Circulation: Cardiovascular Quality and Outcomes

ORIGINAL ARTICLE

Innovative Managed Care May Be Related to Improved Prognosis for Acute Myocardial Infarction Survivors

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BACKGROUND: Mortality following discharge in myocardial infarction survivors remains high. Therefore, we compared outcomes in myocardial infarction survivors participating and not participating in a novel, nationwide managed care program for myocardial infarction survivors in Poland.

METHODS: We used public databases. We included all patients hospitalized due to acute myocardial infarction in Poland between October 1, 2017 and December 31, 2018. We excluded from the analysis all patients aged ≤18 years as well as those who died during hospitalization or within 10 days following discharge from hospital. All patients were prospectively followed. The primary end point was defined as death from any cause.

RESULTS: The mean follow-up was 324.8±140.5 days (78 034.1 patient-years; 340.0±131.7 days in those who did not die during the observation). Participation in the managed care program was related to higher odds ratio of participating in cardiac rehabilitation (4.67 [95% CI, 4.44–4.88]), consultation with a cardiologist (7.32 [6.83–7.84]), implantable cardioverter-defibrillator (1.40 [1.22–1.61]), and cardiac resynchronization therapy with cardioverter-defibrillator implantation (1.57 [1.22–2.03]) but lower odds of emergency (0.88 [0.79–0.98]) and nonemergency percutaneous coronary intervention (0.88 [0.83–0.93]) and coronary artery bypass grafting (0.82 [0.71–0.94]) during the follow-up. One-year all-cause mortality was 4.4% among the program participants and 6.0% in matched nonparticipants. The end point consisting of all-cause death, myocardial infarction, or stroke occurred in 10.6% and 12.0% (*P*<0.01) of participants and nonparticipants respectively, whereas all-cause death or hospitalization for cardiovascular reasons in 42.2% and 47.9% (*P*<0.001) among participants and nonparticipants, respectively. The difference in outcomes between patients participating and not participating in the managed care program could be explained by improved access to cardiac rehabilitation, cardiac care, and cardiac procedures.

CONCLUSIONS: Managed care following myocardial infarction may be related to improved prognosis as it may facilitate access to cardiac rehabilitation and may provide a higher standard of outpatient cardiac care.

Key Words: coronary artery disease ■ mortality ■ myocardial infarction ■ prognosis ■ survivors

See Editorial by Oseran and Wadhera

The in-hospital mortality of patients with acute myocardial infarction (MI) has decreased substantially over the past 2 decades in many countries.[1,2]

However, 1-year mortality following discharge remains high.[3–6] According to the available evidence ≈1 in every 10 patients discharged after MI dies during the next 12

WHAT IS KNOWN

- Despite the overwhelming evidence of benefits, access to cardiovascular procedures and cardiovascular risk factor management is often not optimal in everyday clinical practice.
- The most important causes (in addition to age and comorbidities) of high mortality following myocardial infarction are: inadequate lifestyle changes, unsatisfactory risk factors control, insufficient access to, and delayed, cardiac rehabilitation, suboptimal pharmacotherapy, limited access to cardiac outpatient care, delayed complete myocardial revascularization, and underutilization of implantable cardiac devices.
- Managed care is an organizing principle of care delivery that aims to upgrade the patient's experience of services through enhanced coordination across and between settings.
- To improve health of acute myocardial infarction survivors, there is an urgent need for innovative strategies that facilitate accessibility to cardiac procedures and high-quality cardiac care.

WHAT THE STUDY ADDS

- A centrally guided and well-designed health care policy may have a real and substantial impact on a patient's prognosis over a relatively short period of time.
- Quality of care assessment and financial incentives may help in increasing quality of medical care following myocardial infarction.
- Managed care following myocardial infarction may increase the uptake of cardiac rehabilitation, cardiac consultations, and the number of implantable cardioverter-defibrillator implantations. However, it may decrease number of myocardial revascularization procedures.
- Facilitating access to cardiac rehabilitation programs and providing better outpatient cardiac care may improve prognosis of acute myocardial infarction survivors.
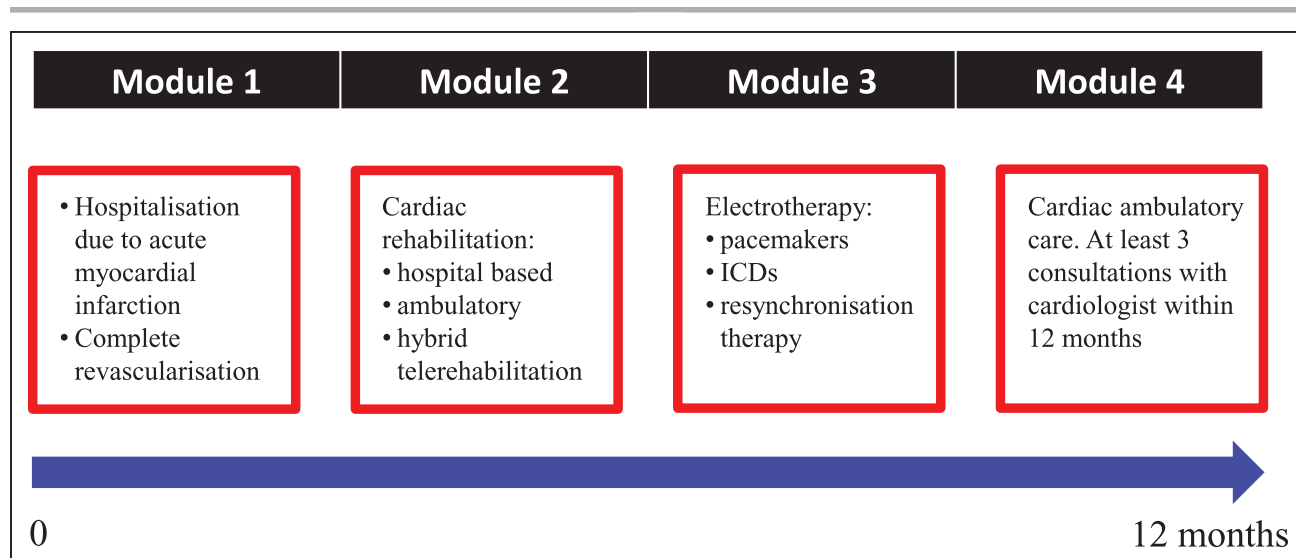
Nonstandard Abbreviations and Acronyms

