

## Comparative Evaluation Of The Effectiveness Of Innovative High-Tech Cardiac Surgery In Patients Who Have Suffered An Acute Myocardial Infarction

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### ABSTRACT

**Background:** The proposed scientific article discusses the results of evaluating the medical and social effectiveness of innovative high-tech cardiac surgery for patients who have suffered an acute myocardial infarction. It was established that the inpatient mortality rate of patients who did not receive innovative high-tech cardiac surgery is significantly higher than in those patients who received it. These differences are particularly noticeable when comparing data among the elderly.

**Methods:** A comprehensive assessment of the effectiveness of implementing high-tech medical services in the field of cardiovascular system includes an analysis of medical and statistical, sociological methods, financial and economic, organizational and managerial methods, as well as an assessment of the level of application of relevant regulations.

**Results:** The results of a study using a logarithmic test showed that stenting of coronary vessels and aorta-coronary bypass surgery significantly reduce hospital mortality in patients with myocardial infarction in all age groups. The hospital mortality rate among patients of the main (who have received HTMC) age group was 0.96%, and among patients of the control (who haven't received HTMC) group - 11.84% ( $p = 0.002$ ). There was no significant reduction in mortality among the group of old patients ( $p = 0.779$ ). Thus, the largest difference in hospital mortality between the main and control groups was found only in elderly patients,  $p = 0.002$ .

**Conclusion:** the effectiveness of the achieved success depends not only on the introduction of innovative technology, but also on the availability of highly qualified cardiac surgeons and basic medical material and technical resources.

**Keywords:** myocardial infarction, innovative high-tech cardiac surgery, hospital mortality, reliability of effectiveness.

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### INTRODUCTION

According to official medical statistics from the Regional Health Department, over the past 25 years, up to 57% of the population's deaths were caused by diseases of the cardiovascular system, including coronary heart disease, which is known to be the cause of death in 49% of the population. This medical aid not only reduces the number of deaths from myocardial infarction, but also increases the average life expectancy of the population. According to international medical practice, more than 8,000 high-tech operations are

required for 1 million people suffering from chronic non-epidemic diseases. 6,000 of them are associated with complications of myocardial infarction. In this regard, it is required to perform 24 thousand surgeries a year only for the residents of Turkestan region and Shymkent city. In accordance with the National program for the development of the healthcare system for 2010-2019, innovative medical care has been introduced into practical healthcare.

Due to the need to organize highly specialized medical services, the Ministry of Healthcare of the Republic of Kazakhstan adopted the Resolution 1112 "On approval of types of high-tech medical services (HTMC)" on December 28, 2016.

Analysis of patient treatment results and assessment of the effectiveness of innovative high-tech medical aids is one of the most important scientific, practical and socio-medical problems of our time.

Currently, there are very few scientific papers published in the country on the provision of such medical care. Therefore, the relevance of this scientific work is very high.

**Goal of research.** Assessment of the effectiveness of high-tech medical services for the population with cardiovascular diseases in South Kazakhstan region (since 2020 Turkestan region) and in Shymkent city.

## **MATERIALS AND METHODS**

To ensure the reliability of the research results, we used socio-hygienic, clinical and statistical, variant, correlation and multivariate analysis of variance, correlation indices and methods for determining the degree of relative risk. To ensure the reliability of the obtained research results, we used a general or sample statistical set to ensure its representativeness. We used the Student's test to clearly show the deviation of indicators from the average and relative values, as well as to establish differences between the compared indicators. Each nosology identified in the study of diseases of the circulatory system was designated as a unit of statistical observation. A system of extensive and intensive indicators was used to analyze the morbidity and disability of the population.

To compare health indicators in each administrative territory, we used empirical data on the level of morbidity and disability indicators, which were calculated for 10,000 and 100,000 people. To determine the main risk factors for the increase in inpatient mortality, a multiple analysis was performed using the method of logistic regression. The quality of the model was determined using ROC analysis. To compare the mortality rate of the two groups compared, the ratio indicator and its confidence interval were used. Qualitative assessment of long-term viability curves was performed using the Cox regression model and the Kaplan-Meier method. The Log-rank test was used to evaluate the accuracy of the difference between survival curves. For all analyses, it was considered correct when the difference between the two levels was  $p < 0.05$ . Relative risk indicators (OR) were used to determine differences in the levels of indicators formed in different social groups of patients.

