ORIGINAL ARTICLE

IMPACT OF CERTAIN PUBLIC HEALTH FACTORS ON THE DURATION OF INPATIENT TREATMENT OF MI PATIENTS

DOI: 10.36740/WLek202005103

Natalia O. Terenda, Arkadii H. Shulhai, Yurii M. Petrashyk, Olha N. Lytvynova, Natalia Y. Panchyshyn, Natalia O. Slobodian, Liudmyla V. Lishtaba, Valentyna L. Smirnova, Larysa P. Zaporozhan
I.HORBACHEVSKY TERNOPIL NATIONAL MEDICAL UNIVERSITY, TERNOPIL, UKRAINE

ABSTRACT

The aim was to study the impact of predictors on the duration of inpatient treatment of MI patients.

Materials and methods: We copied data of 462 inpatient medical records of myocardial infarction patients who underwent hospital treatment by different methods (coronary artery stenting, thrombolytic therapy, conventional drug therapy). We determined basic predictors and duration of inpatient treatment of MI patients. Impact of the parameters was studied using Cox regression.

Results: We built models of hazard ratios of coronary artery stenting impact on treatment duration for myocardial infarction patients, which proved that this treatment method significantly reduced the treatment duration, even after correction of confounders like sex (HR=1.32; p=0.041), age over 60 (HR=1.31; p=0.048) and heart failure Stage 2A-2B (HR=1.36; p=0.020).

Conclusions: The results we obtained indicate a statistically significant effect of CAS on MI patients' treatment duration, both separately and combined with multiple effects of confounders, indicating its medical effectiveness and the need for widespread introduction of this treatment method in medical practice in every region of Ukraine.

KEY WORDS: myocardial infarction; predictors; treatment duration; coronary artery stenting

Wiad Lek. 2020;73(5):850-856

INTRODUCTION

The current paradigm of cardiovascular disease management, including myocardial infarction, emphasizes the importance of risk assessment when making decisions about their prevention and treatment [1]. The study of predictors of the risk of developing cardiovascular diseases and their prevention is the main focus of the modern health care system [2-10]. The combination of individual predictors in one patient creates a multiplier effect and increases the risk of death from diseases of the circulatory system by a factor of 5 to 7 [11]. The results of 18 cohort studies conducted in the United States show that only 3% of people aged 55 have the optimal level of risk factors [12].

Global, national, regional initiatives, programs, strategies for reducing the medical, economic and social burden of myocardial infarction are being introduced in the world. One of their components is the introduction of optimal treatment methods and a reduction in the length of inpatient treatment for myocardial infarction (MI) patients.

THE AIM

The aim was to study the impact of predictors on the duration of inpatient treatment of MI patients.

MATERIALS AND METHODS

We copied data of 462 inpatient medical records of myocardial infarction patients who underwent hospital treatment by different methods (coronary artery stenting, thrombolytic therapy, conventional drug therapy). We determined basic predictors and duration of inpatient treatment of MI patients. Impact of the parameters was studied using Cox regression. The research has been checked by the Bioethics Commission of I. Horbachevsky Ternopil National Medical University, protocol No 55 of 04 November 2019.

RESULTS

Groups of MI patients with different treatments were significantly different by age. Regression analysis with a single predictor – patient's age – showed that it increases the treatment duration by 19.0% (Figure 1).

In-depth analysis of age groups found that age reduces, with statistical significance, the hospital treatment duration by 35% in the second group, and increases by 26% in the third group (Table I).

Aggregate curves that characterize the impact of age groups on the duration of in-patient treatment for MI patients suggest that patients under the age of 44 are least likely to be hospitalized (up to 15 bed-days), and an increase in age leads to prolonged treatment especially in patients over 60 (Figures 2, 3).

