MEDPHARMRES
pISSN : 1859-1779 | eISSN : 2615-9139

Original Article
MedPharmRes 2025;9(3):356-366
https://doi.org/10.32895/MPR.24.00083

Effectiveness of clinical pharmacist interventions on improving the appropriateness of prescription and treatment outcomes for acute myocardial infarction patients: a before-after study at a Vietnamese hospital

Nhu Quynh Tran[1,2], Tan Van Nguyen[3,4], Quynh Thi Huong Bui[1,2,*]

[1]*Deparment of Clinical Pharmacy, Faculty of Pharmacy, University of Medicine and Pharmacy at Ho Chi Minh City, Ho Chi Minh City, Vietnam*
[2]*Department of Pharmacy, Thong Nhat Hospital, Ho Chi Minh City, Vietnam*
[3]*Department of Geriatrics and Gerontology, University of Medicine and Pharmacy at Ho Chi Minh City, Ho Chi Minh City, Vietnam*
[4]*Department of Interventional Cardiology, Thong Nhat Hospital, Ho Chi Minh City, Vietnam*

Abstract

Introduction: Acute myocardial infarction (AMI) is a leading cause of global morbidity and mortality. Clinical pharmacist intervention offers a promising approach to improve prescription appropriateness and treatment outcomes. This study evaluated the impact of this intervention in treatment for AMI patients.

Methods: A retrospective before-and-after study was conducted on all AMI patients at the Department of Interventional Cardiology, comparing two phases. The *pre* phase was designed without clinical pharmacist intervention (August 1, 2019, to December 31, 2019) and the *post* phase with the participation of clinical pharmacists in the prescription process (August 1, 2022, to December 31, 2022); with 6-month post-AMI follow-up periods in each phase. The impact of interventions was evaluated by comparing appropriateness of prescription, treatment outcomes, and adverse drug events (ADEs) between the two phases.

Results: The study included 183 and 211 patients in the *pre* and *post* phases, respectively. The overall rates of prescription appropriateness were significantly higher in the *post* phase (85.8% vs. 48.6%, p<0.001). The mortality rates within 6 months of AMI discharge in the two phases were 18.6% and 16.5%, respectively (p=0.604). The proportions of patients who experienced ADEs were 57.4% and 56.4%, respectively (p=0.845). Clinical pharmacist interventions were associated with a higher rate of overall prescription appropriateness (OR: 6.734; 95% CI: 4.098–11.065; p<0.001).

Conclusions: Clinical pharmacist interventions significantly improved the appropriateness of prescription for AMI treatment but did not reduce occurrence of mortality or ADE.

Keywords: clinical pharmacist; drug prescription; myocardial infarction

1. INTRODUCTION

Acute myocardial infarction (AMI) is an ischemic syndrome-induced myocardial necrosis [1]. AMI is the leading

Received: Dec 4, 2024 / Revised: Mar 7, 2025 / Accepted: Mar 11, 2025
*Corresponding author: Quynh Thi Huong Bui. Deparment of Clinical Pharmacy, Faculty of Pharmacy, University of Medicine and Pharmacy at Ho Chi Minh City, Ho Chi Minh City, Vietnam. E-mail: bthquynh@ump.edu.vn

cause of morbidity and mortality worldwide, responsible for over 15% of annual mortality [2] and creates significant economic burden on the society [3]. Currently, the main treatment approach for AMI focuses on optimal medical therapy, percutaneous coronary intervention (PCI) and coronary artery bypass grafting to restore perfusion, prevent further myocardial necrosis and severe cardiovascular events [1,4,5]. The incidence of AMI and rates of associated mortality have decreased in some developed countries [2]. This is probably influenced by the innovation and strengthening of healthcare systems, and advances in treatment management [2]. However, patients with AMI are often treated with polypharmacy [4,5], which increases the risk of adverse drug events (ADEs). ADEs are associated with escalated morbidity and mortality, prolonged hospitalization, and increased healthcare costs [6]. Therefore, during therapy, patients must be carefully monitored for the benefits and risks from drug regimens, to optimize their treatment effectiveness and safety. Adherence to clinical practice guidelines for the treatment of AMI and prevention of secondary atherosclerotic cardiovascular events after AMI have shown to reduce the risk of recurrent cardiovascular events, hospital readmission, and incidence of death [1,4,5]. However, data from the United Kingdom Myocardial Ischemia National Audit Project showed that approximately half of patients did not receive the recommended treatment after acute coronary syndrome (ACS) [7]. Clinical pharmacist intervention is a promising approach to promote appropriate prescription practices. These interventions, which include medication adjustments, patient counselling and monitoring, associated with reduced mortality rate, improved adherence, and better clinical outcomes [8–11]. Clinical pharmacists play a role in supporting prescription decisions at hospital admission, in-hospital phase and post-discharge follow-up [8,9]. Several studies were conducted to evaluate the effectiveness of clinical pharmacist interventions in patients with AMI [10,11].

