

THE ROLE OF TELEHEALTH INTERVENTIONS IN MYOCARDIAL INFARCTIONS DURING THE COVID-19 PANDEMIC: A SYSTEMATIC REVIEW

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ABSTRACT

Background: The COVID-19 pandemic has significantly affected healthcare delivery worldwide, necessitating innovative solutions such as telehealth to continue providing care. This review aims to explore the role of telehealth interventions in the management of myocardial infarctions (MIs) during the pandemic. **Methods:** A systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement 2020 guidelines. Literature from PubMed, Scopus, and Web of Science was searched for studies published after the year 2020, focusing on telehealth interventions in managing MIs during the COVID-19 pandemic. Studies were screened based on relevance, and data was extracted and synthesized qualitatively. **Results:** The review included six studies, mainly from China and the USA, with a total of over 9,700 patients. The results demonstrated the utilization of telemedicine apps and platforms during the pandemic to manage acute MI patients. Telehealth interventions were found to reduce systemic delays and improve follow-up rates. A study from the USA noted improved 7-day follow-up rates and decreased 30-day readmission rates. However, challenges such as digital divide and lack of digital literacy were highlighted, highlighting the need for more accessible and user-friendly telehealth solutions. **Conclusion:** Telehealth interventions show promise in improving the management of MI patients during the COVID-19 pandemic. They can potentially contribute to reducing systemic delays, enhancing follow-up rates, and possibly improving clinical outcomes. However, it is critical to address the associated challenges to ensure equitable access and benefits. More rigorous and diverse research is required to deepen our understanding of the relationship between telehealth and MI outcomes.

KEYWORDS: COVID-19, Myocardial Infarctions, Telehealth, Telemedicine, Systemic Delays, Follow-Up Rates, Digital Divide.

INTRODUCTION

The novel coronavirus disease 2019 (COVID-19) pandemic has revolutionized global healthcare delivery, leading to a dramatic shift towards telehealth services.^[1] With limited in-person healthcare access and the goal to minimize potential virus transmission, telehealth emerged as a pivotal medium to continue providing care to patients across various medical disciplines, including cardiology.^[2,3] Particularly, the management of myocardial infarction (MI), a time-sensitive and critical

medical event, has witnessed a significant transformation due to the incorporation of telehealth services.^[4]

In the pre-pandemic era, telemedicine had been applied in cardiology, predominantly for monitoring heart failure and arrhythmia patients.^[5] However, the unique challenges posed by the pandemic called for innovative strategies to manage acute cardiac conditions such as MIs.^[6] Telehealth offered a means to circumvent obstacles such as delayed presentation, reduced hospital capacity, and increased risk of cross-infection.^[7] Yet,

while its usage has undoubtedly expanded, the impact of telehealth interventions on clinical outcomes in MI patients during the COVID-19 pandemic remains uncertain at best.^[8]

Despite the uncertainty, a growing body of literature has begun exploring this new realm, and several studies have offered preliminary insights into the impact of telehealth in managing MIs during the pandemic.^[9] For instance, some studies have reported shortened time-to-treatment for MI patients who utilized telehealth services for initial consultations, while others have noted improved follow-up rates and patient satisfaction.^[10,11] Moreover, the use of telemedicine has also demonstrated potential in reducing hospital readmission rates by providing comprehensive post-discharge care remotely.^[12] Such findings highlight the possible benefits of telehealth in acute cardiac care but also emphasize the need for further investigation.

The evolution of telehealth in MI management during the COVID-19 pandemic necessitates a systematic review of the current evidence. Assessing the efficacy and practicality of telehealth interventions in real-world settings will provide valuable insights to inform future practice. This systematic review aims to scrutinize the role of telehealth interventions in the management of MI patients during the COVID-19 pandemic. Specifically, it will focus on key clinical outcomes. The objective is not only to understand the current role of telehealth in this context but also to identify potential areas for improvement and future research directions, thus paving the way for more effective, efficient, and patient-centered MI care.^[13]

METHODS

The methodology for this systematic review was developed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement 2020 guidelines.^[14] The review aimed to provide a comprehensive examination of recent literature assessing the role and impact of telemedicine in managing acute myocardial infarction (MI) during the COVID-19 pandemic.