ICD	implantable cardioverter-defibrillator
LDL	low-density lipoprotein
MACAMIS	Managed Care for Acute Myocardial Infarction Survivors
MI	myocardial infarction
PCI	percutaneous coronary intervention

months.[3,6] Besides age and comorbidities, the most important reasons for high mortality are inadequate lifestyle changes, unsatisfactory risk factors control, insufficient access to, and delayed, cardiac rehabilitation, suboptimal pharmacotherapy, limited access to cardiac outpatient care, delayed complete myocardial revascularization, and

underutilization of implantable cardiac devices (ie, cardioverters-defibrillators).[7–9] These gaps in care constitute targets where an improvement in quality is desired.[10] Indeed, all these barriers could be modified.

Managed care is an organizing principle of care delivery that aims to upgrade the patient's experience of services through enhanced coordination across and between settings. The managed care is related to improved prognosis in various health care settings.[11–14] It is also cost-effective.[14,15] It was in view of the advantages of managed care and the complexity of the determinants of the high mortality rate following MI that a new nationwide system of Managed Care for Acute Myocardial Infarction Survivors (MACAMIS) was implemented in Poland in 2017.[7] The system comprises a continuum of acute treatment of MI, staged revascularization, cardiac rehabilitation, cardiac electrotherapy, and cardiac ambulatory care within one year following MI (Figure 1). The first module consists in acute management, including immediate or staged revascularization, the second involves cardiac rehabilitation (hospital-based, ambulatory, or hybrid telerehabilitation), the third centers on implantation of cardioverters-defibrillators (ICD, with or without resynchronization therapy) in eligible patients, whereas the fourth module focuses on scheduled outpatient cardiology care (at least three consultations within 12 months are required). All hospitals participating in the program were expected to offer participation in the program to all patients who survived the acute phase of MI and, according to the physician, were eligible for this type of care. The reasons for the refusal to participate in the program could be the patient's lack of consent due to living in a place remote from the cardiology center, problems with transportation, caring for a seriously ill family member, lack of time, and other health problems. Another component of the MACAMIS program is the quality of care assessment based on quality indicators, including both clinical measures and the rate of minor and major cardiovascular events.[7] Each of the centers participating in the MACAMIS program is required to report the following measures: smoking, blood pressure, LDL (low-density lipoprotein) cholesterol and HbA1c level, and body mass index along with information on patients with implanted ICD, patients who have undergone complete revascularization, as well as patients participating in cardiac rehabilitation. Another unique feature of the MACAMIS program is the use of financial incentives in the form of bonuses paid by the National Health Fund. If a patient stays in the program for 12 months and completes all the modules the center is paid 15% more for the initial hospitalization and outpatient care; if the patient is revascularized by cardiac surgeons the center is paid 20% more for the operation; if the cardiac rehabilitation program starts within 14 days after discharge from the hospital the

Module 1	Module 2	Module 3	Module 4
• Hospitalisation due to acute myocardial infarction • Complete revascularisation	Cardiac rehabilitation: • hospital based • ambulatory • hybrid telerehabilitation	Electrotherapy: • pacemakers • ICDs • resynchronisation therapy	Cardiac ambulatory care. At least 3 consultations with cardiologist within 12 months

0   12 months

Figure 1. Outline of the Managed Care for Acute Myocardial Infarction Survivors Program.
ICD indicates implantable cardioverter-defibrillator.

center is paid 10% more for the rehabilitation; the centers also receive an additional 10% for the ambulatory rehabilitation. Finally, the centers are awarded a 10% bonus for the initial hospitalization and outpatient care of a patient who was professionally active and returns to work within 4 months following discharge from hospital.

The goal of the analysis was to compare the outcomes of MI survivors participating and not participating in the MACAMIS program.

METHODS

The data that support the findings of this study are available from the corresponding author upon reasonable request. The authors had access to the database population used to create the study population. The data were checked for accuracy, completeness, consistency, relevancy, validity, and uniformity.