Thong Nhat Hospital is a Grade 1 general hospital under the Ministry of Health specialized in geriatrics. Located in Ho Chi Minh City, the largest metropolitan area and a major healthcare hub in southern Vietnam, the hospital holds a pivotal role in providing advanced medical services [12]. The Department of Interventional Cardiology, recognized as one of the leading cardiovascular intervention centres in the region, commits to the management of patients with AMI and other complex cardiovascular diseases [13]. Since January 2020, a clinical pharmacist has been working as a member of a multidisciplinary team in the department to ensure the appropriateness of prescriptions. This could improve the quality of treatment and reinforce the safety of inpatients. This study aimed to assess the effectiveness of clinical pharmacist interventions on improving the appropriateness of prescriptions and treatment outcomes in patients with AMI.

2. MATERIALS AND METHODS

2.1. Study setting

A retrospective before-and-after study was conducted on inpatients diagnosed with and treated for AMI, including ST-segment elevation myocardial infarction (STEMI) and non-ST-segment elevation myocardial infarction (NSTEMI), at the Department of Interventional Cardiology, Thong Nhat Hospital. The study consisted of two phases. In the pre-intervention phase (or the *pre* phase; from August 1st, 2019, to December 31st, 2019; with a 6-month post-AMI follow-up), clinical pharmacists did not intervene in physician's decisions regarding medication prescriptions. In the intervention phase (or the *post* phase; from August 1st, 2022, to December 31st, 2022, with a 6-month post-AMI follow-up), clinical pharmacists actively participated in the decision-making process for prescriptions.

2.2. Study population and sampling

The study sampled all patients aged 18 or older who were diagnosed and treated for AMI (including STEMI and NSTEMI with ICD codes I21 or I22) at the Department of Interventional Cardiology, Thong Nhat Hospital, Ho Chi Minh City, Vietnam, during the two study phases. The exclusion criteria were patients who were transferred to another hospital, refused treatment, or lost contact within 6 months after AMI. Furthermore, if patients were hospitalized more than once for AMI at the Department of Interventional Cardiology during the same study phase, the study only collect-

ed data from the first hospitalization.

2.3. Study outcomes

The data collection considered information on patient characteristics, number of drugs per day, appropriateness of prescription (during hospitalization and discharge), treatment outcomes, and ADEs. Patient characteristics included age, sex, AMI classification, revascularization strategy comorbidity, number of comorbidities, Charlson comorbidity index (CCI), estimated glomerular filtration rate (eGFR), number of drugs per day and the length of hospital stay. The appropriateness of prescription included the number of drug-related problems (DRPs), appropriateness of indications, dosage, route of administration, and the variables were derived for overall appropriateness. The treatment outcome was the mortality rate within 6 months after AMI. ADEs included those that appeared during hospitalization, but not at the time of admission.

The impact of the clinical pharmacist interventions was evaluated by comparing indicators pair-wised from the *pre* and *post* phases. The evaluation focused on two key aspects: the primary outcome, which was the appropriateness of prescription; and the secondary outcomes, which included treatment outcomes and the occurrence of ADEs. This approach allowed for a comprehensive analysis of the pharmacist's contribution to improving medication use and patient care.

2.3.1. Definition

2.3.1.1. Clinical pharmacist interventions

The clinical pharmacist intervention was defined as the intervention made by a graduated clinical pharmacist with at least three years of professional experience; who was assigned to work in the Department of Interventional Cardiology for at least 4 hours/day, 5 days/week and participated in the care of all patient cases, including patients with AMI, alongside doctors, nurses, and other healthcare professionals; specifically, those who participated in staff meetings, examined patients with a physician, reviewed medical records, assessed the appropriateness of prescription to treat AMI, monitored for potential side effects, and provided recommendations to optimize medication therapy. The clinical pharmacist may also share further rationale information to both patients and healthcare staff regarding medication management after AMI.

The clinical pharmacist reviewed the medical records from the previous weekend on the first day of the following week and continued to intervene if any issues were identified. In case of emergency, doctors could directly contact the on-duty pharmacists in the pharmacy department.

The interventions by the clinical pharmacist must be recorded in an electronic archive housed on the hospital's secure internal server. To ensure confidentiality and data security, the folder was password-protected, and access was restricted to assigned clinical pharmacists only.

2.3.1.2. The appropriateness of prescription

The appropriateness of AMI prescriptions was evaluated during hospitalization based on specific criteria. These included the appropriateness of indications, dosage, route of administration, and overall appropriateness of prescription for AMI management (such as nitrates, opioid analgesics, anticoagulants, antiplatelets, beta-blockers, calcium channel blockers [CCBs], angiotensin-converting enzyme inhibitors [ACEis] angiotensin receptor blockers [ARBs], aldosterone antagonists, statins, and proton pump inhibitors [PPIs]). These evaluations were conducted in accordance to the "Vietnam Minister of Health Guidelines for Diagnosis and Treatment of Acute Coronary Syndrome 2019 [1]" and "Vietnamese National Drug Formulary 2018 [14]".