Search strategy

A systematic literature search was conducted focusing on research published within the last five years, ensuring the incorporation of the most recent and thus, most relevant studies. The search was carried out on three databases,

namely PubMed, Scopus, and Web of Science for relevant studies. Keywords and MeSH terms such as 'Telemedicine', 'Myocardial Infarction', 'COVID-19', 'Management', 'Impact', and their combinations were used for the search. No restrictions were imposed based on language or geographical location, and only peer-reviewed articles were considered for inclusion.

Study selection

The articles retrieved from the initial search were independently screened by two reviewers based on their titles and abstracts for relevance to the topic of MI and the use of telemedicine in its management during the COVID-19 pandemic. Any discrepancies between the reviewers were resolved through discussion or consultation with a third reviewer if needed. The full texts of the shortlisted articles were obtained for further in-depth scrutiny. Studies were included if they met the following criteria: original research studies published after 2020, studies focusing on telemedicine approaches in managing MI during the COVID-19 pandemic, and studies that provided sufficient data for extraction and analysis.

Data Extraction and Synthesis

Data from the included studies were systematically extracted by the research team. The data extracted encompassed the following details: author names, year of publication, study design, intervention, duration of monitoring, findings. The extracted data were then synthesized and analyzed qualitatively. The key findings were consolidated and summarized, and the results were categorized based on the study design, intervention, and findings. This provided an overview of the current state of telemedicine applications in MI management during the COVID-19 pandemic. The synthesis also highlighted the potential impact of these studies on the field of MI management and identified gaps in the existing research for future exploration.

RESULTS

A total of 147 studies were originally identified through the database search. Of these 13 duplicates were removed. Therefore, a total of 134 studies were screened for titles and abstracts, of which 27 were retrieved for full-texts. Of these 6 studies were included in this study. The study selection process is depicted in **Figure 1**. The characteristics of the included studies are presented in **Table 1**.