## **RESULTS**

The results of many studies have shown that almost all cases of myocardial infarction occur among middle-aged and older people of working age, as well as among elderly and old people.

Analysis of changes in demographic indicators of the population of South Kazakhstan region over the past 10 years (1999-2019) shows that the number of middle-aged and older people of working age decreased from 58.42% to 57.20%, while the share of elderly and old people increased from 9.72% to 12.94%. The percentage of children aged 0-14 years in the demographic indicators of the population taken into account by the birth rate decreased by 2.0% (figure 1).

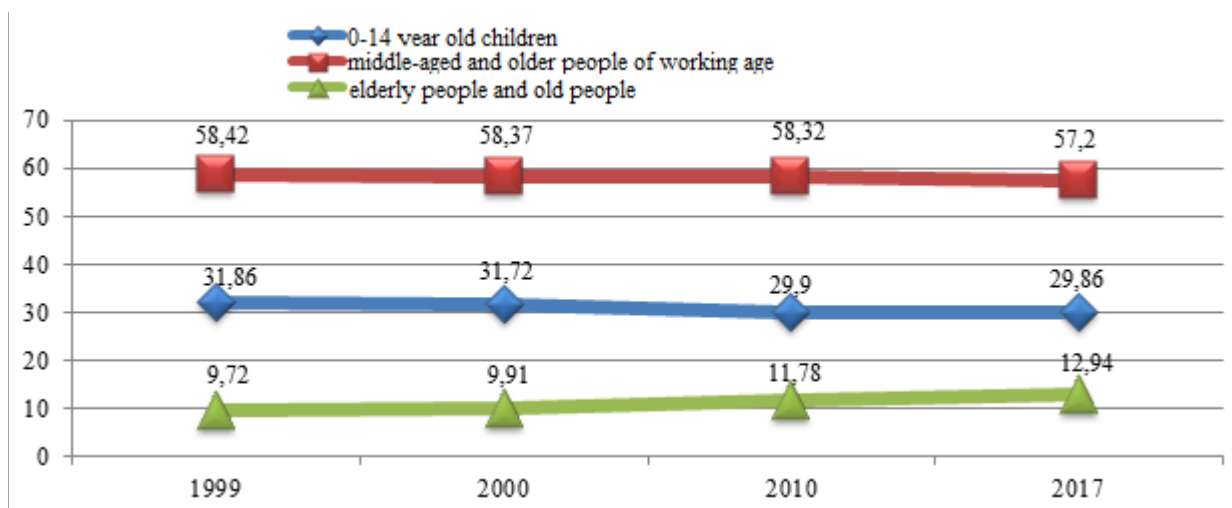


Figure 1 Dynamics of changes in the share of people belonging to various social groups in South Kazakhstan region (in %)

q/r	The name of nosology	Primary morbidity					General morbidity				
		2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
1	Diseases of the circulatory system	26268,92	26269,64	27782,36	28432,97	27736,64	43349,31	42908,34	43621,46	45379,72	44987,16
2	Hypertension (all types)	8611,84	8592,05	8738,62	8749,34	8748,48	14358,82	13951,87	14799,83	15326,5	14892,7
3	Coronary heart disease	3127,41	3149,28	3312,53	3438,32	3372,87	5323,59	5082,57	5647,92	5973,84	5849,46
4	Acute myocardial infarction	248,72	252,93	260,35	257,42	258,37	298,44	301,76	312,38	309,71	311,94
5	Cerebrovascular diseases	2671,35	2649,93	2718,54	2685,38	2692,15	4901,38	4835,36	4912,64	4894,82	4874,39
6	Strokes (all types)	350,19	348,78	452,24	459,71	457,43	379,74	365,39	499,79	443,75	452,83
7	Rheumatism	310,62	315,27	325,41	348,36	336,27	529,91	528,98	579,16	629,36	598,72
8	Other diseases of the circulatory system	10969,08	10967,74	11968,34	12490,51	11984,37	17567,06	17843,62	16870,09	17704,52	17582,53

During the study of the obtained results an increase in the dynamics of primary and general morbidity in the population was revealed due to an increase in the incidence of diseases of the cardiovascular system. If in 2013-2014 the level of primary morbidity of the population with diseases of the circulatory system was 26268.9–26269.6 ‰, in 2015-2017 it increased to 27782.3-2849.9 ‰. Thus, economic and social stagnation led to a sharp increase in the incidence of diseases of the circulatory system in 2015-2017. The same situation is observed with the levels of other nosological diseases. The average incidence of

hypertension in 2013-2014 increased from 8611.8<sup>0</sup>/<sub>0000</sub> to 8748.4<sup>0</sup>/<sub>0000</sub>. The greatest concern is caused by the incidence of coronary heart disease, the level of which in the studied years increased from 3127.4 <sup>0</sup>/<sub>0000</sub> to 3372.8 <sup>0</sup>/<sub>0000</sub>.

