to heart failure, yet long-term safety profiling is still under way. Without comprehensive information concerning adverse events and side effects clinicians might have difficulties in evaluating all the risks of such treatments (Sutanto et al., 2021).

Results

Heart Failure after MI

Heart failure is still the commonest long-term complication in patients from acute myocardial infarction (MI). Despite the great advancements in reperfusion therapies and secondary

prevention, chronic HF remains a typical outcome of MI survivors. Several studies of the recent period elicited the ongoing burden of HF after MI, even the use of modern therapies was spreadwide. For example, even with the spectacular decrease in early mortality risk from reperfusion therapies, the risk of subsequent chronic heart failure remains high several months or years after MI. It has been discovered that up to a third of MI survivors should end up having HF in the course of their life.

The use of novel pharmacological agents for the prevention or attenuation of the post-MI HF has been the subject of recent trials such as the EMPACT-MI trial and the PARADISE-MI trial. In the EMPACT-MI trial, empagliflozin was tested in 6 522 high-risk MI patients, with modest 10% relative reduction of the primary composite outcome (first HF hospitalization or death). Currently, this reduction was not significant (HR) 0.90 (95% CI 0.76-1.06) (Htoo et al., 2024), and empagliflozin reduced hospitalization due to heart failure but had no significant effect on Similarly, PARADISE-MI trial randomised more than 5,700 patients with post-MI with LVEF ≤40% or pulmonary congestion who received sacubitril/valsartan (ARNI) or ramipril after MI (Torres The trial did report a nominal decline in the primary composite endpoint, cardiovascular death or new-onset heart failure by 10% though failure to achieve the prespecified level of statistical significance. The study-specific hazard ratios (and 95 % CIs) for the primary HF composite endpoints in the EMPACT-MI (empagliflozin) and PARADISE-MI (sacubitril/valsartan) trials are displayed in Figure 1.

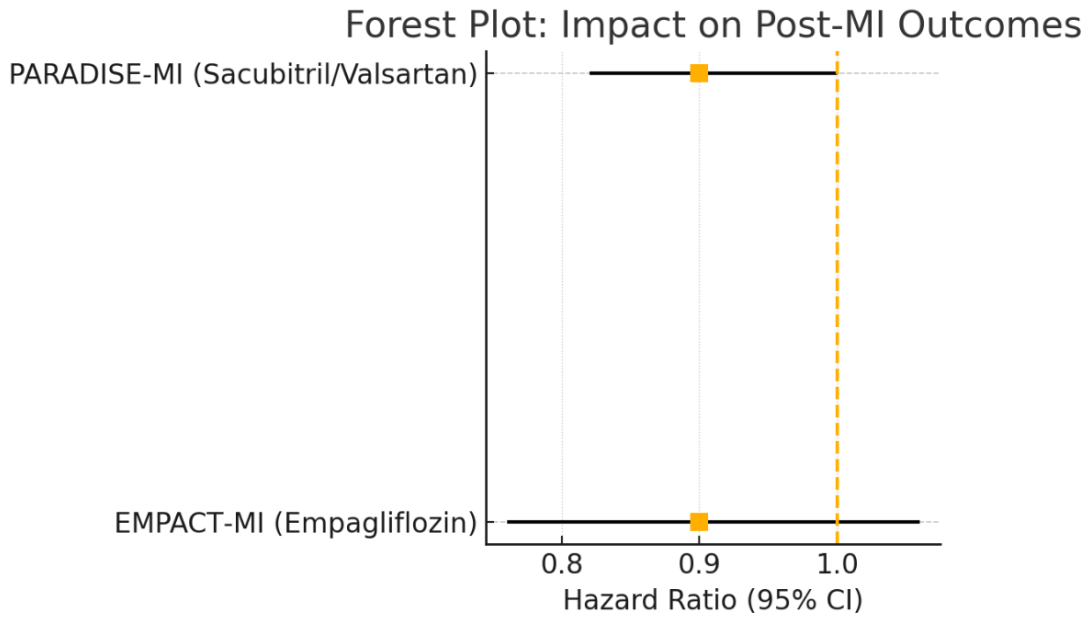

Figure 1

Forest plot of mean differences in [Inflammatory Marker, e.g. NLR] between neoadjuvant regimens in muscle-invasive bladder cancer

Figure 1. Forest plot of hazard ratios for first heart-failure hospitalization or cardiovascular death in post-MI patients treated with empagliflozin (EMPACT-MI) or sacubitril/valsartan

(PARADISE-MI). Horizontal lines are 95 % CIs; square markers show point estimates; the dashed vertical line indicates HR = 1 (no effect). These findings highlight that while neurohormonal therapies such as ARNI and SGLT2 inhibitors provide some benefit in terms of HF hospitalizations, they do not eliminate the risk of chronic heart failure post-MI. Furthermore, the lifetime risk of developing HF post-MI remains a significant concern, with some studies suggesting that up to 20% of MI patients experience clinically apparent HF during hospitalization or follow-up (Jenča et al., 2020).