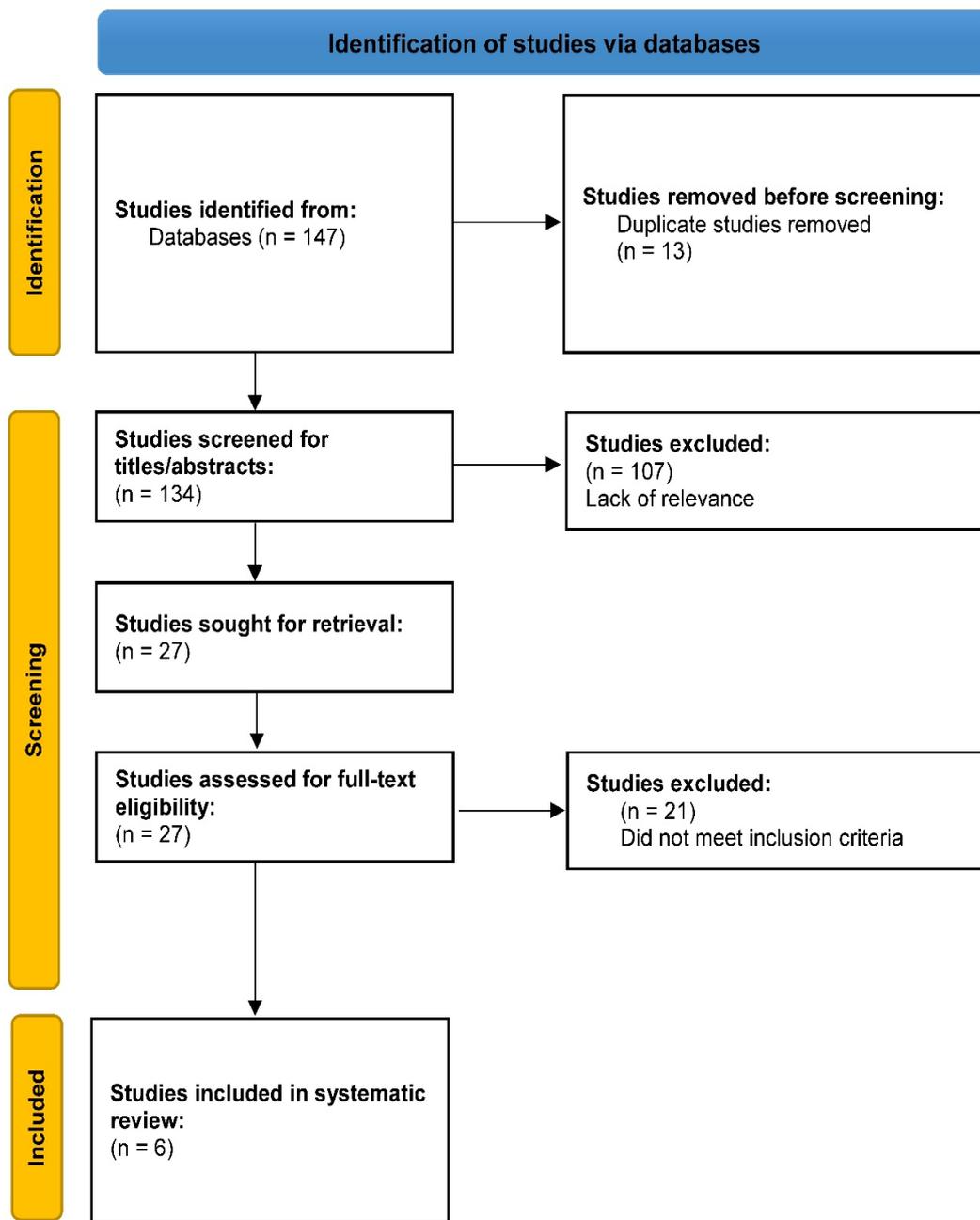


Figure 1: PRISMA flowchart depicting the study selection process.

Table 1: Characteristics of the Included Studies (N=6).

Author, Year	Title	Study Type	Country	N	Intervention	Duration of Monitoring	Findings
Nan, 2020 (15)	Comparison of Clinical Outcomes in Patients with ST Elevation Myocardial Infarction with Percutaneous Coronary Intervention and	Comparative Study	China	243	Use of a telemedicine app in addition to percutaneous coronary intervention (PCI)	August 2019 - March 2020	The time from symptom onset to calling an ambulance (SCT), door to balloon time (DTB), and total ischemia time (TIT) were significantly prolonged in patients after the pandemic.

	the Use of a Telemedicine App Before and After the COVID-19 Pandemic at a Center in Beijing, China, from August 2019 to March 2020						Patients who used the app had shorter SCT, DTB, and TIT compared to those who did not, both before and after the pandemic. However, there was no significant difference in short-term adverse clinical outcomes between patients who used the app and those who did not before and after the pandemic.
Nan, 2020 (16)	The Impact of the COVID-19 Pandemic and the Importance of Telemedicine in Managing Acute ST Segment Elevation Myocardial Infarction Patients: Preliminary Experience and Literature Review	Observational Study	China	6000+	Use of the Tiantanzhixin smartphone app	Not specified	Patients using the app had shorter systemic delays compared to those who did not. Three-month follow-up interactions indicated that the STEMI patients who used the app presented higher left ventricular ejection fractions and lower left ventricular end-diastolic diameters. There was also an increase in patient satisfaction during hospitalization. Other telemedicine tools, in general, showed promise in managing various cardiovascular diseases including AMI, hypertension, heart failure, and arrhythmias.
Collyer, 2021 (17)	Impact of COVID-19 lockdowns on hospital presentations and admissions in the context of low community transmission: evidence from time series analysis in Melbourne, Australia	Observational Study	Australia	173 (ED presentations for MI), 221 (acute admissions for MI)	COVID-19 Lockdowns & Switch to telemedicine	March 1 - September 20, 2020	For myocardial infarction cases, observed ED presentations (175) and acute admissions (213) were close to the expected range, suggesting that even during lockdowns and a switch to telemedicine, individuals with serious conditions like myocardial infarctions were still able to receive appropriate care.