As a result, the incidence of acute myocardial infarction (3.4%) and stroke (15.9%) has significantly increased, which leads to disability or causes premature death in the population.

The increase in the level of primary morbidity affected the level of general morbidity of the population. If in 2013 the total incidence of diseases of the circulatory system was 43349.3 <sup>0</sup>/<sub>0000</sub>, in 2017 its level increased to 44987.1<sup>0</sup>/<sub>0000</sub>. In 2016, the level of development of these pathologies becomes even higher (45,379. 7<sup>0</sup>/<sub>0000</sub>). Hypertension has a significant impact on the development of myocardial infarction and stroke. During the years of study, the level of this pathology also increased from 14358.8<sup>0</sup>/<sub>0000</sub> to 14892.7 <sup>0</sup>/<sub>0000</sub>. Coronary heart disease among the population of Turkestan region has increased from 5323.5<sup>0</sup>/<sub>0000</sub> to 5849.4<sup>0</sup>/<sub>0000</sub> over these years. This circumstance is reflected in the formation of acute myocardial infarction among the population (from 298.4<sup>0</sup>/<sub>0000</sub> to 311.9<sup>0</sup>/<sub>0000</sub>) and stroke (from 379.7<sup>0</sup>/<sub>0000</sub> to 452.8<sup>0</sup>/<sub>0000</sub>). The obtained statistics show that the prevalence of diseases of the cardiovascular system and coronary heart disease among the population of Shymkent and South Kazakhstan region is constantly increasing.

The reliability of the decrease in the in patient mortality rate among the groups of middle-aged and older people of working age who have under gone high-tech cardiac surgery has not been established, compared to the mortality rate reduction among patients in the control group who haven't undergone high-tech medical care. There was no statistically significant link between coronary artery stenting in myocardial infarction and hospital mortality among patients of working age. Also, the association of high-tech medical care with hospital mortality caused by myocardial infarction among older people is not statistically significant if patients had chronic kidney disease and blood fraction levels <40% in the development of acute myocardial infarction.

**Table 2 Comparative assessment of the level of hospital mortality among patients with myocardial infarction who have received high-tech medical care (HTMC) and those who haven't .**

Experimental group	working age, n=556			P	Elderly people n =467				P	Old people, n =244		
	Absoluten umber	Number of deaths	Inpatient mortality,		Absoluten umber	Number of deaths	Inpatient mortality, %	Absoluten umber		Number of deaths	Inpatient mortality,	
Experimental group	284	8	2,82	0,000	363	43	11,84	0,026	235	44	18,72	
Main group	272	2	0,74	0,717	104	1	0,96	0,424	9	1	11,1	
r,Chi -square	0,127				0,002					0,779		

The hospital mortality rate among patients of the main (who have received HTMC) age group was 0.96%, and among patients of the control (who haven't received HTMC) group - 11.84% (p = 0.002). There was no significant reduction in mortality among the group of old patients (p = 0.779). Thus, the largest difference in hospital mortality between the main and control groups was found only in elderly patients, p = 0.002 (Chi-square).

Also, the level of mortality in hospital from myocardial infarction in the main group increases with the age of patients.

The rate of inpatient mortality in elderly patients was -11.92% ( $p = 0.000$ ), which is four times higher than in patients of average working age. In contrast, hospital mortality in older patients was twice as high as among older patients ( $p = 0.026$ ). We found that the degree of correlation between the age of patients in the control group and the level of hospital mortality ( $r = 0.997$ ,  $p = 0.045$ ) was very high.

