

THE ROLE OF CONSERVATIVE TREATMENT IN REGIONAL VARIATIONS OF 30-DAY ACUTE MYOCARDIAL INFARCTION MORTALITY: A CASE OF THE CZECH REPUBLIC

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SUMMARY

Objectives: The aim of the study was to analyse the role of conservative treatment and regional differences in 30-day hospital mortality for acute myocardial infarction (AMI) patients in the Czech Republic.

Methods: Using administrative data from Czech health insurance companies for 2018–2020, we employed a probit model to examine factors influencing mortality across 13 complex cardiovascular centres, calculating average marginal effects to ensure interpretable results.

Results: Conservative treatment was associated with a 4.7 percentage point increase in 30-day mortality compared to percutaneous coronary intervention (PCI) treatment (95% CI: 3.6–5.7). This effect varied significantly across different types of AMI and healthcare providers, with regional variations in mortality ranging from 0 to 4.3 percentage points relative to the best-performing centre.

Conclusions: Higher proportions of conservative treatment significantly contribute to increased 30-day mortality in complex cardiovascular centres. The persistent regional variations after controlling for patient characteristics suggest the need for standardized treatment protocols and improved data collection systems to reduce disparities in outcomes.

Key words: acute myocardial infarction, conservative treatment, regional variation, mortality, probit model

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<https://doi.org/10.21101/cejph.a8462>

INTRODUCTION

Acute myocardial infarction (AMI) remains a significant global health concern with substantial mortality impact across developed countries. Despite improvements in treatment protocols and technologies, considerable regional variations in outcomes persist, pointing to potential differences in healthcare organization, access to specialized care, and implementation of evidence-based practices.

Various epidemiological analyses have reported a significant decrease in cardiovascular disease (CVD)-related mortality across nearly all EU countries. Despite this overall decline, AMI continues to be a primary cause of morbidity and mortality within the spectrum of CVD. Timmis et al. (1) noted that higher-income regions (including the EU) have seen progressive reductions in mortality from AMI during the past 20 years.

Zuin et al. (2) indicated that age-adjusted mortality related to acute myocardial infarction (AMI) has consistently decreased across the majority of EU-27 member states over the past decade. Nevertheless, variations persist between Western and Eastern European nations. The most significant reductions in AMI mortality rates were noted in Sweden, Belgium, Czech Republic, Denmark, Finland, Luxembourg, and Ireland.

These trends are largely attributed to progressive advancements in routine clinical practice concerning both AMI prevention and treatment. These include timely reperfusion strategies, the introduction of novel antithrombotic and antiplatelet agents, the development of therapies for post-myocardial infarction heart failure, and the intensified management of modifiable cardiovascular risk factors.

In line with these European trends, the Czech Republic has experienced similar improvements, though cardiovascular diseases remain the country's leading cause of mortality, accounting for 36.5% of male and 43.1% of female deaths in 2020 (3). The Czech Republic's progress is evidenced by significant declines in ischaemic heart disease mortality – 66.2% for men and 65.4% for women aged 25–74 between 1985 and 2007 (4). Despite these improvements, the disease burden continues to be substantial, with 2,895,605 patients affected by circulatory system diseases in the Czech Republic as of 2022 (3).

In the Czech Republic, approximately 14,000 patients are hospitalized for AMI annually, with in-hospital mortality fluctuating around 6% while the overall annual mortality rate exceeds 10% (5). In 2022, 917 patients died from AMI during hospitalization (within 30 days of admission), representing 5.2% of all patients hospitalized for AMI (diagnoses I21–I22) (6).

A detailed analysis of mortality data reveals the significant impact of care system improvements on AMI outcomes in the Czech Republic. Between 2010 and 2021, AMI-related deaths decreased substantially from 6,436 (61.2 per 100,000 population) to 3,401 (31.7 per 100,000 population). During this same period, the 30-day hospital mortality for AMI dropped from 7.1% to 5.2%, placing the Czech Republic among countries with the lowest rates internationally. However, this positive trend in AMI outcomes contrasts with the concerning rise in heart failure mortality, which increased from 20.3 to 83.5 per 100,000 population between 2010 and 2021, resulting in 4,041 deaths – surpassing the mortality from AMI in the Czech Republic (6, 7).