Indications were considered appropriate if the prescribed medications aligned with guideline recommendations and had no contraindications. The appropriateness of dosage was assessed to ensure that all key drugs for the treatment of AMI were prescribed at reasonable doses that aligned with clinical guidelines. Similarly, the route of administration was evaluated to confirm that the prescribed method of drug delivery was suitable and consistent with the recommended practice for AMI management.

The overall appropriateness of prescription was defined as the fulfilment of all three criteria – appropriateness of indications, dosage, and route of administration. Notably, the

https://doi.org/10.32895/MPR.24.00083

dosage and route of administration were assessed only if the indication was deemed appropriate.

A DRP was identified if patients were prescribed at least one drug to treat AMI with an inappropriate indication, dosage, or route of administration. Indications, contraindications, and dosages applied to assess the rational use of certain drugs in the treatment of AMI are presented in Supplementary Table S1.

2.3.1.3. Treatment outcomes

The study recorded the mortality rate within six months following AMI, which included two components. In-hospital mortality was defined as death that occurred during the patient's hospital stay, prior to discharge. Post-discharge mortality was recorded in patients who survived to discharge, up to six-month follow-up after the onset of AMI to capture any subsequent deaths. Data on mortality was obtained from the hospital information system and the electronic portal of the Vietnam Social Insurance, ensuring comprehensive and accurate documentation.

2.3.1.4. Adverse drug events

The study considered ADEs that occurred during hospitalization, but were not presented at the time of admission. ADEs were recorded by pharmacists, physicians or nurses, either from the medical records or by direct observation. In both phases, all ADEs were registered in the hospital's ADE surveillance network. This network collects information and reports to The National Centre of Drug Information and Adverse Drug Reactions Monitoring in Vietnam. The ADE aetiology was assessed using the Naranjo algorithm. Both "certain" and "likely" (≥5 points) ADEs were recorded. ADEs with Naranjo scores of under 5 were excluded.

The criteria for ADE diagnosis in this study are presented in Supplementary Table S2.

2.4. Statistical method

All data were analysed using the Statistical Package for the Social Sciences (SPSS) software, version 20.0, with the significance threshold at $p<0.05$. Descriptive statistics were used to summarize the data. Variables with normal distribution were presented as means±SD, and those with non-normal distribution were summarized in medians with interquartile ranges (IQR). Categorical variables (such as AMI classification, sex, comorbidities, appropriateness of prescription, type of DRPs, treatment outcomes, and ADEs) were presented as frequency and percentage.

Inferential analyses were performed to compare variables between the two groups. Categorical variables were analysed using the Chi-square test. When more than 20% of expected cell counts were below 5, Fisher's exact test was applied. Continuous variables were compared using Student's t-test for normally distributed data or the Mann-Whitney U test for data with non-normal distribution.

Multivariable logistic regression analysis, employing the backward elimination method, was conducted to identify factors associated with the appropriateness of prescription for treating AMI at the hospital. The dependent variable was overall prescription appropriateness, while independent variables included age, dyslipidaemia, history of coronary heart disease, number of drugs per day, and whether clinical pharmacist intervention was provided (yes/no). Independent variables were examined for potential univariate associations with statistical significance threshold of 80%, and multicollinearity prior to regression model entry. Additionally, the independent variables were examined for multicollinearity. Variance inflation factors (VIFs) and Hosmer-Lemeshow test were used for model selection.

2.5. Ethical considerations

The study protocol followed the ethical standards set by institutional and national research committees, and was approved by the Institutional Review Board of Thong Nhat Hospital, Ho Chi Minh City, Vietnam (60/2022/BVTN–HDYD September 20th, 2022). Patient's personal information was kept confidential and used only for research purposes.

3. RESULTS

3.1. Characteristics of the study population

The study included 394 patients, of which 183 patients were in the *pre* phase and 211 in the *post* phase. A total of

180 (45.7%) patients were diagnosed with STEMI, whereas 214 (54.3%) were diagnosed with NSTEMI. There was no difference in the AMI classification between the two phases (p=0.081). The majority of the study population were elderly patients (≥60 years old), with a median age of 66 (57–79) years for all study populations. The age group of 75 years and above accounted for 32.5%, with a statistically significant difference between the two phases, primarily observed in this age group. The proportion of males was higher than females (66.5% vs. 33.5%). The rate of patients undergoing PCI in the study was recorded as 54.1% in phase 1 and 61.1% in phase 2 (p=0.158). The most common comorbidities in both study phases were hypertension, heart failure, and dyslipidaemia. The median length of hospital stay in the