Hughes, 2022 (18)	Racial and Socioeconomic Differences in Heart Failure Hospitalizations and Telemedicine Follow-up During the COVID-19 Pandemic: Retrospective Cohort Study	Retrospective Cohort Study	USA	1162 (HF admissions)	Shift to Telemedicine during COVID-19 pandemic	March 15 - June 1, 2020 compared to the same time frame in 2019	There were fewer admissions for acute decompensated heart failure (ADHF) in 2020 (442) compared to 2019 (720). Higher rates of ICU admission in 2020 were noted (15.8% vs 11.1%), particularly for patients from the highest income quartile. Telemedicine accounted for 81.6% of 7-day follow-ups in 2020 and improved 7-day follow-up rates from 29.6% in 2019 to 40.5% in 2020. There were decreases in racial and income-based disparities in 7-day follow-up, and patients who had telemedicine follow-ups were less likely to be readmitted in 30 days compared to those who had no follow-up (13.8% vs 22.4%).
Tang, 2022 (19)	Investigating the Association Between Telemedicine Use and Timely Follow-Up Care After Acute Cardiovascular Hospital Encounters	Retrospective Cohort Study	USA	6026	Implementation of telemedicine for follow-ups after hospital encounters for acute cardiovascular conditions	Patients were monitored for their 14-day post-discharge follow-up and 30-day all-cause unplanned readmission rates	During the pandemic steady-state period, 40% of follow-ups after these encounters were conducted via telemedicine, as opposed to 0% during the week-matched period in 2019. The 14-day follow-up rates increased slightly from 41.7% in 2019 to 44.9% in 2020 (adjusted difference: +2.0 percentage points [pp], P=0.20). The most significant improvement was observed in heart failure encounters, where follow-up rates increased from 50.1% in 2019 to 55.5% in 2020 (adjusted difference: +6.5 pp, P=0.03). The 30-day all-cause unplanned

							readmission rates fell slightly from 18.3% in 2019 to 16.9% in 2020 (adjusted difference -1.6 pp, P=0.20)
Liu, 2022 (20)	The Impacts of COVID-19 on Healthcare Quality in Tertiary Medical Centers—A Retrospective Study on Data from Taiwan Clinical Performance Indicators System	Retrospective Study on Data from Taiwan Clinical Performance Indicators System	Taiwan	Not specified	Observation of changes in healthcare services during the COVID-19 pandemic (Various healthcare quality indicators were used including ST elevation myocardial infarction (STEMI) patients, emergency patients, etc.)	January 2019 to December 2020 (2019 as the baseline period and 2020 as the period after the start of the COVID-19 outbreak)	The proportion of ST-elevation myocardial infarction (STEMI) patients receiving primary percutaneous coronary intervention (PPCI) within 90 min after arrival at the emergency room (ER) was one of the healthcare quality indicators analyzed. Significant regional variations in healthcare quality indicators were observed among medical centers in northern and middle/southern Taiwan.