While overall outcomes in the Czech healthcare system are favourable, regional differences in mortality require thorough analysis, as these disparities may reflect variations in care organization, patient trajectories, treatment phase effectiveness, and data reporting practices rather than differences in clinical care quality.

The 2020 ESC Guidelines for non-ST-segment elevation acute coronary syndrome (NSTEMI-ACS) by Collet et al. (8) and 2017 European Society of Cardiology (ESC) STEMI Guidelines by Ibanez et al. (9) highlight several important considerations regarding treatment strategies. Collet et al. (8) specifically address the evolution in NSTEMI-ACS treatment, noting that the proportion of patients with non-ST-elevation myocardial infarction (NSTEMI) increased from one-third in 1995 to more than half in 2015, coinciding with significant changes in management strategies, particularly regarding early invasive approaches.

Recent studies have documented significant regional variations in AMI treatment strategies and outcomes. Puymirat et al. (10) analysed temporal changes in AMI patient characteristics, management, and outcomes over 20 years, finding that while overall mortality has decreased, regional differences in treatment approaches persist. Lopez and Adair (11) further examined this trend, investigating whether the historical decline in cardiovascular disease mortality in high-income countries continues or has stalled.

The role of conservative versus invasive treatment in AMI outcomes remains an important area of investigation. Rozenfeld et al. (12) conducted a significant study of 530 elderly patients (>75 years) with ST-elevation myocardial infarction (STEMI), finding that only 5% received conservative treatment. Their research demonstrated substantially better outcomes with invasive treatment, showing lower 30-day mortality (10% vs. 27%) and 1-year mortality (14% vs. 35%) compared to conservative management. These findings suggest that age alone should not determine treatment strategy, aligning with Hall et al. (13) emphasis that guideline-indicated treatments and risk scoring systems significantly influence survival rates, though implementation varies across regions.

Regional healthcare system characteristics significantly influence AMI treatment strategies and outcomes. Olivari et al. (14) observed that real-world implementation of invasive strategies varies considerably across regions, affecting benchmark targets for quality care. This variation in treatment approaches has been linked to differences in 30-day mortality rates. Laukkanen et al. (15) provided additional insight through their meta-analysis of contemporary randomized controlled trials comparing percutaneous coronary intervention (PCI) versus medical therapy, highlighting the importance of evidence-based decision-making

in treatment selection. Bueno et al. (16) noted that the relationship between treatment strategies and mortality outcomes must be interpreted within the context of regional healthcare system capabilities and patient characteristics.

Our study analyses detailed patient-level data from 13 complex cardiovascular centres to identify underlying causes of regional differences in 30-day hospital mortality for AMI patients in the Czech Republic. This research extends previous work by Widimský et al. (17), offering insights applicable to diverse healthcare settings.

This study makes several unique contributions to international literature. First, it provides a comprehensive analysis of regional variations in AMI care using patient-level data from all complex cardiovascular centres in the Czech Republic. Second, it specifically examines the role of conservative treatment in mortality outcomes, an aspect often overlooked in previous research. Third, it offers insights into how healthcare system organization influences AMI outcomes, with implications for other countries considering similar network models.

MATERIALS AND METHODS

Study Design

We analyse administrative data from Czech health insurance companies covering 20,047 AMI cases from 2018–2020 (18). The study includes adult patients aged 18–100 who were hospitalized in one of 13 complex cardiovascular centres for adults (CCC). These centres comprise 11 centres for highly specialized complex cardiovascular care for adults and 2 centres that also perform heart transplants and related procedures.

Data Sources and Variables

The dependent variable is 30-day crude mortality for AMI patients, defined as death within 30 days of admission for patients with a defined therapeutic procedure. Independent variables include 16 indicators on patient's status and treatment, as well as the year of treatment. Key variables encompass length of hospitalization (LOS), patient demographics, AMI type, treatment type, and comorbidities.