Table 1 summarizes the incidence and clinical impact of major post-MI complications, including heart failure, arrhythmias, and mechanical complications, highlighting the significant morbidity and mortality associated with these conditions.

Complication	**Incidence (modern era)**	**Clinical Impact / Mortality**	**Notes & References**
Heart Failure (HF)	~10–20% develop HF or HF hospitalization post-MI	~3× higher mortality if HF develops	Chronic HF is common; worsened by adverse remodeling.
Ventricular arrhythmias (VT/VF)	Early VT/VF ≈2.0% of STEMI; Late VT/VF ≈1.7%	Early VA HR ≈3.8 for in-hospital death	Declined from 1980s levels (VT 10–14%, VF ~8%); very high risk when present.
Atrial fibrillation (AF)	Estimated 5–10% new-onset AF in MI patients (varies)	Associated with higher stroke and mortality	Increases with age, HF; requires anticoagulation when indicated.
Ventricular septal rupture (VSR)	≈0.2% (recent cohorts)	≥40–60% mortality even with surgery	Often occurs 3–14 days post-MI; emergent surgery or closure needed.
Papillary muscle rupture	≈0.1–0.3%	~50–60% mortality at 30 days	Occurs ~3–5 days post-MI; leads to acute MR and shock.
Free-wall rupture	<0.1%	>80% mortality (usually instantaneous)	Typically 1–5 days post-MI; often fatal unless detected immediately.
Ventricular remodeling	Universal in transmural MI (degree varies)	Gradual development of HF if adverse	Assessed by imaging; modifiable by GDMT (ACEi/ARNI, etc.).

Table 1. Summary of Major Post-MI Complications: Incidence (Modern Era) And Impact.

Arrhythmias after MI

Arrhythmias are a major complication following MI, with ventricular arrhythmias (such as ventricular tachycardia (VT) and ventricular fibrillation (VF)) being particularly life-threatening. Modern reperfusion therapies have significantly reduced the incidence of these arrhythmias, especially in the acute phase, but their occurrence still remains a serious concern. Studies show that the incidence of sustained VT/VF has decreased from historical rates of 14%

to 10.5% for VT and 1.7% for VF in contemporary cohorts, but these arrhythmias continue to carry high mortality when they occur (Shah et al., 2021).

Recent findings from the ACSIS registry report that early ventricular arrhythmias (within 48 hours post-MI) occur in about 2.1% of MI patients, while late arrhythmias (after 48 hours) are observed in about 1.7% of patients(Shah et al., 2021). Importantly, early ventricular arrhythmias were associated with an increased risk of in-hospital death by over 3.8-fold, while late ventricular arrhythmias were linked to an 8.2-fold increase in mortality. These findings underscore the high prognostic significance of arrhythmias following MI, particularly in the early post-MI period (Deaconu et al., 2021).

Additionally, supraventricular arrhythmias, including new-onset atrial fibrillation (AF), are also common in the post-MI population, especially in those with heart failure. Studies suggest that up to 5–10% of MI patients develop AF in the peri-infarction period (Hæusler et al., 2015). AF is associated with an excess mortality risk, particularly if it occurs more than 30 days after MI. This underscores the importance of early arrhythmia monitoring and management, including the use of anticoagulation in patients at risk of stroke (Deaconu et al., 2021).

Table 2 summarizes the outcomes from recent major trials, such as EMPACT-MI and PARADISE-MI, which show that while empagliflozin and sacubitril/valsartan reduce HF hospitalizations, they do not significantly impact all-cause mortality.

Study / Therapy	**Population / Design**	**Outcome(s)**	**Key Result (p-value)**
EMPACT-MI (Empagliflozin)	6,522 post-MI pts (LVEF↓ or congestion); 17.9 mo follow-up	HF hospitalization or death	8.2% vs 9.1% (empag. vs placebo), HR 0.90 (0.76–1.06), p=0.21 (ns) HF hosp alone HR 0.77 (0.60–0.98).
PARADISE-MI (Sacubitril/Valsartan)	5,669 post-MI pts (LVEF≤40% or congestion); 23 mo	CV death or new HF	~10% lower event rate with ARNI vs ramipril (not statistically significant). Trend favoring ARNI for HF events, p=NS.