The analysis showed that the age of patients significantly affects the increase in treatment duration regardless of the chosen treatment and can be a confounder in treatment of myocardial infarction patients.

```
. stcox     Age

        failure _d:  1 (meaning all fail)
  analysis time _t:  Duration_total

Iteration 0:   log likelihood = -1390.5654
Iteration 1:   log likelihood = -1388.4096
Iteration 2:   log likelihood = -1388.3968
Iteration 3:   log likelihood = -1388.3968
Refining estimates:
Iteration 0:   log likelihood = -1388.3968

Cox regression -- Breslow method for ties

No. of subjects =          288                     Number of obs   =       288
No. of failures =          288
Time at risk    =         3591
                                                   LR chi2(1)      =      4.34
Log likelihood  =   -1388.3968                     Prob > chi2     =    0.0373
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_t	Haz. Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Age	.8076369	.0810137	-2.13	0.033	.6634872	.9831047

Fig. 1. Impact of age of MI patients on the duration of inpatient treatment

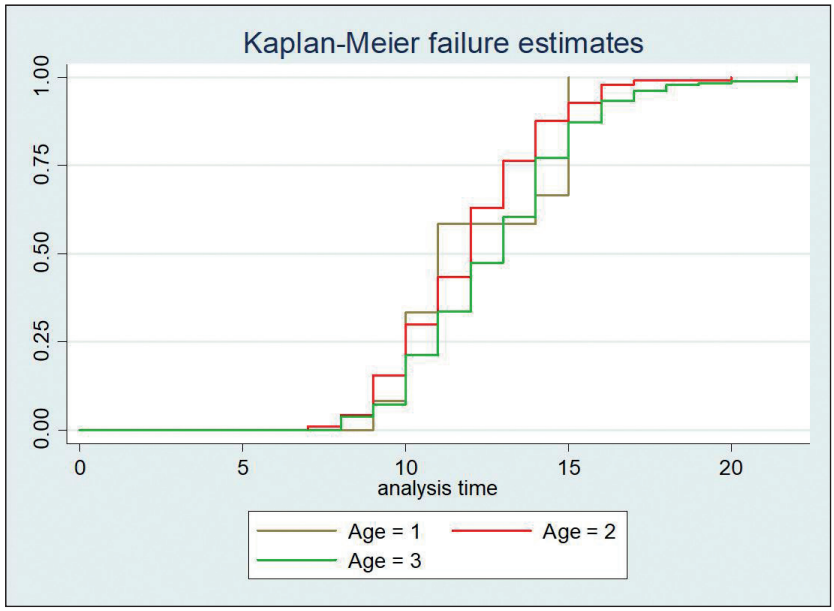

Fig. 2. Impact of age groups of myocardial infarction patients on the duration of hospital stay (Age=1 – up to 44, Age=2 – 45-59, Age=3 – over 60)

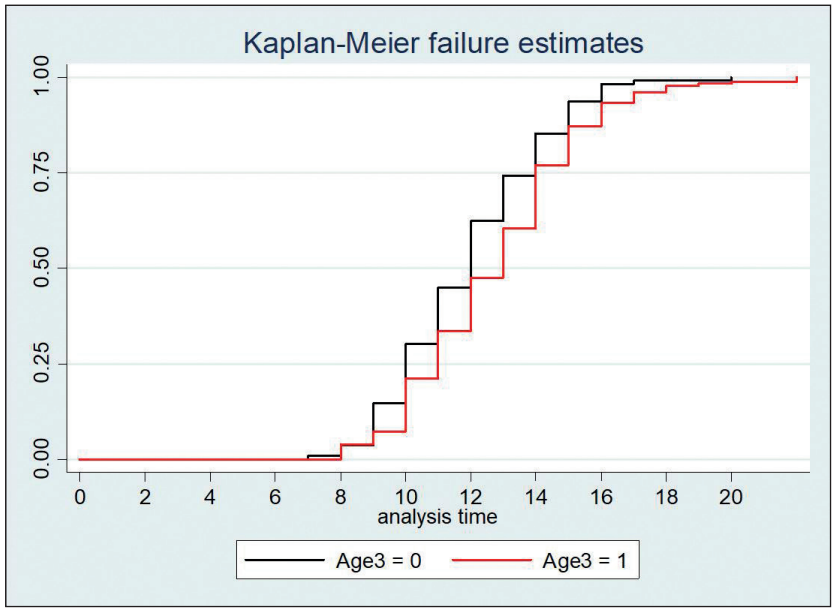

Fig. 3. Impact of age of MI patients over 60 on the duration of hospital stay (Age3=1 – over 60, Age3=0 – other age groups)

Table I. Impact of age of MI patients on the duration of inpatient treatment by different treatment methods

Age groups	HR	95% CI	p
up to 44 [1]	1.10	0.61-1.96	0.758
45-59 [2]	1.35	1.05-1.72	0.018
over 60 [3]	0.74	0.59-0.95	0.016

Table II. Impact of localization and depth of heart muscle damage in MI patients on duration of inpatient treatment by different treatment methods

Indicator	HR	95% CI	p
Prevailing lesion of posterior parts of the heart with Q wave	1.02	0.80-1.29	0.890
Prevailing lesion of posterior parts of the heart without Q wave	1.07	0.76-1.51	0.710
Prevailing lesion of anterior parts of the heart with Q wave	0.93	0.72-1.19	0.565
Prevailing lesion of anterior parts of the heart without Q wave	1.03	0.76-1.40	0.830
Development of relapsing MI	0.91	0.68-1.22	0.542

Table III. Impact of level of arterial hypertension in MI patients on duration of inpatient treatment by different treatment methods

Indicator		HR	95% CI	p
1		2	3	4
Level of AH		-	-	-
incl.	Level 1	1.24	0.94-1.63	0.134
	Level 2	1.04	0.75-1.45	0.805
	Level 3	0.81	0.62-1.05	0.117
Hypertensive crisis		0.97	0.67-1.41	0.885

Table IV. Effect of taking antihypertensive drugs in patients with MI and hypertension on duration of inpatient treatment by different treatment methods

Indicator	HR	95% CI	p
Taking antihypertensive therapy:	1.06	0.94-1.19	0.361
- regularly	0.85	0.65-1.10	0.214
- irregularly	1.05	0.80-1.39	0.713
- no therapy	1.22	0.88-1.70	0.234

We studied the main risk factors of development of MI and analyzed them as variables in regression analysis. Namely, tobacco smoking (HR=0.89, [95% CI 0.67-1.18], p=0.421), family history of CVD burden (HR=1.22, [95% CI 0.91-1.64], p=0.193), atrial fibrillation (HR=0.88, [95% CI 0.56-1.38], p=0.579), preinfarction angina pectoris (HR=0.83, [95% CI 0.65-1, 07], p=0,150) do not have a statistically significant effect on the treatment duration.