For the purposes of the study, conservative treatment was defined as: “no interventional procedure or administration of a fibrinolytic agent, identified by the reporting of ZULPB01AD02–alteplase for fibrinolysis.” Analysis of the Health Insurance Bureau data indicates that conservative treatment may be one of the causes of higher 30-day in-hospital mortality among AMI patients at the level of care provided in healthcare provider centres (HCP) interchangeably used with term complex cardiovascular centres for adults (CCC).

For AMI type, we used the following classification: STEMI: ST-elevation myocardial infarction (reference category); NSTEMI: non-ST-elevation myocardial infarction; continuing MI: continuing myocardial infarction; other serious MI: other serious myocardial infarction.

For treatment approach, we categorized patients as receiving: PCI: percutaneous coronary intervention (reference category); conservative treatment: no interventional procedure performed;

CABG: coronary artery bypass grafting; PCI+CABG: both PCI and CABG procedures.

Comorbidities included diabetes mellitus, hypertension, anticoagulant use, acute stroke history (ASH), and ischaemic lower limb disease (ISCHAEMIA). Healthcare providers (HCP) were coded numerically (1–13), with HCP 2 selected as the reference category due to its lowest reported 30-day mortality rate. This choice of reference allows us to examine how other centres compare to the best-performing centre in terms of mortality outcomes.

Our sample consists predominantly of male patients (70%), with an average age of 66 years (SD=12.45) and the average length of stay (LOS) of 5.8 days (SD=6.3). (Table 1). The majority of cases are ST-elevation myocardial infarction (59%), followed by non-ST-elevation myocardial infarction (39%), with smaller proportions of continuing MI (0.6%), and other serious MI (1%). Regarding treatment approaches, percutaneous coronary intervention is the most common (83%), followed by conservative treatment (10%) and coronary artery bypass grafting (6%). Table 2 shows statistics about the diagnosis and chosen treatment.

Statistical Analysis

To analyse factors influencing 30-day mortality, we employ a probit regression model, which is particularly suitable for binary outcome variables like mortality (yes/no). The probit model has been extensively used in healthcare research (19, 20), as it effectively handles the non-linear relationship between predictors and binary outcomes while constraining predicted probabilities between 0 and 1 (21).

The theoretical foundation for using probit over alternative specifications (like linear probability models) lies in its ability to model the underlying latent variable structure, where the observed binary outcome is assumed to result from an unobserved continuous process (22). In our context, this aligns with the theoretical understanding that mortality risk varies continuously, even though we only observe the binary outcome. Wooldridge (21) provides the formal derivation of the maximum likelihood estimation for the probit model.

Following recent methodological approaches in cardiovascular outcomes research (23, 24), we estimate average marginal effects to ensure interpretable results. The model was estimated using Stata 17's probit command with robust standard errors clustered at the healthcare provider level to account for potential correlation

Table 1. Summary statistics

Variable	n (%)
Male	14,059 (70.1)
Diagnosis	
STEMI	11,830 (59.0)
NSTEMI	7,812 (39.0)
Continuing MI	120 (0.6)
Other serious MI	285 (1.4)
Treatment	
Conservative treatment	1,980 (9.9)
PCI	16,637 (83.0)
CABG	1,161 (5.8)
PCI CABG	269 (1.3)
Mortality	
Deaths within 30 days	1,414 (7.1)
Comorbidities	
Diabetes	5,753 (28.7)
Anticoagulation	8,376 (41.8)
Hypertension	1,166 (5.8)
Stroke	888 (5.5)
Ischaemia	1,229 (6.1)
Year	
2018	7,030 (35.1)
2019	7,121 (35.5)
2020	5,896 (29.4)
Total	20,047

This Table presents characteristics of 20,047 AMI patients treated in 13 complex cardiovascular centres in the Czech Republic during 2018–2020. The continuous variables length of stay (mean = 5.79, SD = 6.29, range: 1–245 days) and age (mean = 66.01, SD = 12.45, range: 18–100 years) are not shown in the Table. Percentages are calculated from the total sample.