As the MACAMIS program was introduced in Poland on October 1, 2017, we included all patients hospitalized due to acute MI in Poland between October 1, 2017 and December 31, 2018. We excluded from the analysis all patients aged <18 years as well as those who died during hospitalization or within 10 days following discharge from hospital.

A patient's history was determined using the data of the National Health Fund. A patient was coded as having a disease if the disease was reported by any hospital or any outpatient clinic to the National Health Fund database. Survival was determined according to the national database of deaths. Recurrent hospitalizations, including acute MI and stroke-related hospitalizations, were determined using the National Health Fund database. Hospitalization was defined as admission to a health care facility lasting >24 hours unless the patient died within 24 hours. The use of such procedures as percutaneous coronary intervention (PCI), coronary artery bypass grafting, pacemaker implantation, implantable cardioverter-defibrillator implantation, cardiac rehabilitation, and consultations with a cardiologist or a general practitioner

were determined based on the National Health Fund database. The hospital and department classification were based on the Polish Ministry of Health data.

We decided to assess the relation between attendance in the MACAMIS program and a consultation with a cardiologist or a general practitioner within 6 weeks of hospital discharge because the European Society of Cardiology guidelines recommend a reevaluation of blood lipids 4 to 6 weeks after an acute coronary syndrome.[16,17] The relation between the MACAMIS program on the one hand and starting cardiac rehabilitation within 14 days following discharge on the other was assessed because the Polish National Health Fund pays bonuses for starting cardiac rehabilitation within 14 days following discharge if a patient participates in the MACAMIS program. Ethics committee approval was not needed as the authors analyzed national database. The Informed consent was not required.

End Points

The primary end point was defined as death from any cause, whereas secondary end points were (1) all-cause death or hospitalization due to any cardiovascular disease and (2) all-cause death or myocardial infarction or stroke.

Statistical Analysis

Continuous variables are presented as mean±SDs, while categorical values are presented as percentages. A P value of <0.05 was considered statistically significant. Normally distributed continuous variables were compared using the Student t test. The Mann-Whitney U test was used in the case of variables without normal distribution. The Pearson χ^2 test was applied to all categorical variables. Bonferroni-corrected P value was used to account for multiple comparisons.

Propensity score matching encompassing nearest neighbor matching (1:1) without replacement, using variables listed in Table 1, was applied to form comparable groups of patients participating and not participating in the MACAMIS program. Propensity score was calculated using the logistic regression. Additionally, we ran 2 extra propensity score matching (see

Data Supplement). First, after exclusion of patients hospitalized in hospitals nonparticipating in the MACAMIS program. Second, after exclusion of patients nonparticipating in the MACAMIS program but hospitalized in hospitals participating in the program. Kaplan-Meier methods were used to construct unadjusted survival curves for each outcome and log-rank tests were performed to evaluate differences between matched cohorts for each end point. The Cox proportional hazard regression analysis was used to assess the relation between participation in the MACAMIS program and the end points. Commencing with all the variables presented in Table 1 stepwise analysis was conducted using the probability value >0.05. Subgroup analysis examined the relationship between participation in the MACAMIS program and survival in multivariable analysis. The test for interaction in the Cox model was used to compare hazard ratios between the analyzed subgroups. Multivariable logistic analysis was used to assess the independent relations between the MACAMIS program and the following: participation in cardiac rehabilitation, undergoing PCI, coronary artery bypass grafting, implantation of a pacemaker or ICD, as well as consultation with a cardiologist or a general

practitioner. The statistics were calculated with STATISTICA 13 software (TIBCO Software).

RESULTS

Overall, data from 87 739 patients were analyzed (overwhelming majority of patients were of Polish origin). Among them, 10 404 (11.9%) patients participated in the MACAMIS program. These patients were hospitalized in 48 hospitals around the country (≈34% of all hospitals treating acute MI patients in Poland). Of the 34 064 patients discharged from hospitals where the MACAMIS program had been implemented, 30.5% participated in the program. The baseline characteristics of the analyzed groups are presented in Table 1. Participants of the MACAMIS program were significantly younger and more often male compared to those not participating in the program. The groups also differed with respect to several other variables. Using the 1:1 propensity score,

Table 1. Baseline Characteristics of the Analyzed Groups

	The whole cohort of patients not participating in the program		Patients participating in the program		Matched cohort of patients not participating in the program
	N=77 335	*P* value	N=10 404	*P* value	N=10 404
Age, y	68.5±11.9	<0.001	65.6±11.0	0.95	65.6±11.6
Sex					
Males, %	62.7	<0.001	68.1	0.50	68.5
Females, %	37.3		31.9		31.5
Patients' history					
Hypertension, %	74.0	<0.001	70.3	0.80	70.4
Diabetes, %	30.8	<0.001	28.1	0.26	27.4
Atrial fibrillation, %	12.6	<0.001	8.7	0.41	8.4
Previous stroke, %	2.9	<0.001	2.3	0.18	2.0
Previous myocardial infarction, %	7.7	<0.001	5.7	0.79	5.6
Previous PCI, %	11.4	<0.001	10.0	0.95	10.0
Previous CABG, %	0.9	0.39	0.9	0.09	0.7
Heart failure, %	22.1	<0.001	14.5	0.91	14.4
Chronic kidney disease, %	8.2	<0.001	5.3	0.85	5.2
Previous dialysis, %	1.2	<0.001	0.5	0.51	0.6
Cancer in the history, %	22.7	0.03	21.7	0.60	21.4
Chronic obstructive pulmonary disease, %	10.9	<0.001	9.4	0.92	9.5
Index hospitalization					
ST-segment–elevation myocardial infarction presentation, %	32.8	<0.001	41.3	0.46	41.8
Coroangiography, %	88.9	<0.001	97.7	0.15	98.0
PCI, %	71.6	<0.001	90.0	0.43	90.3
CABG, %	4.3	<0.001	2.9	0.47	3.1
Department					
Cardiology, %	86.7	<0.001	94.2	0.68	94.0
Internal diseases, %	9.8	<0.001	4.8	0.77	4.9
Other, %	3.5	<0.001	1.1	0.74	1.1