Table 1. Patient's characteristics

Characteristics	All (N=394)	Pre-intervention (n^1=183)	Intervention (n^2=211)	p-value
Age (years) (median [IQR])	66 (57–79)	67 (56–83)	65 (57–74)	0.025[1)]
Age group (n [%])				
<50	47 (11.9)	23 (12.6)	24 (11.4)	
50≤75	219 (55.6)	84 (45.9)	135 (64.0)	0.001[2)]
≥75	128 (32.5)	76 (41.5)	52 (24.6)	
Sex (n [%])				
Male	262 (66.5)	120 (65.6)	142 (67.3)	0.718[2)]
Female	132 (33.5)	63 (34.4)	69 (32.7)	
AMI classification (n [%])				
STEMI	180 (45.7)	75 (41.0)	105 (49.8)	0.081[2)]
NSTEMI	214 (54.3)	108 (59.0)	106 (50.2)	
Revascularization strategy (n [%])				
PCI	228 (57.9)	99 (54.1)	129 (61.1)	0.158[2)]
CABG	0 (0)	0 (0)	0 (0)	-
Comorbidities (n [%])				
Hypertension	371 (94.2)	172 (94.0)	199 (94.3)	0.891[2)]
Dyslipidemia	297 (75.4)	114 (62.3)	183 (86.7)	<0.001[2)]
Heart failure	236 (59.9)	103 (56.3)	133 (63.0)	0.173[2)]
Diabetes	146 (37.1)	57 (31.1)	89 (42.2)	0.024[2)]
Coronary heart disease	96 (24.4)	46 (25.1)	50 (23.7)	0.740[2)]
Chronic kidney disease	54 (13.7)	19 (10.4)	35 (16.6)	0.074[2)]
History of stroke	29 (7.4)	15 (8.2)	14 (6.6)	0.554[2)]
Atrial fibrillation	19 (4.8)	11 (6.0)	8 (3.8)	0.305[2)]
Peripheral artery disease	2 (0.5)	2 (1.1)	0 (0)	0.215[4)]
Number of comorbidities (median [IQR])	5 (3–6)	4 (3–6)	5 (4–6)	<0.001[1)]
CCI (n [%])				
0	83 (21.1)	35 (19.1)	48 (22.7)	
1	148 (37.6)	69 (37.7)	79 (37.4)	
2	91 (23.1)	45 (24.6)	46 (21.8)	0.916[2)]
3	38 (9.6)	18 (9.8)	20 (9.5)	
≥4	34 (8.6)	16 (8.7)	18 (8.5)	
eGFR (ml/min/1.73 m^2, [mean±SD])	65.3±27.0	63.2±27.9	67.0±26.1	0.165[3)]
Number of drugs per day (median [IQR])	11 (9–14)	11 (9–14)	11 (9–13)	0.94[31)]
The length of hospital stays (median [IQR])	8 (6–13)	9 (6–14)	8 (6–12)	0.315[1)]

[1)] Mann-Whitney U test, [2)] chi-square test, [3)] student's T test, [4)] Fisher's exact test.
IQR, interquartile ranges; AMI, acute myocardial infarction; STEMI, ST-segment elevation myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; PCI, percutaneous coronary intervention; CABG, coronary artery bypass grafting; CCI, Charlson comorbidity index; eGFR; estimated glomerular filtration rate.

https://doi.org/10.32895/MPR.24.00083

two phases was 9 (IQR: 6–14) days and 8 (IQR: 6–12) days, respectively (p=0.315). Characteristics of the study population are summarized in Table 1.

3.2. The effectiveness of clinical pharmacist interventions

3.2.1. The appropriateness of acute myocardial infarction prescription during hospitalization

The overall prescription appropriateness for AMI treatment was higher in the intervention phase (85.8%) than in the *pre*-intervention phase (48.6%).

The number of DRPs in the *post* phase decreased significantly compared with that in the *pre* phase. One occurrence of DRP accounted for the highest proportion of cases in both phases, and there were no cases with more than two DRPs in the *post* phase. In the *pre* phase, the rate of inappropriate indications and dosages of PPIs were the highest and decreased significantly in the *post* phase. Details regarding the appropriateness of prescribing medications in both study phases are presented in Table 2. The sub-analysis, excluding DRPs related to PPI prescribing, indicated that the rates of overall prescription appropriateness of primary medications for AMI treatment (excluding PPIs) in *pre* and *post* phases were 86.9% and 91.5%, respectively (p=0.141, Supplementary Table S3).

Supplementary Table S4 presents the selection process for the multivariate model based on univariate regression analysis, and demonstrates the goodness of fit for the chosen model through VIF assessment and the Hosmer-Lemeshow test. The results of the multivariable logistic regression analysis indicated that clinical pharmacist interventions were associated with a higher rate of overall prescription appropriateness for AMI treatment in the hospital (Table 3). In contrast,

Table 2. The appropriateness of prescribing drugs to treat acute myocardial infarction