MI – myocardial infarction; STEMI – ST-elevation myocardial infarction; NSTEMI – non-ST-elevation myocardial infarction; PCI – percutaneous coronary intervention; CABG – coronary artery bypass grafting

tion within providers. Following probit estimation, we calculated average marginal effects using the margins command. These marginal effects – which we report throughout our results – directly represent changes in mortality probabilities in percentage points

Table 2. Distribution of treatment approaches across acute myocardial infarction (AMI) diagnosis types

Diagnosis	Treatment n (%)				
	PCI+CABG	CABG	PCI	CT	Total
Other serious MI	1 (0.35)	4 (1.40)	186 (65.26)	94 (32.98)	285 (100)
Continuing MI	1 (0.83)	8 (6.67)	98 (81.67)	13 (10.83)	120 (100)
NSTEMI	132 (1.69)	843 (10.79)	5,948 (76.14)	889 (11.38)	7,812 (100)
STEMI	135 (1.14)	306 (2.59)	10,405 (87.95)	984 (8.32)	11,830 (100)
Total	269 (1.34)	1,161 (5.79)	16,637 (82.99)	1,980 (9.88)	20,047 (100)

Values represent frequencies with percentages in parentheses for the years 2018–2020. Row percentages sum to 100% for each diagnosis category. The Table shows the distribution of treatment approaches across different types of AMI.

MI – myocardial infarction; STEMI – ST-elevation myocardial infarction; NSTEMI – non-ST-elevation myocardial infarction; PCI – percutaneous coronary intervention; CABG – coronary artery bypass grafting; CT – conservative treatment

rather than the raw probit coefficients or z-scores. For instance, a marginal effect of 0.05 for a variable indicates that a one-unit change in that variable is associated with a 5-percentage point increase in the probability of 30-day mortality, holding all other variables constant (25).

To address concerns about low case counts in certain categories (specifically diagnosis categories 1 and 2, and treatment category 1, we conduct sensitivity analyses with two model specifications: combined categories model (combining diagnosis categories 1 and 2, and combining treatment categories 1 and 2), and restricted model (excluding observations with diagnoses 1 and 2, and treatment 1).

We conduct additional sensitivity analyses to test the robustness of our findings: subgroup analysis of patients with hospitalization longer than one day, addressing potential bias from early deaths; age-stratified analysis (≤ 70 years), examining whether relationships hold in younger populations; and comparison with logit model specifications to ensure results are not model-dependent. This comprehensive analytical approach aligns with current best practices in health services research (26) and provides a robust framework for examining mortality determinants.

RESULTS

Our preferred model specification (Fig. 1, Table 3) includes the full dataset, with standard errors clustered at the healthcare provider level and a non-linear age effect. Conservative treatment is associated with a 4.7 percentage point increase in 30-day mortality compared to PCI treatment (95% CI: 3.6–5.7) for STEMI patients.

The effect of conservative treatment on mortality is not statistically different from PCI+CABG or CABG alone. The mortality difference between conservative treatment and PCI varies across healthcare providers with HCP 2 as a reference, ranging from 0 to

4.3 percentage points. Age is associated with increased mortality risk, with each additional year (from mean age) increasing risk by 0.37 percentage points on average. Among comorbidities, acute stroke history (2.7 percentage points), ischaemic lower limb disease (2.5 percentage points), and diabetes mellitus (2.0 percentage points) are associated with the largest increases in mortality risk.

To address concerns about low case counts in certain categories, we conducted sensitivity analyses with multiple model specifications (Table 3). Column 2 presents results from a subgroup where the length of hospitalization exceeded 1 day using a probit model. This addresses potential bias from cases where patients died within 24 hours of admission, which showed significantly higher mortality rates, possibly due to unmeasured factors. The results remain consistent with our preferred model, though the effect of conservative treatment is slightly reduced to 3.3 percentage points.