Table 2. Key Trial Outcomes for Post-MI Therapies (HF Endpoints).

(Note: CI = confidence interval; ns = not significant.)

Mechanical Complications of MI

Mechanical complications following MI, such as ventricular septal rupture (VSR), papillary muscle rupture, and left ventricular free wall rupture, are rare but carry high mortality when they do occur. In the era of reperfusion therapy, the incidence of these complications has fallen to less than 0.1% of MI patients. However, despite the decrease in incidence, mechanical complications remain associated with extremely high mortality when they occur (Gong et al., 2020).

For example, ventricular septal rupture (VSR), which causes a left-to-right shunt, occurs in about 0.2% of MI patients following early reperfusion. Similarly, papillary muscle rupture, which results in severe mitral regurgitation, occurs in approximately 0.1–0.3% of MI patients (Gong et al., 2020). Despite their rarity, these complications are dramatic, often presenting acutely within the first week post-MI, with symptoms of severe cardiogenic shock and pulmonary edema. Immediate echocardiography is essential for diagnosis, and early surgical repair is the gold standard for treatment. However, 30–50% operative mortality is common due to the critical state of patients and the fragility of infarcted tissue (Novák et al., 2015).

In some cases, transcatheter closure devices are being explored, especially for patients at high surgical risk, although surgical repair remains the most definitive treatment. The COVID-19 pandemic has had a significant impact on the incidence of mechanical complications, with delayed presentations leading to prolonged untreated infarctions and an increased incidence of mechanical complications.

Ventricular Remodeling after MI

Ventricular remodeling is a key process that leads to the development of heart failure post-MI. This process involves progressive myocardial injury, fibrosis, and ventricular dilation, which in turn leads to reduced ejection fraction and worsened cardiac function. The degree of remodeling after MI correlates with the long-term prognosis, with more severe remodeling resulting in higher rates of heart failure and mortality (Gabriel-Costa, 2018) .

Recent studies indicate that therapies which include angiotensin-converting enzyme (ACE) inhibitors, beta-blockers, and ARNI can slow the adverse ventricular remodeling process, though not fully prevent it (Kloner et al., 2015 Studies like the PARADISE-MI echo sub-study have shown that followed by sacubitril/valsartan therapy, reduces left ventricular enlargement in degree as opposed to ACE inhibitors, meaning that more aggressive neurohormonal blocks can alleviate some of the remodeling , despite these improvements, no therapy exists to date, that can reverse adverse remodelling (Kloner et al, 2015).

Therapies emerging for the treatment of fibrosis (such as anti fibrotic drugs etc) and stem cell therapies are under investigation, but have not yet demonstrated clinical benefit through well run large trials. Advanced imaging modalities, such as strain echocardiography and cardiac MRI, are also being studied to define patients at high risk for adverse remodeling, i.e., a potential object of personal treatment strategies.

Discussion

This synthesis of latest literature highlights key ideas in after myocardial infarction (MI) care and provides profound insight on HF prevention, arrhythmias, mechanical complications, ventricular remodeling. Although acute MI has been advanced by many great strides such reperfusion therapies, the long-term consequence of MI remain significant clinical problem. The results of latest clinical trials and observational studies, which are presented, indicate the advances to date and areas of unmet need in management of post-MI complications, especially the complexities of HF and ventricular remodeling.

Heart Failure Prevention and Challenges

The prevention of heart failure is still among the principal goals of the patients with post-MI management. Although chronic survival has greatly improved with reperfusion therapies, the burden of chronic heart failure remains high among the large number of MI survivors. Following

evidence of a modest reduction in HF hospitalization by the neurohormonal therapies including ARNI, (sacubitril/valsartan) and SGLT2 inhibitors (empagliflozin), these did not have a definite mortality benefit l in post-MI

Reported reductions in HF hospitalization in the EMPACT-MI and PARADISE-MI trials are rather small (around 10%) and relative risk reduction is not important, confirming the idea that the HF after MI is multifactorial (Gatto, 202 Associated factors including diabetes, chronic kidney diseases, and metabolic dysfunction accelerate the progression of heart failure, and personalized risk prediction and aggressive risk-factor management are needed. Targeted therapy outside the current neurohormonal blockade is needed to properly address the complexity of HF post-MI (Abel & Clark, 2021).