Social status of MI patients (HR=0.97, [95% CI 0.90-1.05], p=0.447) also has no statistically significant effect on the treatment duration.

According to the Unified Clinical Protocol, MI patients must be delivered to ICU or specialized department within the first 12 hours of MI onset. Given the heterogeneity of the groups regarding the treatment methods for this parameter, this predictor was studied using the Cox regression method. Our analysis did not reveal any statistically significant effect of hospitalization timing on treatment duration, regardless of the treatment method, both up to 2 hours (HR=0.92, [95% CI 0.83-1.03], p=0.144) and up to 12 years (HR=1.19, [95% CI 0.91-1.55], p=0.202) from the onset of the disease.

The next predictor was clinical features, depending on localization and spread of the area of ischemia and necrosis as well as the presence of relapsing MI. Patients usually have relapsing MI with the development of a more severe clinical presentation and complications. 20.5% of the patients we examined had a relapsing myocardial infarction. Regression analysis did not reveal a statistically significant correlation between clinical symptoms and duration of inpatient treatment, both generally and in individual symptom-complexes (Table II).

Comorbid pathology significantly complicates the course of MI (Type 2 diabetes) and contributes to its development (essential hypertension). However, treatment duration is not significantly affected by the presence of Type 2 diabetes (HR=0.94, [95% CI 0.72-1.23], p=0.655).

According to our research, EH is diagnosed in 77.1% of MI patients. The Cox regression analysis found no statistically significant impact of the presence of EH (HR=0.97, [95% CI 0.74-1.28], p=0.834) and its duration (HR=0.94, [95% CI 0.85 -1.04], p=0.215) on MI patients' treatment duration.

More detailed analysis of the course (presence of hypertensive crises) and severity (level of arterial hypertension) of EH showed no statistically significant effect on patients' stay in the hospital (Table III).

Another important factor that affects the course of EH is the use of antihypertensive therapy. According to our research, less than half (48%) of patients with EH take antihypertensive drugs regularly, others remain under increased risk of complications and aggravation of EH course. However, the Cox regression analysis did not reveal a statistically significant correlation between the use of antihypertensive therapy in MI patients with concomitant EH and duration of inpatient treatment (Table IV).

Therefore, the comorbidity of MI patients does not affect treatment duration.

An important clinical prognostic syndrome is the presence of heart failure, depending on its degree. The analysis of this predictor showed a statistically significant increase in the treatment duration by 22.0% (p=0.026) at heart failure Stage 2A (Figure 4) compared with heart failure stage 1.