Values are presented as mean±SD, or n (%). CABG indicate coronary artery bypass grafting; and PCI, percutaneous coronary intervention.

matching groups with well-balanced covariables were formed (Table 1, Figure I in the Data Supplement).

The mean follow-up was 324.8±140.5 days (78 034.1 patient-years) for the analyzed population as a whole and 340.0±131.7 for those who did not die during the observation. Overall, 403 participants of the MACAMIS program and 7010 nonparticipants died during the observation period. In addition, 613 participants and 5121 nonparticipants suffered from myocardial infarction, whereas 95 participants and 1195 nonparticipants suffered strokes.

The 1-year all-cause mortality was 4.4% among program participants (n=10 404) and 9.5% among those who did not participate in the program (n=77 335; $P<0.001$). The corresponding all-cause mortality was also lower among participants when we analyzed the matched groups (4.4% versus 6.0%, Figure 2A). The one-year all-cause mortality was lower among participants of the program irrespectively of sex and age (Figure II in the Data Supplement). The end point comprising all-cause death, myocardial infarction, or stroke occurred in 10.6% and 16.2% in the participants and nonparticipants respectively ($P<0.001$) when analyzing nonmatched groups and 10.6% versus 12.0% ($P<0.01$) when comparing matched groups (Figure 2B). The end point consisting of all-cause death or hospitalization for cardiovascular reasons occurred in a smaller proportion of participants compared to nonparticipants both when we analyzed nonmatched groups (42.2% versus 50.6%, $P<0.001$) as well as when we analyzed matched groups (42.2% versus 47.9%, $P<0.001$, Figure 2C).

A similar proportion of participants and nonparticipants underwent PCI when comparing the nonmatched groups, but proportion of participants who underwent PCI was lower among participants when the matched groups were analyzed (Table 2). The number of days from hospital discharge to PCI was similar. A significantly higher proportion of nonparticipants of the MACAMIS program underwent coronary artery bypass grafting during the observation period. ICDs (with and without resynchronization therapy) were implanted more often in participants of the MACAMIS program. Significantly more patients from the MACAMIS group underwent inpatient, outpatient as well as hybrid cardiac rehabilitation. The difference was especially large when we compared proportions of patients who began cardiac rehabilitation within 14 days of discharge (Table 2). A higher proportion of the MACAMIS program participants had a consultation with a cardiologist and the difference is even more marked in the case of consultations taking place within 6 weeks following discharge. The mean number of consultations with a cardiologist was also significantly lower among nonparticipants of the program. However, the nonparticipants had significantly more contacts with general practitioners. Table 3 shows the relation between participation in the MACAMIS program and all procedures listed in Table 2 after multivariable adjustments.
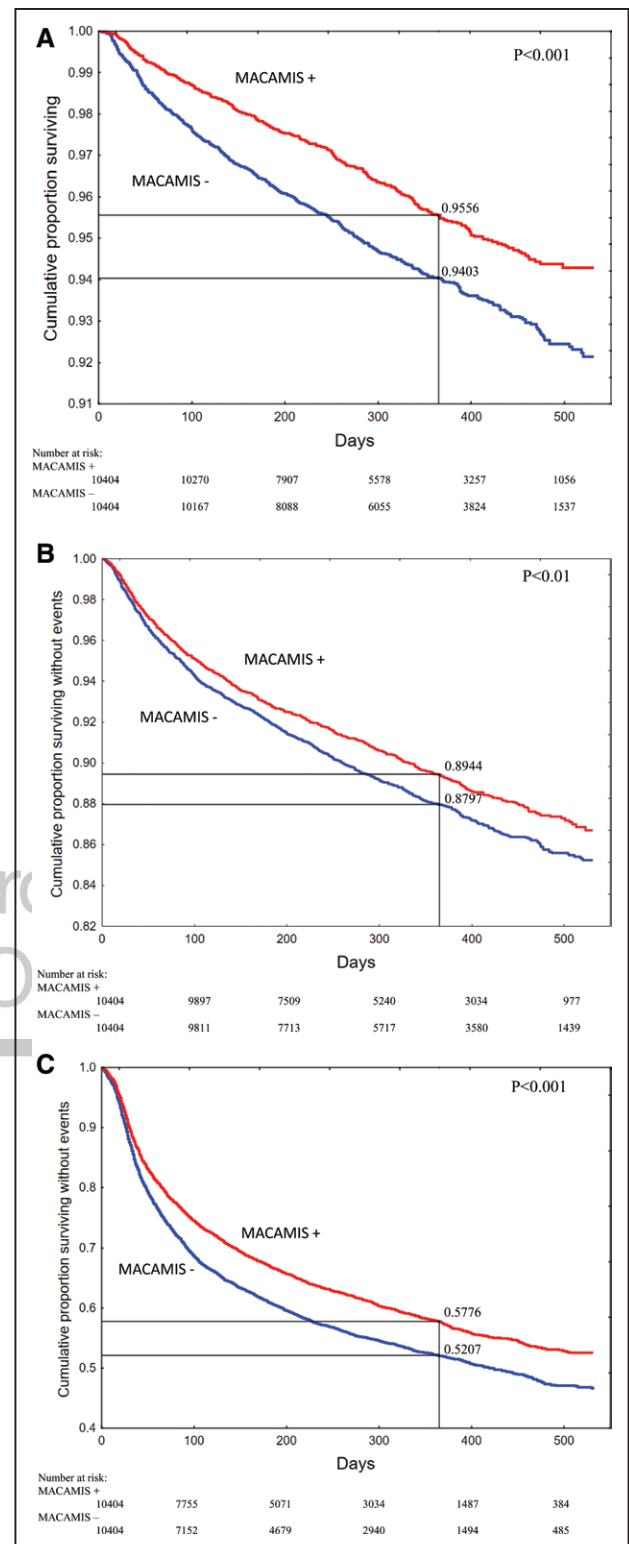
Figure 2. Kaplan-Meier curves displaying the estimated event-free survival probability of patients participating and not participating in the Managed Care for Acute Myocardial Infarction Survivors (MACAMIS) program.
Matched groups. **A**, All-cause death. **B**, All-cause death or myocardial infarction or stroke. **C**, All-cause death or hospitalization for cardiovascular purposes.