These results suggest that comprehensive secondary prevention strategies should be routinely implemented into clinical practice. Although neurohormonal therapy is fundamental, the need to consider early risk stratification, individualized treatment regimens, and innovative therapies needs to be studied to prevent the downstream effects of heart failure and ventricular remodeling in patients at high risk.

Arrhythmias after MI: Shifting Landscape and Mortality Risk

Although there has been significant improvement for its management, including the avoidance and treatment of severe arrhythmias, arrhythmias, in particular ventricular arrhythmias (VT/VF), remain vital causes of morbidity and mortality after MI. Reperfusion therapies have been effective in diminishing the incidence of life threatening ventricular arrhythmias. however their presence still indicates very severe MI or recurrent ischemia, with dramatic prognostic implications(Manfrini et al., 2020). Although relatively low incidence (~2% early, 1–2% late) of ventricular arrhythmias in modern MI cohorts is associated with significant short-term mortality risk. Early ventricular arrhythmias have an in – hospital 3.8 fold risk of death compared to late ventricular arrhythmias associated with 8.2 fold mortality risk (Deaconu et al., 2021).

The decline in the rate of incidence of ventricular arrhythmias with increasing time is heartening but the sustained presence of these arrhythmias in post-MI cases underlines the need for continuous monitoring. Telemetry monitoring and early intervention are nevertheless essential in the course of the acute MI to prevent sudden cardiac death. Permanent placement of ICD (implantable cardioverter-defibrillator) in the primary prevention is indicated in patients with left ventricular ejection fraction (LVEF) severely reduced despite the high-continued risk for arrhythmia after the acute stage (Pour-G

Furthermore, atrial fibrillation (AF) continues to be an important issue, in older MI survivors or the patients with heart failure. New-onset AF is found in up to 5-10% of MI patients and carries with it an excess mortality risk. Prompt anticoagulation therapy and rate/rhythm control requirement is of paramount importance in preventing stroke and reducing the clinical load of heart failure. Due to the increased occurrence of AF; customized strategies in managing the condition will be needed to enhance the long-term results of MI survivors (Lambert et al, 2021). Arrhythmia surveillance and electrophysiology consultation should be among these strategies, for high-risk people.

Mechanical Complications: Rare but Severe

Mechanical complication while rare, remains a major threat to post MI patients. Ventricular septal rupture (VSR), papillary muscle rupture, and left ventricular free wall rupture currently

occur in less than 0.1% of MI patients as a consequence of the improvements in reperfusion therapy. When they do occur, however, they present with very high mortality, in many cases owing to late diagnosis or late intervention (Gong et al., 2020). The Echocardiography diagnosis in the early stages plays an invaluable role because it greatly helps to promptly diagnose such complications early. Researchers point out that delayed care including the kind during the covid-19 pandemic lead to increased cases of mechanical complications and this underlines the need for timely access to care and early intervention that can save one from catastrophic outcomes(Evans et al., 2021).

In the last few years, percutaneous procedures including VSD occluders and transcatheter mitral valve repair have developed as good alternatives for patients to whom surgery cannot be performed(Damluji et al., 2021). Nevertheless, surgical repair is still the gold standard in repair of ventricular septal rupture and papillary muscle rupture. The multidisciplinary care and the heart teams are crucial in making timely decision in the patients with such serious complications.

Ventricular Remodeling: The Need for a Whole Approach

Ventricular remodelling is an unavoidable consequence for post-MI patients, and fibrosis, dilation of ventricle and hypertrophy of the heart muscle play a role in ventricular remodelling and the development of heart failure. The results of this review highlight an enduring problem with adverse ventricular remodeling which has been affecting post MI patients despite the use of current neurohormonal therapies (Janssens et al., 2023). Although therapies including ACE inhibitors, beta-blockers as well as SGLT2-inhibitors can retard remodeling and better the outcomes, they cannot totally stop the process.

The results demonstrate that metabolism and inflammatation causes, such as diabetes or obesity, worsen ventricular remodeling, hastening the progression toward to heart failure. Comprehensive secondary prevention strategies; (controlling diabetes, lowering of lipids and managing hypertension), are therefore essential in reducing remodeling impact. Moreover, personalized medicine approaches must be introduced to post-MI care because “one-size-fits-all” is not adequate for handling the complexity of this population. High risk patients for adverse remodeling are being diagnosed by advanced imaging modalities such as MRI with late gadolinium enhancement. Those biomarkers could be used to stratify risk and the aggressive therapy of high-risk patients and thus, probably, prevent the development of HF.