Appropriateness		All (N=394)	Pre-intervention (n^1=183)	Intervention (n^2=211)	p-value
The appropriateness of indications (n [%])		346 (87.8)	145 (79.2)	201 (95.3)	<0.001[1)]
The appropriateness of the dose (n [%])		314 (79.7)	121 (66.1)	193 (91.5)	<0.001[1)]
The appropriateness of the route of administration (n [%])		380 (96.4)	173 (94.5)	207 (98.1)	0.056[1)]
Overall appropriateness (n [%])		270 (68.5)	89 (48.6)	181 (85.8)	<0.001[1)]
The number of DRPs	Median (IQR)	0 (0–1)	1 (0–1)	0 (0–0)	<0.001[2)]
0 DRP (n [%])		270 (68.5)	89 (48.6)	181 (85.8)	
1 DRP (n [%])		99 (25.1)	71 (38.8)	28 (13.3)	<0.001[1)]
≥2 DRPs (n [%])		25 (6.3)	23 (12.6)	2 (0.9)	
Inappropriate indication (n [%])					
Contraindications of ACEi/ARB		4 (1.0)	4 (2.2)	0 (0)	0.045[3)]
Contraindications of spironolacton		10 (2.5)	3 (1.6)	7 (3.3)	0.350[3)]
Contraindications of statin		7 (1.8)	5 (2.7)	2 (0.9)	0.258[3)]
Incorrect/or lack of PPI indication		31 (7.9)	30 (16.4)	1 (0.5)	<0.001[3)]
Inappropriate dose (n [%])					
Inappropriate dose of anticoagulant		16 (4.1)	7 (3.8)	9 (4.3)	0.825[1)]
Inappropriate loading dose of clopidogrel		4 (1.0)	4 (2.2)	0 (0)	0.046[3)]
Inappropriate loading dose of statin		4 (1.0)	4 (2.2)	0 (0)	0.046[3)]
Inappropriate dose of beta-blocker		1 (0.3)	1 (0.5)	0 (0)	0.464[3)]
Inappropriate dose of ACEi/ARB		3 (0.8)	1 (0.6)	2 (0.9)	1.000[3)]
Inappropriate dose of PPI		62 (15.7)	56 (30.6)	6 (2.8)	<0.001[1)]
Inappropriate route of administration (n [%])					
Inappropriate route of administration of PPI		14 (3.6)	10 (5.5)	4 (1.9)	0.056[3)]

[1)] Chi-square test, [2)] Mann-Whitney U test, [3)] Fisher's exact test.
IQR, interquartile ranges; DRP, drug-related problems; ACEi, angiotensin-converting enzyme inhibitors; ARB, angiotensin II receptor blockers; PPI, proton pump inhibitors.

Table 3. Factors related to the appropriateness of prescribing during hospitalization by multivariable logistic regression analysis

Factors	p-value[1)]	OR	95% CI
Interventions (yes)	<0.001	6.734	4.098–11.065
History of coronary heart disease	0.005	0.466	0.273–0.797
Number of drugs per day	0.043	0.932	0.870–0.998

[1)] Multivariable logistic regression.
OR, odds ratios; CI, confidence interval.

a history of coronary artery disease and an increased number of drugs used per day were associated with a lower rate of appropriate prescriptions ($p<0.05$).

3.2.2. Treatment outcomes

The 6-month post-AMI mortality rate in the *pre* phase was 18.6%, which was higher than that in the *post* phase (16.6%). However, the difference was not statistically significant (Table 4).

3.2.3. Adverse drug events

A total of 105 patients (57.4%) in the *pre* phase and 119 patients (56.4%) in the *post* phase experienced at least one ADE during their hospital stay ($p=0.845$). The most common ADEs recorded in this study were electrolyte disorders (including hyperkalaemia, hypokalaemia, hypernatremia, and hyponatremia), bleeding, and acute kidney injury, with the rate of each ADE exceeding 15% (Table 5).

4. DISCUSSION

In this study, the prevalence of STEMI and NSTEMI were 45.7% and 54.3%, respectively. These results are similar to those from the study by Kim et al. [15], which reported 43.4% of patients with STEMI and 56.6% of patients with NSTEMI. The majority of the study population was elderly

Table 4. The treatment outcomes of the study population

Outcome	All (N=394)	Pre-intervention (n^1=183)	Intervention (n^2=211)	p-value
Survival	325 (82.5)	149 (81.4)	176 (83.4)	0.604[1)]
Mortality at 6 months after AMI	69 (17.5)	34 (18.6)	35 (16.6)	0.604[1)]
In-hospital mortality	4 (1.0)	3 (1.6)	1 (0.5)	0.341[2)]
Post-discharge mortality (n^1=180, n^2=210)	65 (16.7)	31 (17.2)	34 (16.2)	0.785[1)]

[1)] Chi-square test, [2)] Fisher's exact test.
AMI, acute myocardial infarction.

Table 5. Adverse drug events in the study

ADEs (n [%])	All (N=394)	Pre-intervention (n^1=183)	Intervention (n^2=211)	p-value
At least one ADE	224 (56.9)	105 (57.4)	119 (56.4)	0.845[1)]
Electrolyte disorder	119 (30.2)	68 (37.2)	51 (24.2)	0.005[1)]
Bleeding	105 (26.6)	51 (27.9)	54 (25.6)	0.610[1)]
Acute kidney injury	75 (19.0)	29 (15.8)	46 (21.8)	0.133[1)]
ADEs on the digestive system	37 (9.4)	16 (8.7)	21 (10.0)	0.731[1)]
Acute liver injury	27 (6.9)	13 (7.1)	14 (6.6)	0.854[1)]
Headache	14 (3.6)	8 (4.4)	6 (2.8)	0.414[1)]
Hypotension	11 (2.8)	8 (4.4)	3 (1.4)	0.076[2)]
Mental disorder	9 (2.3)	5 (2.7)	4 (1.9)	0.739[2)]
Cough	9 (2.3)	6 (3.3)	3 (1.4)	0.314[2)]
Anaphylaxis	7 (1.8)	5 (2.7)	2 (0.9)	0.258[2)]
Hypoglycaemia	6 (1.5)	2 (1.1)	4 (1.9)	0.690[2)]
Thrombocytopenia	4 (1.0)	2 (1.1)	2 (0.9)	1.000[2)]
Hypertension	3 (0.8)	2 (1.1)	1 (0.5)	0.599[2)]
Dyspnoea	2 (0.5)	0 (0.0)	2 (0.9)	0.501[2)]