```
. stcox             CH

        failure _d:  1 (meaning all fail)
  analysis time _t:  Duration_total

Iteration 0:   log likelihood = -1390.5654
Iteration 1:   log likelihood = -1388.0578
Iteration 2:   log likelihood = -1388.0574
Refining estimates:
Iteration 0:   log likelihood = -1388.0574

Cox regression -- Breslow method for ties

No. of subjects =          288                     Number of obs   =       288
No. of failures =          288
Time at risk    =         3591
                                                   LR chi2(1)      =      5.02
Log likelihood  =   -1388.0574                     Prob > chi2     =    0.0251
```

_t	Haz. Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
CH	.7807432	.0867948	-2.23	0.026	.6278857	.9708134

Fig. 4. Effect of heart failure Stage 2A on the duration of stay of MI patients on inpatient treatment

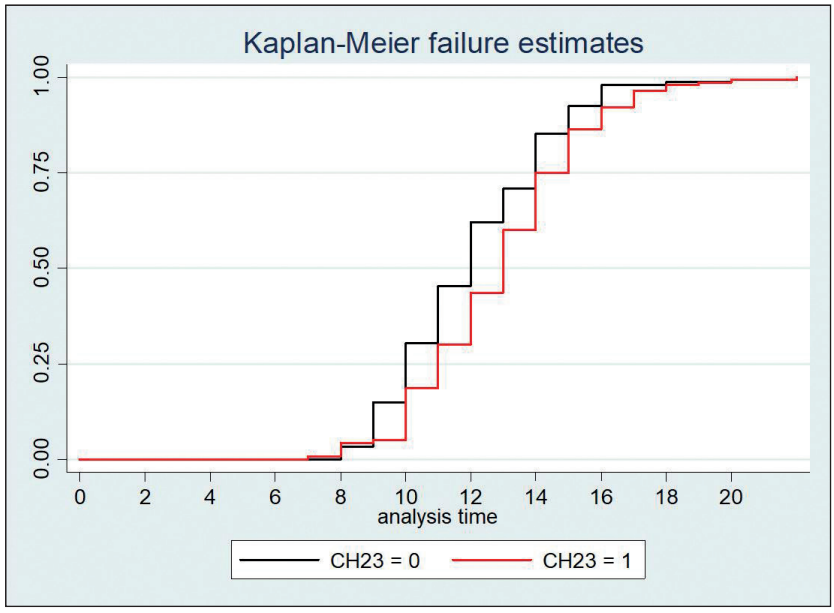

Fig. 5. Impact of heart failure Stage 1 and 2 on duration of inpatient treatment of MI patients (CH23=0 – heart failure Stage 1, CH23=1 – heart failure Stage 2A-2B)

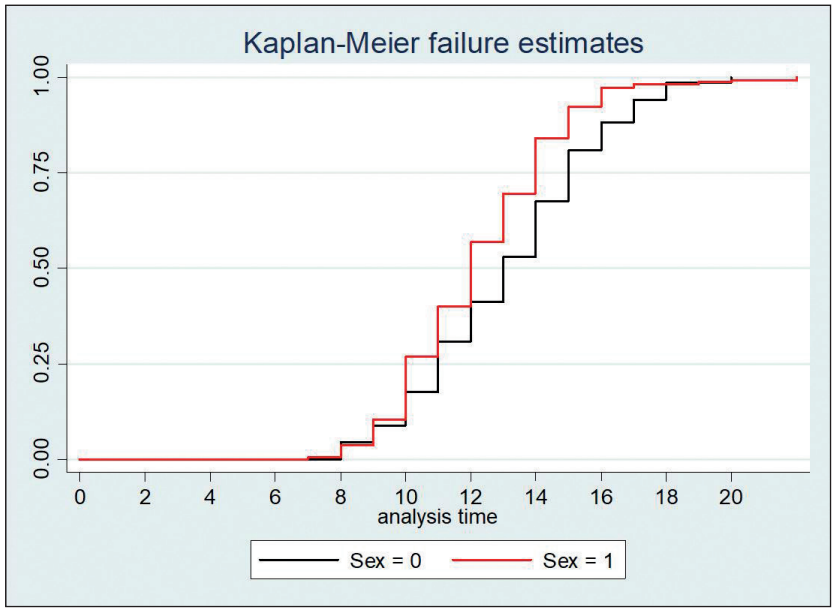

Fig. 6. Impact of sex on inpatient treatment duration of MI patients (sex=1 – men, sex=0 – women)

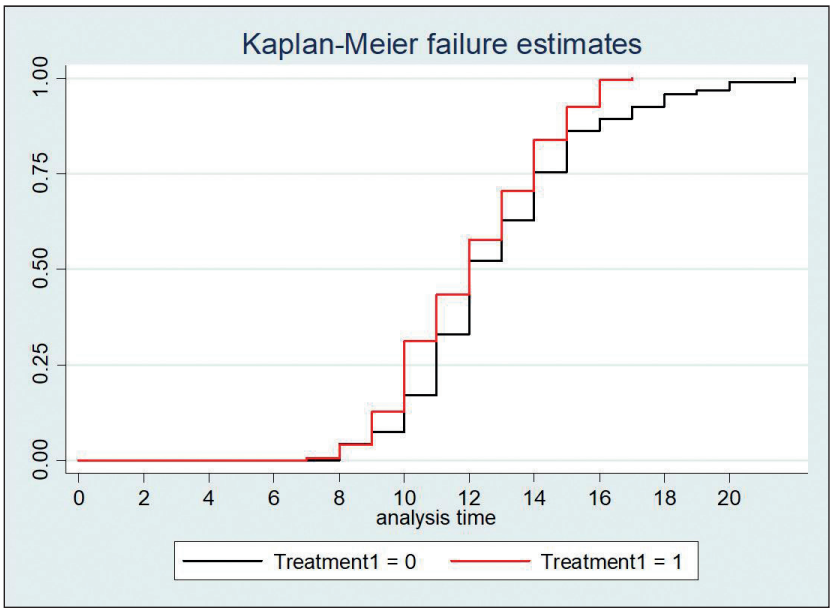

Fig. 7. Impact of CAS with BAP and conventional drug therapy of MI patients on duration of inpatient treatment (Treatment1=1 – CAS with BAP, Treatment1=0 – conventional drug therapy)

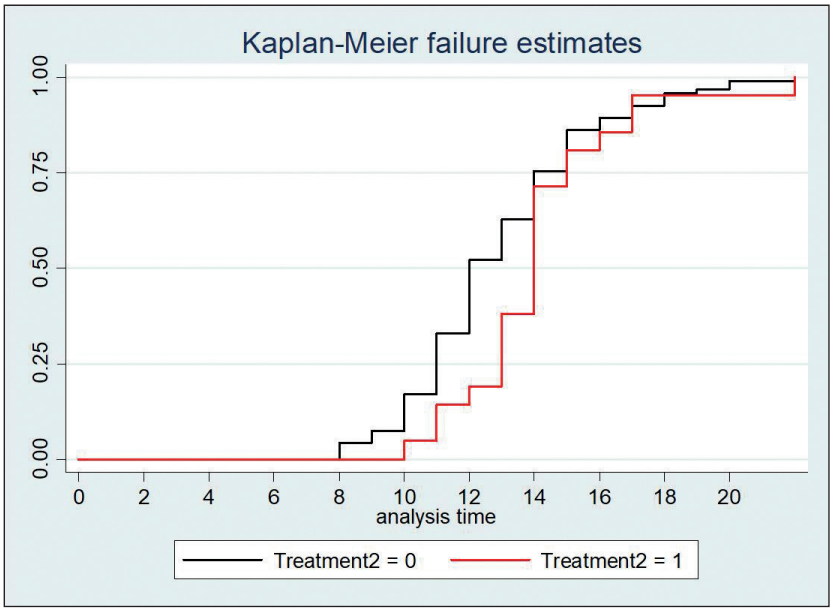

Fig. 8. Impact of thrombolytic therapy and conventional drug therapy of MI patients on duration of inpatient treatment (Treatment2=1 – TLB, Treatment2=0 – conventional drug therapy)