Column 3 shows results for patients aged 70 years or younger, addressing the exponential increase in mortality rates beyond this age that might be influenced by unobserved factors. The results largely align with our main findings. Notably, for HCP 8, we observe a shift to a positive and statistically significant coefficient, likely reflecting different treatment protocols or patient selection practices for younger patients at this centre compared to the reference provider. For patients aged 70 or younger, admission to any HCP except HCP 2 is associated with an increased mortality probability of 0.1% to 5.4% relative to the reference HCP 2.

Column 4 presents results from a logit model for the complete sample, which yield estimates very similar to our preferred probit specification, confirming that our findings are not model-dependent.

Columns 5 and 6 address the issue of low case counts in certain diagnosis and treatment categories. Column 5 presents a model where we combined diagnoses 1 (other serious MI) and 2 (continuing MI) into a single category, and similarly combined

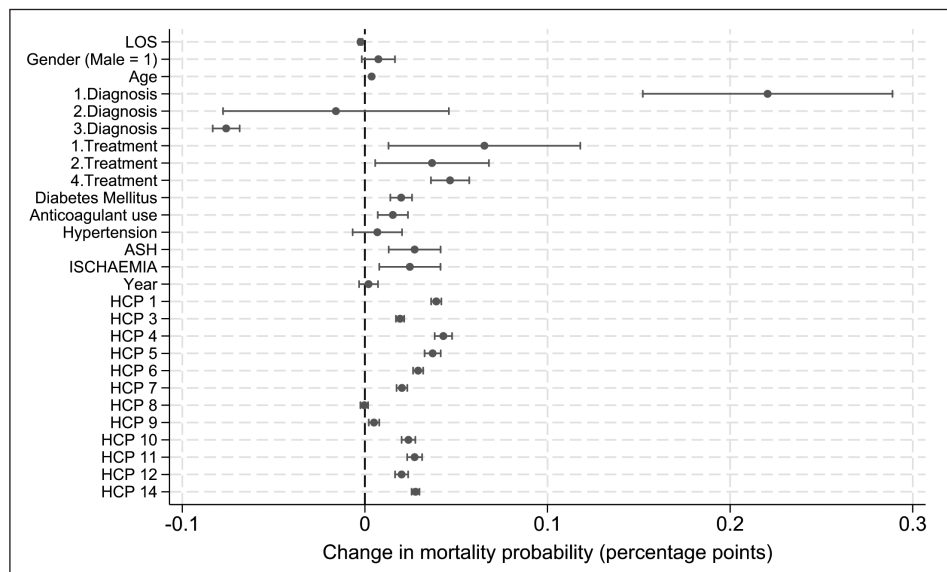


Fig. 1. Marginal effects on 30-day mortality probability from probit regression model.

Points represent average marginal effects (percentage point changes in 30-day mortality probability) with 95% confidence intervals. For diagnoses, STEMI (ST-elevation myocardial infarction) is the reference category: 1. Diagnosis – other serious MI; 2. Diagnosis – continuing MI; 3. Diagnosis – NSTEMI. For treatments, PCI (percutaneous coronary intervention) is the reference category: 1. Treatment – PCI+CABG; 2. Treatment – CABG; 4. Treatment – conservative treatment; ASH – acute stroke history; ISCHAEMIA – ischaemic lower limb disease.

HCP 2 (Healthcare provider 2) is the reference for healthcare providers. HCP 2 was used as the reference due to its lowest reported 30-day mortality rate. This choice affects the interpretation of results, where variables in a given group are always interpreted in relation to the reference variable.