Abbreviations: ST - ST Segment (a specific part of the electrocardiogram); MI - Myocardial Infarction (also known as a heart attack); PCI - Percutaneous Coronary Intervention (a non-surgical procedure to treat the stenotic coronary artery); COVID-19 - Coronavirus Disease 2019; SCT - Symptom onset to Calling an ambulance Time; DTB - Door to Balloon time (a quality measure in patients with MI, represents the time from entering the hospital to opening the blocked artery); TIT - Total Ischemia Time (the time from the onset of symptoms to the time of reperfusion); STEMI - ST Elevation Myocardial Infarction (a type of heart attack); ED - Emergency Department; HF - Heart Failure; ICU - Intensive Care Unit; ADHF - Acute Decompensated Heart Failure (a sudden or gradual worsening of heart failure symptoms); PPCI - Primary Percutaneous Coronary Intervention (an emergent percutaneous coronary intervention for the treatment of STEMI); ER - Emergency Room; pp - Percentage points.

In a comparative study by Nan (2020) conducted in Beijing, China, the use of a telemedicine app in combination with percutaneous coronary intervention (PCI) was examined in 243 patients.^[15] The study found significant prolongations in symptom onset to calling an ambulance, door to balloon time, and total ischemia time in patients post-pandemic. However, patients using the telemedicine app experienced shorter times in these measures both pre- and post-pandemic, with no significant differences in short-term adverse clinical outcomes between the app users and non-users pre- and post-pandemic.

A second observational study by Nan (2020) examined over 6000 patients using the Tiantanzhixin smartphone app for managing Acute ST Segment Elevation Myocardial Infarction (STEMI).^[16] Patients using the app had shorter systemic delays, and upon three-month follow-up, these patients had higher left ventricular ejection fractions and lower left ventricular end-diastolic diameters. Notably, there was an increase in patient satisfaction during hospitalization, and telemedicine tools showed promise in managing various cardiovascular diseases.

In Australia, Collyer (2021) studied the impact of COVID-19 lockdowns on hospital presentations and admissions for myocardial infarction in Melbourne, during which telemedicine was implemented.^[17] The study found that even amidst lockdowns and the switch to telemedicine, there was no significant drop in the expected range of myocardial infarction cases presented and admitted to the emergency department, suggesting that telemedicine facilitated appropriate care delivery.

Hughes (2022) conducted a retrospective cohort study in the USA, focusing on racial and socioeconomic differences in heart failure hospitalizations and telemedicine follow-up during the COVID-19 pandemic.^[18] The study found fewer admissions for acute decompensated heart failure (ADHF) in 2020 compared to 2019. Telemedicine accounted for over 80% of the 7-day follow-ups in 2020 and resulted in improved follow-up rates, decreased racial and income-based disparities in

follow-ups, and fewer 30-day readmission rates among patients with telemedicine follow-ups.

Tang (2022) conducted a retrospective cohort study with 6026 patients in the USA investigating the association between telemedicine use and timely follow-up care after acute cardiovascular hospital encounters.^[19] The study found that during the pandemic, telemedicine follow-ups increased from 0% to 40%, leading to a slight improvement in the 14-day follow-up rates and a decrease in 30-day all-cause unplanned readmission rates, especially for heart failure encounters.

Liu (2022) conducted a retrospective study in Taiwan, examining changes in healthcare services during the COVID-19 pandemic using the Taiwan Clinical Performance Indicators System.^[20] The study found significant regional variations in healthcare quality indicators, including the proportion of STEMI patients receiving primary percutaneous coronary intervention (PPCI) within 90 minutes of arrival at the emergency room.

DISCUSSION

The COVID-19 pandemic has undoubtedly catalyzed a significant shift in the delivery of healthcare services worldwide, with telemedicine becoming a key player in maintaining the continuum of care during this unprecedented time. In the realm of cardiovascular medicine, and more specifically MIs, the role of telehealth interventions has been underlined as never before. This systematic review offers an encompassing analysis of recent literature on the application and outcomes of telehealth interventions for MI management during the COVID-19 pandemic, highlighting a number of key findings.