Table 2. Cardiac Procedures According to the Analyzed Groups

	The whole cohort of patients not participating in the program		Patients participating in the program		Matched cohort of patients not participating in the program
	N=77 335	*P* value	N=10 404	*P* value	N=10 404
PCI					
All, n (%)	13 953 (18.04)	0.79	1888 (18.15)	<0.001	2171 (20.87)
Emergency, n (%)	3452 (4.46)	<0.001	378 (3.63)	<0.01	447 (4.30)
Nonemergency, n (%)	10 501 (13.58)	<0.01	1510 (14.51)	<0.001	1724 (16.57)
Days from discharge					
To emergency PCI, d	72 (30–162)	0.11	81 (31–165)	0.49	94 (36–216)
To nonemergency PCI, d	44 (28–86)	0.68	47 (29–88)	0.14	49 (30–93)
CABG					
n (%)	2210 (2.86)	<0.01	242 (2.33)	0.04	289 (2.78)
Days from discharge to CABG, days	64 (33–114)	<0.01	79 (41–127)	0.93	78 (44–128)
Any nonemergency revascularization ≤30 d from discharge, n (%)	3709 (4.80)	0.23	527 (5.07)	0.61	512 (4.92)
Implantable devices					
ICD, n (%)	1310 (1.69)	<0.001	252 (2.42)	<0.001	159 (1.53)
CRT-D, n (%)	395 (0.51)	<0.01	76 (0.73)	0.05	54 (0.52)
CRT-P, n (%)	65 (0.08)	0.06	3 (0.03)	0.21	7 (0.7)
Pacemaker, n (%)	749 (0.97)	0.07	82 (0.79)	0.88	84 (0.81)
Days from discharge to implantation of an implantable device, d	119 (56–213)	0.29	110 (64–182)	0.68	111 (52–195)
Cardiac rehabilitation					
Overall, n (%)	22 704 (29.36)	<0.001	7342 (70.57)	<0.001	3943 (37.90)
≤14 d after discharge, n (%)	3892 (5.03)	<0.001	4937 (47.45)	<0.001	742 (7.13)
Inpatient cardiac rehabilitation					
Overall, n (%)	19 565 (25.30)	<0.001	4097 (39.38)	<0.001	3310 (31.81)
≤14 d after discharge, n (%)	3121 (4.04)	<0.001	2533 (24.35)	<0.001	576 (5.54)
Outpatient cardiac rehabilitation					
Overall, n (%)	3630 (4.69)	<0.001	3374 (32.43)	<0.001	732 (7.04)
≤14 d after discharge, n (%)	768 (0.99)	<0.001	2378 (22.86)	<0.001	167 (1.61)
Hybrid cardiac telerehabilitation					
Overall, n (%)	145 (0.19)	<0.001	102 (0.98)	<0.001	29 (0.28)
≤14 d after discharge, n (%)	9 (0.01)	<0.001	35 (0.34)	<0.001	1 (0.01)
Cardiologists					
Consulted patients, n (%)	42 121 (54.47)	<0.001	9468 (91.00)	<0.001	6242 (60.00)
Consulted patients <42 d after discharge, n (%)	11 736 (15.18)	<0.001	5886 (56.57)	<0.001	1769 (17.00)
Mean number of consultations per patient	1.82±2.33	<0.001	3.08±2.11	<0.001	2.07±2.47
Days from discharge to first consultation, d	80 (36–140)	<0.001	39 (34–49)	<0.001	80 (35–136)
General practitioners					
Consulted patients, n (%)	74 327 (96.11)	0.16	10 029 (96.40)	0.28	10 057 (96.66)
Consulted patients <42 d after discharge, n (%)	63 706 (82.38)	<0.001	7098 (68.22)	<0.001	8644 (83.08)
Mean number of consultations per patient	14.66±10.38	<0.001	13.43±8.81	<0.001	14.72±10.20
Days from discharge to first consultation, d	13 (5–27)	<0.001	22 (7–48)	<0.001	12 (5–27)