Table V. Model of hazard ratios of impact of coronary artery stenting with balloon angioplasty on MI patients' treatment duration (Model 1)

Indicator	HR	95% CI	p
CAS with BAP	1.30	1.00-1.70	0.048
Sex	1.25	0.92-1.68	0.149
Heart failure	0.78	0.62-0.98	0.030

Table VI. Model of hazard ratios of impact of coronary artery stenting with balloon angioplasty on MI patients' treatment duration (Model 2)

Indicator	HR	95% CI	p
CAS with BAP	1.31	1.01-1.71	0.046
Age over 60 years old	0.87	0.67-1.13	0.289
Heart failure	0.79	0.62-1.00	0.050

The comparison of effects of heart failure Stage 2A and 2B, unlike Stage 1, shows a statistically significant increase in treatment duration by 25.0% (HR=0.75, [95% CI 0.59-0.95], p=0.015), confirmed by the regression curve (Figure 5).

Cox regression analysis revealed a statistically significant effect of sex on treatment duration – men had a 37.7% (p=0.023) shorter inpatient treatment than women (Figure 6).

Thus, the study of behavioral, social, biological and clinical predictors in MI patients showed a statistically significant impact on the increase in inpatient treatment duration of variables such as feminine sex, age over 60 and presence of heart failure Stage 2A and 2B, which can be confounders in the process of treating such patients.

DISCUSSION

One of the objectives of our study was to compare the effectiveness of treatment methods in MI patients. Cox regression analysis showed that the use of CAS with balloon angioplasty significantly reduced the duration of