Conclusion

This review highlights the ongoing challenges in managing post-myocardial infarction (MI) complications, despite significant advances in acute care and reperfusion strategies. Heart failure (HF) remains the predominant long-term complication, with a substantial subset of MI survivors developing chronic HF, even with the use of modern neurohormonal therapies. While therapies such as SGLT2 inhibitors and ARNI show modest benefits in reducing HF hospitalizations, they have not significantly impacted all-cause mortality, underscoring the multifactorial nature of HF post-MI and the need for more innovative treatment strategies.

Arrhythmias, particularly ventricular arrhythmias (VT/VF) and atrial fibrillation (AF), continue to pose a substantial risk to MI survivors. Although the incidence of life-threatening ventricular arrhythmias has decreased, they remain strongly associated with increased mortality. Atrial fibrillation, particularly in the presence of heart failure, requires careful management to mitigate risks like stroke and worsening heart function. Continuous arrhythmia surveillance and timely interventions are critical for improving long-term outcomes.

The incidence of mechanical complications such as ventricular septal rupture and papillary muscle rupture has decreased due to modern reperfusion therapies, yet when they do occur, they carry extremely high mortality. Prompt diagnosis and surgical intervention are essential, particularly in the early stages following MI. Delayed care, as seen during the COVID-19 pandemic, highlights the importance of ensuring timely medical attention to prevent adverse outcomes.

Finally, ventricular remodeling remains a key contributor to long-term morbidity and the progression to heart failure. Current treatments can slow the remodeling process, but they do not fully prevent it. There is an urgent need for new therapies targeting myocardial recovery and fibrosis, as well as personalized treatment strategies based on advanced imaging and biomarkers.

In conclusion, while advancements in reperfusion and secondary prevention have reduced early mortality following MI, the long-term management of complications such as heart failure, arrhythmias, mechanical complications, and ventricular remodeling remains a significant clinical challenge. Future research should focus on innovative therapies to target myocardial recovery, early intervention in high-risk patients, and better risk stratification tools. A multidisciplinary approach—integrating guideline-directed medical therapy (GDMT), arrhythmia surveillance, and personalized care—will be essential in optimizing post-MI outcomes and reducing the burden of disease in MI survivors.

References

Abel, A., & Clark, A. L. (2021). Long-Term Pharmacological Management of Reduced Ejection Fraction Following Acute Myocardial Infarction: Current Status and Future Prospects [Review of Long-Term Pharmacological Management of Reduced Ejection Fraction Following Acute Myocardial Infarction: Current Status and Future Prospects]. International Journal of General Medicine, 7797. Dove Medical Press. https://doi.org/10.2147/ijgm.s294896

Arrhythmias After Acute Myocardial Infarction. (2023). https://www.studocu.com/es/document/universidad-catolica-de-valencia-san-vicente-martir/fisiopatologia-medica-y-quirurgica/arrhythmias-after-acute-myocardial-infarction/54335446

Bajaj, A., Sethi, A., Rathor, P., Suppogu, N., & Sethi, A. (2015). Acute Complications of Myocardial Infarction in the Current Era [Review of Acute Complications of Myocardial Infarction in the Current Era]. Journal of Investigative Medicine, 63(7), 844. SAGE Publishing. https://doi.org/10.1097/jim.0000000000000232

Blonde, L., Khunti, K., Harris, S. B., Meizinger, C., & SKOLNIK, N. (2018). Interpretation and Impact of Real-World Clinical Data for the Practicing Clinician [Review of Interpretation and Impact of Real-World Clinical Data for the Practicing Clinician]. Advances in Therapy, 35(11), 1763. Adis, Springer Healthcare. https://doi.org/10.1007/s12325-018-0805-y

Butler, J., Jones, W. S., Udell, J. A., Anker, S. D., Petrie, M. C., Harrington, J., Mattheus, M., Zwiener, I., Amir, O., Bahit, M. C., Bauersachs, J., Bayés-Genís, A., Chen, Y., Chopra, V., Figtree, G. A., Ge, J., Goodman, S. G., Gotcheva, N., Goto, S., … Hernandez, A. F. (2024). Empagliflozin after Acute Myocardial Infarction. New England Journal of Medicine, 390(16), 1455. https://doi.org/10.1056/nejmoa2314051

Cepeda, M. S., Berlin, J. A., Glasser, S., Battisti, W. P., & Schuemie, M. J. (2015). Use of Adjectives in Abstracts when Reporting Results of Randomized, Controlled Trials from Industry and Academia. Drugs in R&D, 15(1), 85. https://doi.org/10.1007/s40268-015-0085-9