Table 3. Marginal effects from probit and logit regression models on 30-day mortality

Variables	Probit	Probit (LOS > 1)	Probit (age ≤ 70)	Logit	Combined	Restricted
General						
Length of stay	-0.00241*** (0.000549)	-0.000411 (0.000367)	-0.000987** (0.000455)	-0.00294*** (0.000693)	-0.00229*** (0.000564)	-0.00180*** (0.000508)
Gender (male = 1)	0.00738 (0.00463)	0.00748** (0.00358)	0.00605 (0.00575)	0.00682 (0.00468)	0.00762 (0.00467)	0.00842* (0.00469)
Age	0.00369*** (0.000217)	0.00305*** (0.000251)	0.00229*** (0.000254)	0.00369*** (0.000204)	0.00371*** (0.000215)	0.00362*** (0.000190)
Diagnosis						
Other serious MI	0.221*** (0.0349)					
Continuing MI	-0.0159 (0.0315)	-0.0354** (0.0157)	-0.00108 (0.0287)	-0.0180 (0.0305)		
NSTEMI	-0.0760*** (0.00376)	-0.0599*** (0.00335)	-0.0466*** (0.00303)	-0.0761*** (0.00380)		
Treatment						
PCI+CABG	0.0655** (0.0268)					
CABG	0.0368** (0.0159)	0.0238** (0.0117)	0.0229** (0.00900)	0.0399** (0.0189)		
CT	0.0467*** (0.00534)	0.0333*** (0.00586)	0.0322*** (0.00802)	0.0462*** (0.00603)		
Comorbidities						
Diabetes mellitus	0.0199*** (0.00303)	0.0177*** (0.00291)	0.0102** (0.00481)	0.0199*** (0.00284)	0.0201*** (0.00309)	0.0209*** (0.00328)
Anticoagulant use	0.0153*** (0.00422)	0.0123*** (0.00334)	0.0106** (0.00528)	0.0150*** (0.00410)	0.0156*** (0.00415)	0.0168*** (0.00401)
Hypertension	0.00681 (0.00689)	0.00928* (0.00555)	0.00648 (0.00937)	0.00666 (0.00714)	0.00687 (0.00680)	0.00531 (0.00551)
Acute stroke history (ASH)	0.0272*** (0.00725)	0.0227*** (0.00664)	0.00700 (0.00923)	0.0266*** (0.00670)	0.0267*** (0.00731)	0.0280*** (0.00721)
Ischaemic lower limb disease (ISCHAEMIA)	0.0246*** (0.00856)	0.0214*** (0.00773)	0.0209*** (0.00676)	0.0230*** (0.00853)	0.0243*** (0.00872)	0.0260*** (0.00828)
Healthcare providers						
HCP 1	0.0391*** (0.00142)	0.0355*** (0.00117)	0.0537*** (0.00140)	0.0351*** (0.00125)	0.0395*** (0.00145)	0.0441*** (0.00155)
HCP 3	0.0192*** (0.00116)	0.0229*** (0.00126)	0.0177*** (0.000875)	0.0156*** (0.00138)	0.0173*** (0.000930)	0.0205*** (0.000940)
HCP 4	0.0430*** (0.00242)	0.0315*** (0.00203)	0.0404*** (0.00186)	0.0416*** (0.00268)	0.0418*** (0.00231)	0.0485*** (0.00199)
HCP 5	0.0371*** (0.00225)	0.0358*** (0.00214)	0.0326*** (0.00115)	0.0332*** (0.00254)	0.0373*** (0.00216)	0.0405*** (0.00207)
HCP 6	0.0292*** (0.00142)	0.0244*** (0.00114)	0.0389*** (0.00111)	0.0257*** (0.00142)	0.0291*** (0.00142)	0.0302*** (0.00122)
HCP 7	0.0203*** (0.00150)	0.0160*** (0.00156)	0.0259*** (0.000886)	0.0180*** (0.00177)	0.0198*** (0.00136)	0.0233*** (0.00140)
HCP 8	-0.000339 (0.00108)	-0.00344*** (0.000995)	0.00975*** (0.000530)	-0.00235* (0.00121)	-0.000238 (0.00109)	0.00311*** (0.00110)
HCP 9	0.00498*** (0.00146)	0.00247** (0.00121)	0.0116*** (0.000819)	0.00203 (0.00164)	0.00540*** (0.00140)	0.00500*** (0.00134)
HCP 10	0.0239*** (0.00192)	0.0248*** (0.00193)	0.0283*** (0.00116)	0.0212*** (0.00201)	0.0221*** (0.00166)	0.0251*** (0.00143)