```
. stcox                              Sex Treatment1

        failure _d:  1 (meaning all fail)
  analysis time _t:  Duration_total

Iteration 0:   log likelihood = -1269.0382
Iteration 1:   log likelihood = -1265.1015
Iteration 2:   log likelihood = -1265.0902
Iteration 3:   log likelihood = -1265.0902
Refining estimates:
Iteration 0:   log likelihood = -1265.0902

Cox regression -- Breslow method for ties

No. of subjects =          267                     Number of obs   =       267
No. of failures =          267
Time at risk    =         3295
                                                   LR chi2(2)      =      7.90
Log likelihood  =   -1265.0902                     Prob > chi2     =    0.0193
```

_t	Haz. Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Sex	1.25943	.1914282	1.52	0.129	.9349644	1.696498
Treatment1	1.31744	.1774489	2.05	0.041	1.011767	1.715462

Fig. 9. Comparative analysis of the impact of sex and CAS with BAP on duration of inpatient treatment of MI patients

```
. stcox                              Age3 Treatment1

        failure _d:  1 (meaning all fail)
  analysis time _t:  Duration_total

Iteration 0:   log likelihood = -1269.0382
Iteration 1:   log likelihood =   -1265.17
Iteration 2:   log likelihood = -1265.1647
Refining estimates:
Iteration 0:   log likelihood = -1265.1647