Values are presented as mean±SD, median (interquartile range), or n (%). The tabulation includes the first procedure for each patient. CABG indicates coronary artery bypass grafting; CRT-D, cardiac resynchronization therapy with cardioverter-defibrillator; CRT-P, cardiac resynchronization therapy with pacemaker; ICD, implantable cardioverter-defibrillator; and PCI, percutaneous coronary intervention.

The independent predictors of all-cause mortality are presented in Table 4. An analysis of the unmatched groups revealed that participation in the MACAMIS program was related to the risk of all-cause death both in univariable (hazard ratio, 0.43 [95% CI, 0.39–0.48]) and multivariable analysis (hazard ratio,

0.67 [95% CI, 0.61–0.74]). The participation in the MACAMIS program was also related to the risk of death or MI or stroke (univariable: 0.63 [0.59–0.68]; multivariable: 0.84 [0.78–0.89]) and risk of death or hospitalization due to cardiovascular reasons: 0.77 (0.75–0.80) and 0.83 (0.80–0.85) for the univariable and multivariable analysis, respectively. When we studied the matched cohorts, the hazard ratio (95% CI) was 0.70 (0.62–0.80) for all-cause death, 0.88 (0.81–0.95) for the end point consisting of death, MI, or stroke, and 0.82 (0.79–0.86) for death or

Table 3. Associations of Medical Procedures Use With Participation in the MACAMIS Program

	Odds ratio (95% CIs)	
	Univariable	Multivariable*
PCI		
Emergency	0.81 (0.73–0.90)	0.88 (0.79–0.98)
Nonemergency	1.08 (1.00–1.17)	0.88 (0.83–0.93)
CABG	0.81 (0.71–0.92)	0.82 (0.71–0.94)
Any nonemergency revascularization ≤30 d from discharge	1.06 (0.99–1.14)	0.98 (0.88–1.08)
Implantable devices		
ICD	1.44 (1.26–1.65)	1.40 (1.22–1.61)
CRT-D	1.43 (1.12–1.83)	1.57 (1.22–2.03)
CRT-P	0.34 (0.11–1.10)	0.48 (0.15–1.55)
Pacemaker	0.81 (0.65–1.02)	1.00 (0.95–1.06)
Any cardiac rehabilitation		
Overall	5.63 (5.38–5.89)	4.67 (4.44–4.88)
≤14 d after discharge	16.89 (16.06–17.76)	14.64 (13.89–15.42)
Inpatient cardiac rehabilitation		
Overall	1.92 (1.84–2.00)	1.53 (1.46–1.60)
≤14 d after discharge	7.65 (7.23–8.10)	6.52 (6.14–6.93)
Outpatient cardiac rehabilitation		
Overall	9.74 (9.24–10.27)	7.52 (7.10–7.95)
≤14 d after discharge	29.54 (27.14–32.15)	22.25 (20.38–24.30)
Hybrid cardiac telerehabilitation		
Overall	5.27 (4.09–6.80)	4.52 (3.49–5.84)
≤14 d after discharge	29.00 (13.93–60.37)	24.69 (11.84–51.47)
Consultation with a cardiologist		
Overall	8.46 (7.89–9.06)	7.32 (6.83–7.84)
<42 d after discharge	7.28 (6.97–7.61)	6.91 (6.60–7.23)
Consultation with a general practitioner		
Overall	1.08 (0.98–1.20)	1.01 (0.81–1.26)
<42 d after discharge	0.46 (0.44–0.48)	0.45 (0.43–0.47)

*The following variables were included in the statistical model: age, sex, hypertension, diabetes, atrial fibrillation, heart failure, stroke, MI, chronic kidney disease, dialysis, chronic obstructive pulmonary disease and cancer in the history, ST-elevation MI at presentation, coroangiography, PCI, CABG, hospital, and department. CABG indicates coronary artery bypass grafting; CRT-D, cardiac resynchronization therapy with cardioverter-defibrillator; CRT-P, cardiac resynchronization therapy with pacemaker; ICD, implantable cardioverter-defibrillator; MACAMIS, Managed Care for Acute Myocardial Infarction Survivors; MI, myocardial infarction; and PCI, percutaneous coronary intervention.