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Variables	Probit	Probit (LOS > 1)	Probit (age ≤ 70)	Logit	Combined	Restricted
HCP 11	0.0272*** (0.00209)	0.0279*** (0.00202)	0.0286*** (0.00134)	0.0247*** (0.00228)	0.0253*** (0.00173)	0.0307*** (0.00156)
HCP 12	0.0201*** (0.00183)	0.0145*** (0.00199)	0.0183*** (0.00150)	0.0185*** (0.00210)	0.0199*** (0.00187)	0.0201*** (0.00151)
HCP 13	0.0277*** (0.00109)	0.0197*** (0.000974)	0.0250*** (0.00117)	0.0278*** (0.00104)	0.0289*** (0.00122)	0.0264*** (0.00120)
Restricted groups						
Continuing MI and other MI					0.148*** (0.0379)	
NSTEMI					-0.0762*** (0.00370)	-0.0756*** (0.00380)
CABG/PCI and CABG					0.0418** (0.0165)	0.0310** (0.0143)
CT					0.0488*** (0.00545)	0.0497*** (0.00513)
Observations	20,047	19,456	12,314	20,047	20,047	19,375
Pseudo R-squared	0.141	0.124	0.110	0.141	0.138	0.129
Log pseudolikelihood	-4390	-3774	-1895	-4390	-4407	-4094

Standard errors are in parentheses ***p<0.01, **p<0.05, *p<0.1

Estimates represent marginal effects (percentage point changes in mortality probability). For the group of diagnoses, STEMI (ST-elevation myocardial infarction) is selected as the reference diagnosis. For treatment approaches, PCI (percutaneous coronary intervention) serves as the reference category. HCP 2 (Healthcare provider 2) was used as the reference for healthcare providers due to its lowest reported 30-day mortality rate.

LOS – length of stay; NSTEMI – non-ST-elevation myocardial infarction; CABG – coronary artery bypass grafting

treatment types 1 (PCI+CABG) and 2 (CABG). Column 6 shows results from a model that excludes observations with diagnoses 1 and 2, and treatment 1 entirely. Both models yield coefficients consistent with our main findings, though with slight variations in magnitude. The effect of conservative treatment remains positive and statistically significant across all specifications, ranging from 3.1% to 5.0%.

Across all model specifications, the pattern of healthcare provider effects remains consistent, with most providers showing significantly higher mortality rates compared to the reference provider (HCP 2). This robust finding suggests that regional variations in AMI outcomes are not merely artefacts of model specification or outlier cases but reflect genuine differences in care quality or patient management across centres.

DISCUSSION

This study examined the relationship between treatment approaches and 30-day mortality rates for acute myocardial infarction patients across 13 complex cardiovascular centres in the Czech Republic. Our analysis revealed several important findings that have implications for clinical practice, healthcare organization, and public health policy.

The most significant finding is that conservative treatment is associated with increased 30-day mortality compared to percutaneous coronary intervention across all model specifications. The magnitude of this effect – a 4.7 percentage point increase in mortality probability – aligns with previous research by Rozenfeld et al. (12), who found substantially higher mortality rates (27% vs. 10%) among elderly STEMI patients receiving conservative

versus invasive treatment. Similarly, Widimský et al. (17) emphasized that timely reperfusion therapy, particularly PCI, improves outcomes for STEMI patients, which our results corroborate.

The definition of conservative treatment deserves reconsideration in the context of modern cardiology practice. Currently defined as “no interventional procedure or administration of a fibrinolytic agent,” this definition is increasingly obsolete given that fibrinolytics like alteplase or tenecteplase are rarely used for AMI treatment in the Czech Republic due to widespread PCI availability. A more comprehensive definition should encompass evidence-based pharmacotherapy recommendations for both pre-hospital care and in-hospital management of STEMI and NSTEMI patients, including timing of medication administration and appropriate dosing.