Cox regression -- Breslow method for ties

No. of subjects =          267                     Number of obs   =       267
No. of failures =          267
Time at risk    =         3295
                                                   LR chi2(2)      =      7.75
Log likelihood  =   -1265.1647                     Prob > chi2     =    0.0208
```

_t	Haz. Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Age3	.8236371	.1059475	-1.51	0.131	.6400924	1.059813
Treatment1	1.308042	.1777624	1.98	0.048	1.002175	1.70726

Fig. 10. Comparative analysis of the effect of age over 60 and CAS with BAP on duration of inpatient treatment of MI patients

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. stcox                              CH23  Treatment1

        failure _d:  1 (meaning all fail)
  analysis time _t:  Duration_total

Iteration 0:   log likelihood = -1269.0382
Iteration 1:   log likelihood = -1263.1906
Iteration 2:   log likelihood = -1263.1869
Refining estimates:
Iteration 0:   log likelihood = -1263.1869

Cox regression -- Breslow method for ties

No. of subjects =          267                     Number of obs   =       267
No. of failures =          267
Time at risk    =         3295
                                                   LR chi2(2)      =     11.70
Log likelihood  =   -1263.1869                     Prob > chi2     =    0.0029
```

_t	Haz. Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
CH23	.7350217	.0909188	-2.49	0.013	.5767803	.9366771
Treatment1	1.361769	.1813292	2.32	0.020	1.048963	1.767856

Fig. 11. Comparative analysis of heart failure Stage 2A and 2B, and CAS with BAP on duration of inpatient treatment of MI patients

inpatient treatment by 36.0% (HR=1.36, [95% CI 1.05-1.77], p=0.021) compared to conventional drug therapy (Figure 7), as opposed to thrombolytic therapy where no such difference was detected (HR=0.74, [95% CI 0.46-1.19], p=0.216) (Figure 8).

To confirm the results, we built models with several predictors that have a statistically significant impact on the increase of treatment duration, and CAS with BAP.

In the analysis that included sex, age over 60 years, heart failure Stage 2A and 2B, CAS with BAP significantly reduced treatment duration (p=0.041, p=0.048, p=0.020 respectively) (Figures 9-11).

At multiple combination of variables like sex and heart failure, CAS with BAP reduced treatment duration by 30.0% (p=0.048) (Table V), age over 60 and heart failure – by 31.0% (p=0.046) (Table VI).

CONCLUSIONS

The results we obtained indicate a statistically significant effect of CAS on MI patients' treatment duration, both separately and combined with multiple effects of confounders, indicating its medical effectiveness and the need for widespread introduction of this treatment method in medical practice in every region of Ukraine.

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The article was performed in framework of department research on Reproduction of the Ukrainian population.

ORCID and contributorship:
Natalia O. Terenda – 0000-0001-5655-4326 [B]
Arkadii H. Shulhai – 0000-0003-4644-7206 [F]
Yurii M. Petrashyk – 0000-0003-1286-110X [D]
Olha N. Lytvynova – 0000-0003-1039-3904 [F]
Natalia Y. Panchyshyn – 0000-0001-5786-3083 [E]
Natalia O. Slobodian – 0000-0002-0963-7986 [C]
Liudmyla V. Lishtaba – 0000-0002-5396-3973 [A]
Valentyna L. Smirnova – 0000-0001-7473-9826 [E]
Larysa P. Zaporozhan – 0000-0003-2299-1469 [E]

Conflict of interest:
The Authors declare no conflict of interest.

CORRESPONDING AUTHOR

Yurii M. Petrashyk
Department of Public Health and Healthcare Management,
I.Horbachevsky Ternopil National Medical University,
2 Y.Slovatsky St., Ternopil, 46001, Ukraine
tel: +380673392342
e-mail: yurii.m.petrashyk@tdmu.edu.ua

Received: 24.01.2020
Accepted: 30.03.2020

A – Work concept and design, **B** – Data collection and analysis, **C** – Responsibility for statistical analysis, **D** – Writing the article, **E** – Critical review, **F** – Final approval of the article