Table 4. Independent Predictors of All-Cause Death (the Whole Cohort; n=87 739)

Variable	Hazard ratio (95% CIs)
Age per 10 y	1.62 (1.58–1.66)
Sex, men: 1, women: 0	1.21 (1.16–1.28)
Hypertension	0.86 (0.80–0.92)
Diabetes	1.23 (1.17–1.29)
Atrial fibrillation	1.11 (1.04–1.17)
Previous stroke	1.55 (1.41–1.70)
Previous myocardial infarction	1.17 (1.09–1.25)
Heart failure	1.66 (1.57–1.75)
Chronic kidney disease	1.27 (1.19–1.36)
Previous dialysis	2.15 (1.88–2.46)
Cancer in the history	1.19 (1.13–1.25)
Chronic obstructive pulmonary disease	1.28 (1.20–1.36)
Index hospitalization	
ST-segment–elevation myocardial infarction presentation	1.08 (1.02–1.15)
Coroangiography	0.63 (0.59–0.68)
PCI	0.72 (0.68–0.76)
CABG	0.50 (0.42–0.59)
Department	
Cardiology	0.61 (0.55–0.67)
Internal diseases	0.79 (0.71–0.88)
Other	1.00
MACAMIS	0.67 (0.61–0.74)

CABG indicates coronary artery bypass grafting; PCI, percutaneous coronary intervention; and MACAMIS, Managed Care for Acute Myocardial Infarction Survivors.

hospitalization for cardiovascular reasons. Table I in the Data Supplement presents associations of outcomes with participation in the MACAMIS program after exclusion of patients hospitalized in hospitals not participating in the MACAMIS program and after exclusion of patients not participating in the MACAMIS program, but hospitalized in hospitals participating in the program.

Table 5 presents the subgroup analysis. The interaction term was significant for age, hypertension, heart failure, previous PCI (an individual's history of PCI before the index MI), and ST-segment–elevation MI, thus suggesting that the influence of the MACAMIS program on prognosis may be lower in more diseased patients. Table 6 presents hazard ratios of the end point with additional adjustments made for the procedures included in the MACAMIS program. The adjustment for a consultation with a cardiologist within 6 weeks following discharge and beginning cardiac rehabilitation within 2 weeks following discharge increased the hazard ratios. When all procedures (myocardial revascularization, consultation with a cardiologist, with a general practitioner, and cardiac rehabilitation) were included in the model the hazard ratios were close to 1.0.

Table 5. Subgroup Analysis of the Relation Between Participation in the MACAMIS Program and All-Cause Death According to Variables Presented in Table 1

Variable	Hazard ratio (95% CIs)	P value for interaction
Age		
≤58 y	0.64 (0.43–0.97)	
58–65 y	0.67 (0.51–0.88)	
65–73 y	0.54 (0.44–0.67)	<0.01
>73 y	0.75 (0.65–0.86)	
Sex		
Males	0.64 (0.56–0.73)	
Females	0.74 (0.63–0.88)	0.07
Hypertension	0.71 (0.64–0.79)	
No hypertension	0.51 (0.39–0.67)	<0.001
Diabetes	0.68 (0.58–0.80)	
No diabetes	0.67 (0.58–0.77)	0.25
Atrial fibrillation	0.64 (0.50–0.82)	
No atrial fibrillation	0.68 (0.61–0.76)	0.53
Previous stroke	0.75 (0.50–1.12)	
No previous stroke	0.67 (0.60–0.74)	0.09
Previous myocardial infarction	0.77 (0.57–1.04)	
No previous myocardial infarction	0.67 (0.60–0.75)	0.27
Previous PCI	0.82 (0.65–1.04)	
No previous PCI	0.66 (0.59–0.74)	0.03
Previous CABG	0.26 (0.09–1.09)	
No previous CABG	0.68 (0.62–0.76)	0.27
Heart failure	0.74 (0.63–0.87)	
No heart failure	0.65 (0.57–0.74)	<0.01
Chronic kidney disease	0.68 (0.52–0.89)	
No chronic kidney disease	0.67 (0.60–0.75)	0.11
Previous dialysis	0.68 (0.35–1.29)	
No previous dialysis	0.67 (0.61–0.75)	0.70
Cancer in the history	0.66 (0.55–0.80)	
No cancer in the history	0.68 (0.60–0.77)	0.46
Chronic obstructive pulmonary disease	0.76 (0.60–0.97)	
No chronic obstructive pulmonary disease	0.65 (0.58–0.73)	0.06
Index hospitalization		
ST-segment–elevation myocardial infarction	0.60 (0.49–0.72)	
Non–ST-segment–elevation myocardial infarction	0.72 (0.63–0.81)	0.03
Coroangiography	0.69 (0.62–0.77)	
No coroangiography	0.51 (0.29–0.90)	0.11
PCI	0.71 (0.63–0.79)	
No PCI	0.61 (0.47–0.81)	0.71
CABG	0.82 (0.42–1.63)	
No CABG	0.67 (0.60–0.74)	0.22
Department		
Cardiology	0.68 (0.61–0.76)	
Internal diseases	0.69 (0.48–1.00)	0.93
Other	0.58 (0.32–1.07)	

CABG indicates coronary artery bypass grafting; PCI, percutaneous coronary intervention; and MACAMIS, Managed Care for Acute Myocardial Infarction Survivors.