Regional variations in mortality outcomes represent another critical finding, with differences between healthcare providers ranging from 0 to 4.3 percentage points relative to the reference centre (HCP 2). These variations persisted across all sensitivity analyses, suggesting they reflect genuine differences in care quality or patient management rather than statistical artefacts. Notably, for HCP 8, we observed an interesting pattern – while it showed no significant effect in the main model, it demonstrated a positive and statistically significant coefficient (increased mortality) for younger patients (≤70 years). This age-specific variation suggests complex underlying factors may be at play, though our current dataset limitations prevent a more detailed exploration of the specific mechanisms responsible for this observed difference.

This study expands upon existing research on geographic disparities in cardiovascular care. Previous work by Olivari et al. (14) documented how implementation of invasive cardiac procedures shows marked regional variability, affecting estab-

lished quality metrics. Similarly, Hall et al. (13) demonstrated that while guideline-adherent treatments and risk stratification tools are associated with improved survival, their application varies considerably between regions. Our analysis extends these findings to the Czech healthcare context, demonstrating that geographic variations in outcomes persist even after adjusting for differences in patient demographics and treatment modalities.

From a public health perspective, our study identifies several opportunities for improvement. The Czech Republic has established a network of specialized cardiovascular centres, but standardized approaches to AMI management still show regional variation. Unlike stroke care, which benefits from comprehensive public awareness campaigns and standardized transport protocols, AMI care lacks similar public health initiatives despite the equally critical “time is myocardium” principle. This gap represents an opportunity for targeted public health interventions.

Several limitations warrant consideration when interpreting our results. First, administrative data lacks detailed clinical information that might explain treatment decisions. Second, while we controlled for several comorbidities, unmeasured confounding factors may exist. Third, the analysis of categories with small case counts (diagnosis categories 1 and 2, treatment category 1) required sensitivity analyses, though our findings remained robust across different model specifications. Fourth, our data does not include information on pre-hospital care timing, which significantly impacts outcomes.

Additionally, it is important to acknowledge the limitations of 30-day mortality as a quality indicator when interpreting our findings. Stolpe et al. recently documented that the OECD indicator “AMI 30-day mortality” reflects differences in healthcare system organization rather than actual quality of acute care (27). Their analysis identified several factors that artificially influence reported mortality rates, including different patient registration practices (particularly for day cases), varying frequencies of inter-hospital transfers, and differences in average length of stay.

In countries with highly centralized PCI services and frequent patient transfers, like Denmark, Norway and Sweden, mortality appears artificially lower because deaths are distributed across more admission cases in the denominator of mortality calculations. This methodological issue may partially explain some of the variations we observed between healthcare providers, particularly for HCP 8, which may have different patient transfer patterns. Additionally, as Stolpe et al. note, different inclusion criteria for hospital registries can significantly impact reported mortality rates, making direct comparisons between centres problematic without accounting for organizational factors (27). These considerations emphasize the need for caution when using mortality rates alone to assess health care quality, and they support our approach of conducting multiple sensitivity analyses to ensure the robustness of our findings.

Future research should address these gaps by tracking additional indicators, including time from symptom onset to first medical contact, percentage of patients receiving timely ECG, detailed pharmacotherapy data, standardized risk assessments (Killip classification for STEMI, Global Registry of Acute Coronary Events (GRACE) score for NSTEMI), comprehensive transfer data, and socioeconomic indicators. Implementing a more comprehensive data collection system would allow for a more nuanced analysis of factors contributing to regional mortality

differences and could inform targeted interventions to improve care quality and reduce disparities.

CONCLUSION

In conclusion, conservative treatment appears to significantly influence deaths within 30 days in AMI patients across Czech cardiovascular centres, with considerable regional variations that cannot be fully explained by patient characteristics. These findings underscore the need for standardized treatment protocols, improved data collection systems, and greater public health focus on AMI care to reduce regional disparities in outcomes.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the authors used Claude 3.5 Sonnet to improve the language used. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Conflicts of Interest

None declared

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Received November 11, 2024
Accepted in revised form March 25, 2025