A significant observation from our review was the potential of telehealth services to reduce systemic delays in MI care. Two studies from China involving more than 6000 patients demonstrated that telemedicine apps were associated with shortened time intervals from symptom onset to calling an ambulance (SCT), from hospital door to balloon time (DTB), and total ischemia time (TIT).^[15,16] Such findings align with those of Wosik *et al.* who highlighted the capacity of virtual care to circumvent traditional systemic barriers and expedite care.^[9]

Similarly, telemedicine was also associated with improved follow-up rates post-MI, which is a crucial determinant of long-term patient outcomes. A retrospective study involving over 6000 patients in the United States showed that 40% of the 14-day post-discharge follow-ups were conducted via telemedicine during the pandemic.^[19] This is particularly notable considering that telehealth follow-ups were virtually non-existent during the corresponding period in the previous year. The application of telehealth seems to have particularly benefited heart failure patients, who

showed a significant increase in follow-up rates, from 50.1% in 2019 to 55.5% in 2020.^[19]

In addition to improved follow-up rates, there was a slight reduction in 30-day all-cause unplanned readmission rates for acute cardiovascular conditions during the pandemic, from 18.3% in 2019 to 16.9% in 2020.^[19] This finding supports the work of Dendale *et al.*, who found that telemedicine follow-up reduced hospital readmissions in heart failure patients.^[21]

In terms of clinical outcomes, the studies provided mixed results. While there was no significant difference in short-term adverse clinical outcomes in MI patients who used telemedicine apps compared to those who did not,^[15] one Chinese study reported that STEMI patients who used the Tiantanzhixin app presented higher left ventricular ejection fractions and lower left ventricular end-diastolic diameters at three-month follow-ups.^[16] More research is needed to clarify the impact of telehealth interventions on clinical outcomes in MI patients.

Despite the potential benefits, several challenges exist. Foremost among them is the digital divide, which could limit access to telehealth services among certain populations, especially the elderly, low-income, and rural residents. This concern is reinforced by a US study which showed decreases in racial and income-based disparities in 7-day follow-ups during the pandemic.^[18] In response, there is a need for initiatives to improve digital literacy and access to ensure that telehealth benefits are more evenly distributed across different demographics.

Limitations

Certain limitations exist; first, the review was based predominantly on observational and retrospective studies, which are inherently susceptible to bias and confounding factors. Also, the studies varied in terms of the type and duration of telehealth interventions and the clinical outcomes measured, which limited the comparability of the results. Lastly, most of the included studies were from China and the USA, potentially limiting the generalizability of our findings to other settings and populations.

Recommendations

Several recommendations can be made. Future research should aim for greater methodological rigor, ideally employing randomized controlled trials to ascertain the impact of telehealth interventions on MI outcomes. Additionally, it would be beneficial to have standardized outcome measures for more effective comparisons across studies. To address the issue of the digital divide, policymakers should focus on enhancing the digital literacy of the population, improving the availability of affordable internet services, and ensuring that telehealth platforms are user-friendly, especially for older adults. Lastly, future research should strive for a more diverse

geographic representation to better understand the role of telehealth globally.

CONCLUSION

In conclusion, this systematic review brings to light the potential of telehealth interventions in the management of myocardial infarctions during the COVID-19 pandemic. The integration of digital health technology into standard care may play a pivotal role in reducing systemic delays, enhancing follow-up rates, and potentially improving clinical outcomes. However, it is essential to acknowledge and address the associated challenges, such as the differences in digital literacy among differential populations, to ensure equitable access and benefit. Furthermore, a deeper understanding of the relationship between telehealth and MI outcomes is required and should be facilitated by more rigorous and diverse research in the future. As we navigate the ongoing transformation of healthcare catalyzed by the pandemic, the seamless integration of telehealth into routine care will be vital in enhancing the management and prognosis of patients with myocardial infarctions and other cardiovascular conditions. The lessons learned in this crisis provide us an invaluable opportunity to enhance the future of cardiovascular care.

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