[1)] Chi-square test, [2)] Fisher's exact test.
ADE, adverse drug events.

https://doi.org/10.32895/MPR.24.00083

patients (67.3%), age is one of the main factors contributing to the increased risk of death [9,16] and bleeding in patients with AMI [16,17]. In both phases of our study, a higher proportion of males (>65%) than females (<35%) were recorded. Several studies have explored the differences in cardiovascular outcomes between genders. Findings in Australia by Nedkoff et al. [18] indicated that the risk of major adverse cardiovascular events, cardiovascular-related deaths, and all-cause mortality were generally higher in females. Score of one in CCI was most common in the study, followed by 2, 0, 3, and ≥4 points. Hypertension (94.2%), dyslipidaemia (75.4%), and heart failure (59.9%) were common comorbidities in both study phases. Comorbidities and polypharmacy are associated with poor patient adherence to medications [19].

Compared to the *pre* phase, the *post* phase showed a statistically significant increase in the overall appropriateness of prescribing AMI medications during hospitalization (48.6% vs. 85.5%, p<0.001). In particular, the appropriateness of the indications and dosages significantly increased during the *post* phase. Most DRPs in the *pre* phase were inappropriate indications and PPI doses, which decreased significantly during the *post* phase. In particular, rabeprazole was repeatedly prescribed despite not being recommended for the prevention of NSAID-induced ulcers, and pantoprazole 40 mg once daily was also frequently used for ulcer prophylaxis, even though this dosage was considered inappropriate [14]. This showed that the DRPs in the treatment of AMI in the Department of Interventional Cardiology had been effectively intervened by clinical pharmacists. The sub-analysis results indicated that the prescribing of primary medications for AMI treatment (excluding PPIs) yielded a high level of appropriateness, with an overall rate of 86.9% in the *pre* phase and no significant difference in the intervention phase. As the Department of Interventional Cardiology at Thong Nhat Hospital is a major intervention centre in Vietnam, physicians demonstrated a high level of competency in providing indications for AMI treatment. In comparison, a study by Gona et al. [20] showed that 52% of patients with ACS had DRPs, with the majority of DRPs related to drug selection (34.05%) and dose selection (26.97%). This is the higher DRP rate than observed in both phases of our study. In general, differences in study populations, areas, and criteria of appropriateness led to difficulties in comparing studies. The effect of the intervention was also proven through the logistic regression analysis results, with intervention from clinical pharmacists as a factor related to increasing the appropriateness of prescribing medications to treat AMI at the hospital (OR: 6.734; 95% CI: 4.098–11.065; p<0.001). The importance of clinical pharmacists in the detection, resolution, and prevention of DRPs, and their contribution in improving patient outcomes and optimizing healthcare costs have been demonstrated in some other studies on cardiovascular patients [20,21]. Conversely, the results from the logistic regression equation showed that a history of coronary heart disease and an increased number of medications used per day were associated with a reduced rate of appropriate medication use in the treatment of AMI. This may be explained by clinical complexity, as patients with coronary heart disease often have multiple comorbidities and are frequently on several medications which can complicate treatment decisions [22]. In summary, the available data and main findings of this study suggested that clinical pharmacist interventions can have a positive impact on improving the rates of prescription appropriateness in treatment for patients with AMI.

Previous studies have reported varying rates of major bleeding in patients with AMI, ranging from 0.39% to 10.8% [17,23,24]. There are several reasons for the variation in bleeding rates, including differences in bleeding definition, patient characteristics, and treatment therapy. Bleeding is a considerable adverse event associated with short-term, long-term, and thrombotic events, such as AMI and stroke. Additionally, interruption of antithrombotic therapy due to bleeding is independently associated with increased mortality [25]. Thirteen ADEs other than bleeding were recorded, with rates ranging from 0.5% to 30.2%. In a study by Mahadevappa et al. [26], 20.7% of the patients experienced 30 different ADR s. The six-month post-AMI mortality rates in Soldati et al. [19], Takeji et al. [27], and Kumar et al. [28] ranged from approximately 8% to 11%, which were lower than in our study. A cohort study assessing long-term surviv-

al following AMI in Australia and New Zealand found that the probability of survival decreased rapidly within the first year after AMI and declined gradually thereafter [29]. For many years, post-AMI mortality rates in different settings are varied because of differences in designated institutions and study populations. In general, our study did not observe any difference in the incidence of ADEs and the mortality rate after 6 months of AMI treatment between the two phases. This may be due to the overall high level of appropriateness in medication use across both phases, except for PPIs, which likely limited the occurrence of ADEs and the mortality rate.