DISCUSSION

The long-term mortality rate after an acute MI continues to be high in many countries. Although causes of high mortality are usually complex, many of them can be addressed by a managed care program. The nationwide MACAMIS program was designed to encompass both state-of-art in-hospital conservative and invasive management of acute MI, as well as postdischarge cardiac rehabilitation, prevention of sudden cardiac death, and meticulous outpatient clinical visits over the course of 12 months following an acute MI. Participation in the MACAMIS program may be related to decreased mortality and morbidity in MI survivors. The program may facilitate access to cardiac outpatient care, cardiac rehabilitation, and implantation of cardiac implantable electronic devices. To the best of our knowledge, the MACAMIS program is the first nationwide, structured, and comprehensive care system that comes close to meeting the criteria for an optimal system of management of patients following MI.

The present results confirm the influence that individual procedures have on the risk of death. Indeed, outpatient follow-up care by a cardiologist following an acute MI or hospitalization due to systolic heart failure is related to a substantial reduction in the risk of death.[18,19] Similarly, cardiac rehabilitation is effective in terms of mortality and morbidity.[20,21] The use of ICDs is related to lower risk of all-cause deaths in patients with impaired left ventricular systolic function.[22] In addition, resynchronization therapy reduces both mortality and morbidity.[23] Complete myocardial revascularization is also related to improved prognosis following acute MI.[24] The adjustment for procedures included in the MACAMIS program resulted in the value of a hazard ratio of ≈1.0, suggesting that these procedures are responsible for a lower risk of the end points among participants of the MACAMS program. Taking all these factors into account, our data further supports the crucial role of a systematic approach to the postdischarge care of patients with MI.

Our study demonstrates that a centrally guided and well-designed healthcare policy may have a real and substantial impact on a patient's prognosis over a relatively short period of time. Financial incentives were shown to be effective in other areas.[25–27] However, the financial penalties may not be related to improved survival.[28,29] To the best of our knowledge, the present analysis is the first premise that financial incentives may contribute to a better prognosis of MI survivors through improved access to life-saving procedures, and possibly higher quality of medical care.

Education, income, unemployment, loneliness, social support, depression, and other socioeconomic factors are related to cardiovascular risk factor control, effectiveness of cardiac rehabilitation programs, and mortality following acute myocardial infarction.[30–35] As we analyzed data from public database, which does not gather information on these factors, we could not take them into account. It is possible that some of the mentioned factors could influence the effectiveness of the MACAMIS program or even partly explain the present results.

Table 6. Associations of Outcomes With Participation in the MACAMIS Program With Additional Adjustment for Procedures Included in the MACAMIS Program

Variable	Hazard ratio (95% CIs)		
	All-cause death	All-cause death or myocardial infarction or stroke	All-cause death or hospitalization due to cardiovascular reasons
MACAMIS program*	0.71 (0.64–0.79)	0.85 (0.79–0.92)	0.85 (0.81–0.88)
Additional adjustment for:			
Consultation with a cardiologist†	0.81 (0.72–0.91)	0.93 (0.86–1.00)	0.89 (0.85–0.93)
Consultation with a general practitioner†	0.69 (0.62–0.77)	0.83 (0.87–0.90)	0.85 (0.82–0.89)
Nonemergency myocardial revascularization‡	0.71 (0.63–0.79)	0.84 (0.78–0.91)	0.85 (0.81–0.88)
Inpatient cardiac rehabilitation§	0.78 (0.69–0.87)	0.89 (0.82–0.96)	0.86 (0.83–0.90)
Outpatient cardiac rehabilitation§	0.80 (0.72–0.90)	0.93 (0.86–1.00)	0.90 (0.87–0.95)
Hybrid cardiac telerehabilitation§	0.72 (0.64–0.79)	0.85 (0.78–0.91)	0.85 (0.81–0.88)
Consultation with a cardiologist†+consultation with a general practitioner†+nonemergency revascularization‡+any cardiac rehabilitation§	1.00 (0.89–1.13)	1.06 (0.97–1.15)	0.98 (0.93–1.02)

All cases with end points occurring within 42 d following discharge were excluded. MACAMIS indicates Managed Care for Acute Myocardial Infarction Survivors.

*Covariables as in Table 4.

†Within <42 d after discharge.

‡Within ≤30 d after discharge.

§Within ≤14 d after discharge.

Limitations

The present analysis has some limitations. First, this is a cohort study. Hence, only a statistical association rather than any causal relationships could be confirmed. Second, the public database we used does not contain information on the completeness of myocardial revascularization in analyzed groups. Although it is possible that the MACAMIS program is also related to the proportion of patients with complete revascularization, no firm conclusion in this regard could be drawn based on the analyzed data. Third, we had no data concerning race, and majority of studied patients were of Polish origin. Therefore, our study design does not allow insight into how managing care affects racial disparities. Fourth, we had no data concerning the socioeconomic status of patients, which potentially could explain the present results. Fifth, we were unable to analyze the patients' lifestyle nor the prescription rates for cardioprotective drugs. The inclusion of such data in the present analysis could even increase the impact of our results. Finally, the present results are based on the robustness of the public databases we used.

Conclusions

Managed care following myocardial infarction may be related to improved prognosis by facilitating access to cardiac rehabilitation programs and providing better outpatient cardiac care.

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Supplemental Materials

Table I

Figures I–II

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