Damluji, A. A., Diepen, S. van, Katz, J. N., Menon, V., Tamis-Holland, J. E., Bakitas, M., Cohen, M. G., Balsam, L. B., & Chikwe, J. (2021). Mechanical Complications of Acute Myocardial Infarction: A

Scientific Statement From the American Heart Association [Review of Mechanical Complications of Acute Myocardial Infarction: A Scientific Statement From the American Heart Association]. Circulation, 144(2). Lippincott Williams & Wilkins. https://doi.org/10.1161/cir.0000000000000985

Deaconu, A., Deaconu, S., Radu, A., & Dorobanţu, M. (2021). Pharmacological Treatment of Tachyarrhythmias in Acute Myocardial Infarction - a Review [Review of Pharmacological Treatment of Tachyarrhythmias in Acute Myocardial Infarction - a Review]. Romanian Journal of Cardiology, 31(2), 311. https://doi.org/10.47803/rjc.2021.31.2.311

Durko, A. P., Budde, R. P. J., Geleijnse, M. L., & Kappetein, A. P. (2017). Recognition, assessment and management of the mechanical complications of acute myocardial infarction [Review of Recognition, assessment and management of the mechanical complications of acute myocardial infarction]. Heart, 104(14), 1216. BMJ. https://doi.org/10.1136/heartjnl-2017-311473

Evans, M. C., Steinberg, D., Rhodes, J. F., & Tedford, R. J. (2021). Ventricular septal defect complicating delayed presentation of acute myocardial infarction during COVID-19 lockdown: a case report. European Heart Journal - Case Reports, 5(2). https://doi.org/10.1093/ehjcr/ytab027

Gabriel-Costa, D. (2018). The pathophysiology of myocardial infarction-induced heart failure [Review of The pathophysiology of myocardial infarction-induced heart failure]. Pathophysiology, 25(4), 277. Multidisciplinary Digital Publishing Institute. https://doi.org/10.1016/j.pathophys.2018.04.003

Gatto, L. (2021). Does sacubitril/valsartan work in acute myocardial infarction? The PARADISE-AMI study. European Heart Journal Supplements, 23. https://doi.org/10.1093/eurheartj/suab098

Gong, F., Vaitenas, I., Malaisrie, S. C., & Maganti, K. (2020). Mechanical Complications of Acute Myocardial Infarction [Review of Mechanical Complications of Acute Myocardial Infarction]. JAMA Cardiology, 6(3), 341. American Medical Association. https://doi.org/10.1001/jamacardio.2020.3690

Guo, W., Lv, C., Guo, M., Zhao, Q. C., Yin, X., & Zhang, L. (2023). Innovative applications of artificial intelligence in zoonotic disease management [Review of Innovative applications of artificial intelligence in zoonotic disease management]. Science in One Health, 2, 100045. Elsevier BV. https://doi.org/10.1016/j.soh.2023.100045

Hæusler, K. G., Gerth, A., Limbourg, T., Tebbe, U., Oeff, M., Wegscheider, K., Treszl, A., Ravens, U., Meinertz, T., Kirchhof, P., Breithardt, G., Steinbeck, G., & Näbauer, M. (2015). Use of vitamin K antagonists for secondary stroke prevention depends on the treating healthcare provider in Germany – results from the German AFNET registry. BMC Neurology, 15(1). https://doi.org/10.1186/s12883-015-0371-8

Hariton, E., & Locascio, J. J. (2018). Randomised controlled trials – the gold standard for effectiveness research. BJOG An International Journal of Obstetrics & Gynaecology, 125(13), 1716. https://doi.org/10.1111/1471-0528.15199

Htoo, P. T., Tesfaye, H., Schneeweiß, S., Wexler, D. J., Everett, B. M., Glynn, R. J., Schmedt, N., Koeneman, L., Déruaz-Luyet, A., Paik, J. M., & Patorno, E. (2024). Effectiveness and safety of empagliflozin: final results from the EMPRISE study. Diabetologia, 67(7), 1328. https://doi.org/10.1007/s00125-024-06126-3

Janssens, K. L. P. M., Kraamer, M., Barbarotta, L., & Bovendeerd, P. H. M. (2023). Post-infarct evolution of ventricular and myocardial function. Biomechanics and Modeling in Mechanobiology, 22(6), 1815. https://doi.org/10.1007/s10237-023-01734-1

Jenča, D., Melenovský, V., Stehlik, J., Staněk, V., Kettner, J., Kautzner, J., Adámkova, V., & Wohlfahrt, P. (2020). Heart failure after myocardial infarction: incidence and predictors [Review of Heart failure after myocardial infarction: incidence and predictors]. ESC Heart Failure, 8(1), 222. Wiley. https://doi.org/10.1002/ehf2.13144