Although this study demonstrated the effectiveness of clinical pharmacist interventions in treating patients with myocardial infarction, we acknowledge several limitations, including the following. The study was conducted at a single centre, limiting its ability to reflect the diversity in culture, race, gender, and age of AMI patients. The before-and-after design with a lengthy gap between data collection points raised the possibility that prescribing improvements over time may have occurred independently of pharmacist intervention. The evaluation of "prescription appropriateness," based on indications, dosages, and administration routes, may not fully reflect the complexity of clinical pharmacy practice. DRPs in the pre phase may have been underreported due to the absence of a clinical pharmacist. Finally, the use of two distinct populations in the pre and *post* phases could introduce bias due to demographic and baseline differences. However, multivariable logistic regression was used to adjust for these factors, minimizing their impact and ensuring a robust evaluation of the interventions.

5. CONCLUSION

Our study demonstrated that clinical pharmacist interventions significantly improved the appropriateness of prescribing medications to treat AMI but did not reduce mortality or ADE. Specifically, clinical pharmacy has played a crucial role in improving the appropriateness of indications and dosages for PPI prescriptions. These findings support enhancing the role of clinical pharmacists in ensuring the appropriateness of AMI prescription to minimize the rate of DRPs and optimize treatment outcomes.

SUPPLEMENTARY MATERIALS

Supplementary materials are only available online from: https://doi.org/10.32895/MPR.24.00083

Acknowledgements

Not applicable.

Funding sources

Not applicable.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

ORCID

Nhu Quynh Tran
https://orcid.org/0009-0009-0379-5826
Tan Van Nguyen
https://orcid.org/0000-0002-0234-6596
Quynh Thi Huong Bui
https://orcid.org/0000-0003-3451-4870

Authors' contributions

Conceptualization: NQ Tran, TV Nguyen, QTH Bui.
Data curation: NQ Tran.
Formal analysis: NQ Tran.
Methodology: NQ Tran, TV Nguyen, QTH Bui.
Software: NQ Tran.
Validation: NQ Tran, QTH Bui.
Investigation: NQ Tran.
Writing - original draft: NQ Tran, QTH Bui.
Writing - review & editing: NQ Tran, TV Nguyen, QTH Bui.

Availability of data and material

Upon reasonable request, the datasets of this study can be available from the corresponding author.

Ethics approval

The study protocol was approved by the Institutional Review Board of Thong Nhat Hospital, Ho Chi Minh City, Vietnam (60/2022/BVTN–HDYD September 20, 2022). Patients' personal information was kept confidential and used only for research purposes. All procedures followed the ethical standards set by institutional and national research committees. However, this did not interfere with the treatment process.

REFERENCES

1. Vietnam Minister of Health. Guidelines for diagnosis and treatment of acute coronary syndrome. Hanoi: Vietnam Minister of Health; 2019. p. 1-34.
2. Joshua Chadwick J, Karapet D, Subramanian SS, Jemmi P. Epidemiology of myocardial infarction. In: Burak P, editor. Myocardial infarction. Rijeka: IntechOpen; 2018.
3. Kolansky DM. Acute coronary syndromes: morbidity, mortality, and pharmacoeconomic burden. Am J Manag Care. 2009;15(2 suppl):S36-41.
4. Collet JP, Thiele H, Barbato E, Barthélémy O, Bauersachs J, Bhatt DL, et al. 2020 ESC guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: the task force for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J. 2021;42(14):1289-367.
5. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, et al. 2017 ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: the task force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J. 2018;39(2):119-77.
6. Classen DC, Pestotnik SL, Evans RS, Lloyd JF, Burke JP. Adverse drug events in hospitalized patients: excess length of stay, extra costs, and attributable mortality. JAMA. 1997;277(4):301-6.
7. Simms AD, Weston CF, West RM, Hall AS, Batin PD, Timmis A, et al. Mortality and missed opportunities along the pathway of care for ST-elevation myocardial infarction: a national cohort study. Eur Heart J Acute Cardiovasc Care. 2015;4(3):241-53.
8. Hassan Y, Kassab Y, Abd Aziz N, Akram H, Ismail O. The impact of pharmacist-initiated interventions in improving acute coronary syndrome secondary prevention pharmacotherapy prescribing upon discharge. J Clin Pharm Ther. 2013;38(2):97-100.
9. Zhai XB, Gu ZC, Liu XY. Clinical pharmacist intervention reduces mortality in patients with acute myocardial infarction: a propensity score matched analysis. Eur J Hosp Pharm. 2019;26(5):248-52.
10. Dorsch MP, Lose JM, DiDomenico RJ. The effect of cardiovascular credentialed pharmacists on process measures and outcomes in myocardial infarction and heart failure. Pharmacotherapy. 2014;34(8):803-8.
11. Lambert-Kerzner A, Del Giacco EJ, Fahdi IE, Bryson CL, Melnyk SD, Bosworth HB, et al. Patient-centered adherence intervention after acute coronary syndrome hospitalization. Circ Cardiovasc Qual Outcomes. 2012;5(4):571-6.
12. Thong Nhat Hospital. Bệnh viện Thống Nhất - Thong Nhat Hospital [Internet]. 2025 [cited 2025 Jan 18]. https://bvtn.org.vn/
13. Thong Nhat Hospital. Khoa Tim mạch cấp cứu và can thiệp [Internet]. 2025 [cited 2025 Jan 18]. https://bvtn.org.vn/chuyen-khoa/tim-mach-cap-cuu-va-can-thiep/
14. Vietnam Minister of Health. Vietnamese National Drug Formulary. Hanoi: Medical Publishing House; 2018.
15. Kim RB, Hwang JY, Park HW, Her AY, Lee JH, Kim MH, et al. Contemporary status of acute myocardial infarction in Korean patients: Korean Registry of Acute Myocardial Infarction for Regional Cardiocerebrovascular Centers. J Clin Med. 2021;10(3):498.
16. Timóteo AT, Ramos R, Toste A, Lousinha A, Alberto Oliveira J, Lurdes Ferreira M, et al. Impact of age on treatment and outcomes after acute myocardial infarction, particularly in very elderly patients. Rev Port Cardiol. 2011;30(12):897-903.
17. Sun Y, Feng L, Li X, Wang Z, Gao R, Wu Y. In-hospital major bleeding in patients with acute coronary syndrome medically treated with dual anti-platelet therapy: associat-

ed factors and impact on mortality. Front Cardiovasc Med. 2022;9:878270.

18. Nedkoff L, Briffa T, Murray K, Gaw J, Yates A, Sanfilippo FM, et al. Risk of early recurrence and mortality in high-risk myocardial infarction patients: a population-based linked data study. Int J Cardiol Cardiovasc Risk Prev. 2023;17:200185.
19. Soldati S, Di Martino M, Castagno D, Davoli M, Fusco D. In-hospital myocardial infarction and adherence to evidence-based drug therapies: a real-world evaluation. BMJ Open. 2021;11(2):e042878.
20. Gona OJ, Shambu SK, Madhan R. Frequency and nature of drug-related problems in patients with acute coronary syndrome: role of the clinical pharmacist in coronary care practice. J Pharm Pract Res. 2020;51(1):36-42.
21. Biradar SM, Kohima B, Nayak V, Nandikol S, Warad V, Byakod SM, et al. Assessment of drug related problems and pharmacist interventions in inpatients with cardiovascular disease. Ration Pharmacother Cardiol. 2022;18(5):536-43.
22. Rossello X, Pocock SJ, Julian DG. Long-term use of cardiovascular drugs: challenges for research and for patient care. J Am Coll Cardiol. 2015;66(11):1273-85.
23. Mathews R, Peterson ED, Chen AY, Wang TY, Chin CT, Fonarow GC, et al. In-hospital major bleeding during ST-elevation and non–ST-elevation myocardial infarction care: derivation and validation of a model from the ACTION Registry®-GWTG™. Am J Cardiol. 2011;107(8):1136-43.
24. Belle L, Cayla G, Cottin Y, Coste P, Khalife K, Labèque JN, et al. French registry on acute ST-elevation and non–ST-elevation myocardial infarction 2015 (FAST-MI 2015). Design and baseline data. Arch Cardiovasc Dis. 2017;110(6–7):366-78.
25. Steg PG, Huber K, Andreotti F, Arnesen H, Atar D, Badimon L, et al. Bleeding in acute coronary syndromes and percutaneous coronary interventions: position paper by the Working Group on Thrombosis of the European Society of Cardiology. Eur Heart J. 2011;32(15):1854-64.
26. Mahadevappa M, Meher C, Pushpa NB, Kulkarni P, Poornima KS, Desai N. Study of pattern & distribution of adverse drug reactions in acute coronary syndrome patients in a tertiary care hospital. Indian J Med Res. 2022;156(1):111-21.
27. Takeji Y, Shiomi H, Morimoto T, Yamamoto K, Matsumura-Nakano Y, Nagao K, et al. Differences in mortality and causes of death between STEMI and NSTEMI in the early and late phases after acute myocardial infarction. PLOS ONE. 2021;16(11):e0259268.
28. Kumar D, Saghir T, Kumar R, Sial JA, Khan KA, Shah JA, et al. Predictors of 6-month mortality in patients with non-ST elevation acute coronary syndrome: a study in Pakistani population. J Saudi Heart Assoc. 2021;33(4):286-92.
29. Nadlacki B, Horton D, Hossain S, Hariharaputhiran S, Ngo L, Ali A, et al. Long term survival after acute myocardial infarction in Australia and New Zealand, 2009–2015: a population cohort study. Med J Aust. 2021;214(11):519-25.

https://doi.org/10.32895/MPR.24.00083