Kloner, R. A., Shi, J., & Dai, W. (2015). New therapies for reducing post-myocardial left ventricular

remodeling. PubMed, 3(2), 20. https://doi.org/10.3978/j.issn.2305-5839.2015.01.13

Lambert, C. T., Patel, D., Bumgarner, J. M., Kanj, M., Cantillon, D. J., Saliba, W. I., Hussein, A. A., Baranowski, B., Dresing, T., Chung, M. K., Rickard, J., Varma, N., Callahan, T. D., Martín, D., Tchou, P., Bhargava, M., Wolski, K., Wazni, O. M., & Tarakji, K. G. (2021). Atrial fibrillation future clinic. Novel platform to integrate smart device electrocardiogram into clinical practice. Cardiovascular Digital Health Journal, 2(2), 92. https://doi.org/10.1016/j.cvdhj.2021.02.002

Lu, L., Ma, X., Zheng, J., Li, L., Yang, W.-N., Kong, Y., & Wang, J. (2020). Quercetin for myocardial ischemia reperfusion injury. Medicine, 99(26). https://doi.org/10.1097/md.0000000000020856

Manfrini, O., Cenko, E., & Bugiardini, R. (2020). Arrhythmias of subacute phase of myocardial infarction. In Elsevier eBooks (p. 571). Elsevier BV. https://doi.org/10.1016/b978-0-12-817728-0.00051-6

Novák, M., Hlinomaz, O., Groch, L., Rezek, M., Seménka, J., Sikora, J., & Sitar, J. (2015). Ventricular Septal Rupture – A Critical Condition as a Complication of Acute Myocardial Infarction. ˜The œJournal of Critical Care Medicine, 1(4), 162. https://doi.org/10.1515/jccm-2015-0030

Peck, R., Shah, P., Vamvakas, S., & Graaf, P. H. van der. (2020). Data Science in Clinical Pharmacology and Drug Development for Improving Health Outcomes in Patients. In Clinical Pharmacology & Therapeutics (Vol. 107, Issue 4, p. 683). Wiley. https://doi.org/10.1002/cpt.1803

Peksiene, D. Z., & Portačenko, J. (2017). Left Ventricular Remodeling after Acute Myocardial Infarction and Biomarkers. Journal of Cardiovascular Diseases & Diagnosis, 5(5). https://doi.org/10.4172/2329-9517.1000291

Pour-Ghaz, I., Heckle, M., Ifedili, I., Kayali, S., Nance, C., Kabra, R., Jha, S., Jefferies, J. L., & Levine, Y. C. (2021). Beyond Ejection Fraction: Novel Clinical Approaches Towards Sudden Cardiac Death Risk Stratification in Patients with Dilated Cardiomyopathy [Review of Beyond Ejection Fraction: Novel Clinical Approaches Towards Sudden Cardiac Death Risk Stratification in Patients with Dilated Cardiomyopathy]. Current Cardiology Reviews, 18(2). Bentham Science Publishers. https://doi.org/10.2174/1573403x17666210804125939

Prabhu, S. D., & Frangogiannis, N. G. (2016). The Biological Basis for Cardiac Repair After Myocardial Infarction [Review of The Biological Basis for Cardiac Repair After Myocardial Infarction]. Circulation Research, 119(1), 91. Lippincott Williams & Wilkins. https://doi.org/10.1161/circresaha.116.303577

Rajagopal, K., Keller, S. P., Akkanti, B., Bime, C., Loyalka, P., Cheema, F. H., Zwischenberger, J. B., Banayosy, A. E., Pappalardo, F., Slaughter, M. S., & Slepian, M. J. (2020). Advanced Pulmonary and Cardiac Support of COVID-19 Patients. Circulation Heart Failure, 13(5). https://doi.org/10.1161/circheartfailure.120.007175

Riva, A., Golda, A., Balagura, G., Amadori, E., Vari, M. S., Piccolo, G., Iacomino, M., Lattanzi, S., Salpietro, V., Minetti, C., & Striano, P. (2021). New Trends and Most Promising Therapeutic Strategies for Epilepsy Treatment [Review of New Trends and Most Promising Therapeutic Strategies for Epilepsy Treatment]. Frontiers in Neurology, 12. Frontiers Media. https://doi.org/10.3389/fneur.2021.753753

Sachdeva, P., Kaur, K., Fatima, S., Mahak, F., Noman, M. Z., Siddenthi, S. M., Surksha, M. A., Munir, M., Fatima, F., Sultana, S. S., Varrassi, G., Khatri, M., Kumar, S., Elder, M., & Mohamad, T. (2023). Advancements in Myocardial Infarction Management: Exploring Novel Approaches and Strategies [Review of Advancements in Myocardial Infarction Management: Exploring Novel Approaches and Strategies]. Cureus. Cureus, Inc. https://doi.org/10.7759/cureus.45578

Savarese, G., Becher, P. M., Lund, L. H., Seferović, P., Rosano, G., & Coats, A. J. S. (2022). Global burden of heart failure: a comprehensive and updated review of epidemiology [Review of Global burden of heart failure: a comprehensive and updated review of epidemiology]. Cardiovascular Research,

118(17), 3272. Oxford University Press. https://doi.org/10.1093/cvr/cvac013

Savarese, G., & Lund, L. H. (2017). Global Public Health Burden of Heart Failure. Cardiac Failure Review, 3(1), 7. https://doi.org/10.15420/cfr.2016:25:2

Schirone, L., Forte, M., D'Ambrosio, L., Valenti, V., Vecchio, D., Schiavon, S., Spinosa, G., Sarto, G., Petrozza, V., Frati, G., & Sciarretta, S. (2022). An Overview of the Molecular Mechanisms Associated with Myocardial Ischemic Injury: State of the Art and Translational Perspectives [Review of An Overview of the Molecular Mechanisms Associated with Myocardial Ischemic Injury: State of the Art and Translational Perspectives]. Cells, 11(7), 1165. Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/cells11071165

Schweizer, M. L., Braun, B. I., & Milstone, A. M. (2016). Research Methods in Healthcare Epidemiology and Antimicrobial Stewardship—Quasi-Experimental Designs. Infection Control and Hospital Epidemiology, 37(10), 1135. https://doi.org/10.1017/ice.2016.117

Shah, J. A., Naz, F., Kumar, R., Hassan, M., Shah, G. A., Ahmed, K., Hussain, J., Abid, K., & Karim, M. (2021). Incidence of Cardiac Arrhythmias in Acute Myocardial Infarction Patients Undergoing Primary Percutaneous Coronary Intervention and Associated Outcomes During the First 24 Hours. Cureus. https://doi.org/10.7759/cureus.12599

Shao, S., Lin, Y.-H., Chang, K.-C., Chan, Y.-Y., Hung, M., Yang, Y. K., & Lai, E. C. (2019). Sodium glucose co-transporter 2 inhibitors and cardiovascular event protections: how applicable are clinical trials and observational studies to real-world patients? BMJ Open Diabetes Research & Care, 7(1). https://doi.org/10.1136/bmjdrc-2019-000742

Sutanto, H., Dobrev, D., & Heijman, J. (2021). Angiotensin Receptor-Neprilysin Inhibitor (ARNI) and Cardiac Arrhythmias [Review of Angiotensin Receptor-Neprilysin Inhibitor (ARNI) and Cardiac Arrhythmias]. International Journal of Molecular Sciences, 22(16), 8994. Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/ijms22168994

Torres, Y. C., & Katholi, R. E. (2018). Recently Approved and Under Investigation Drugs for Treating Patients with Heart Failure [Review of Recently Approved and Under Investigation Drugs for Treating Patients with Heart Failure]. Current Cardiology Reviews, 16(3), 202. Bentham Science Publishers. https://doi.org/10.2174/1573403x14666180702151626

Zhao, W., Zhao, J., & Rong, J. (2020). Pharmacological Modulation of Cardiac Remodeling after Myocardial Infarction [Review of Pharmacological Modulation of Cardiac Remodeling after Myocardial Infarction]. Oxidative Medicine and Cellular Longevity, 2020, 1. Hindawi Publishing Corporation. https://doi.org/10.1155/2020/8815349

Zhao, X., Chen, H., Xiao, D., Yang, H., Itzhaki, I., Qin, X., Chour, T., Aguirre, A., Lehmann, K. A., Kim, Y., Shukla, P., Holmström, A., Zhang, J. Z., Zhuge, Y., Ndoye, B., Zhao, M., Neofytou, E., Zimmermann, W., Jain, M., & Wu, J. C. (2018). Comparison of Non-human Primate versus Human Induced Pluripotent Stem Cell-Derived Cardiomyocytes for Treatment of Myocardial Infarction. Stem Cell Reports, 10(2), 422. https://doi.org/10.1016/j.stemcr.2018.01.002.