There was no significant correlation between the mortality rate among patients in the control group with the increase of age and HTMC. Thus, the level of hospital mortality among middle-aged and older people of working age is 0.74%, among the elderly-0.96%, and among senile patients-11.1%,  $p = 0.717$  and 0.424. The difference in the death rate of middle-aged and elderly patients was  $p = 0.205$ , and the correlation coefficient -  $g = 0.866$ ,  $p = 0.333$ . The results can be explained by the relatively low mortality rate among elderly patients and senile patients who have received HTMC. To reduce mortality from these diseases, the Republic of Kazakhstan has implemented the state program "Densaulyk" for 2016-2019. This program defines a model for improving medical care aimed at preventing 5 socially significant diseases that have a particularly strong impact on the demographic situation in the country. Since 2010, a high-tech cardiac surgery service has been launched to prevent deaths from coronary heart disease. These patients have undergone vascular stenting and coronary artery bypass grafting to restore patency of thrombosed coronary vessels. Consequently, the risk of hospital mortality (-QR-) has started to decrease. As a result, the overall risk of mortality also decreased (the lower limit of the confidence interval decreased from 0.63 to 0.48 points, and the upper limit-from 0.78 to 0.61 points). And the relative risk (-QR -) reduced from 0.92 to 0.63 points. As can be seen from the table, the provision of high-tech medical care is very effective from the medical, demographic and social points of view.

Reconstructive operations on heart valves were also performed in the Cardiac Surgery Department of Shymkent city. However, its volume is significantly smaller than stenting and coronary artery bypass grafting, and they are performed regularly. The effectiveness of measures taken to prevent death from myocardial infarction shows that these innovative operations should be widely performed in district hospitals. Currently, cardiovascular centers are being opened in all districts of the region, and cardiac surgeons are being trained in cardiac research centers of the Russian Federation, Germany and Israel.

## DISCUSSION

It is well known that diseases of the cardiovascular system, including coronary heart disease, are more common among middle-aged and older people of working age, as well as among the elderly and old people. In the last decade, the share of elderly and senile people in the total population of southern Kazakhstan has increased from 9.72% to 12.94%. It goes without saying that in these social groups, myocardial infarction is the main cause of death and a threat that significantly reduces their life expectancy.

It is known that the average life expectancy of the population is taken into account by experts of the World Health Organization when compiling the development index of each country. Therefore, in order to reduce mortality in our country, the National Program "Densaulyk" for 2016-2019 was developed. In this program, the most important direction is the development of high-tech cardiac surgery.

The level of primary morbidity in cardiovascular diseases in 2013-2017 ranged from 26268.92  $^0/0000$  to 28432.97  $^0/0000$ , and coronary heart disease - from 3127.41  $^0/0000$  increased by 3372.87  $^0/0000$ . During this period, the total incidence of coronary heart disease increased from 43349.31  $^0/0000$  to 44987.16  $^0/0000$ , and for coronary heart disease increased from 5323.59  $^0/0000$  to 5849.46  $^0/0000$ . This was reflected in the formation of

the incidence rate of acute myocardial infarction, which increased from 298.4<sup>0</sup>/<sub>0000</sub> to 311.9<sup>0</sup>/<sub>0000</sub> over the years studied.

In accordance with the National Program for reducing mortality, we monitored the effectiveness of innovative high-tech heart surgeries introduced in Shymkent and southern Kazakhstan in 2010-2019, and assessed their impact on the death rate in each age and social group. The results of the study showed that HTMC significantly reduces hospital mortality among patients with myocardial infarction in all age groups. The rate of hospital mortality among the elderly (patients who have received HTM it was 0.96%, and among patients of the control group (who have not received innovative cardiac surgery) - 11.84% (p = 0.002). There was no significant reduction in mortality in the group of old patients (p = 0.779).

Thus, a significant difference in hospital mortality between patients who received HTMC and a group of patients who have not undergone such high-tech heart surgery was found only in elderly patients (65-74 years), p = 0.002 (Chi-square). The number of hospital deaths from myocardial infarction in the main group increases with age.

Hospital mortality among people of working age was 0.74%, among the elderly-0.96%, and among senile people -11.1%, p = 0.717 and 0.424. The difference in the death rate of middle-aged and elderly patients was p = 0.205, the correlation coefficient-g = 0.866, p = 0.333. The results obtained can be explained by a clear decrease in the mortality rate among elderly patients and senile patients who have received HTMC. In connection with the development and implementation of the National Program to reduce mortality from myocardial infarction, the risk of death (- QR -) among the population due to cardiovascular and ischemic heart diseases began to decrease in South Kazakhstan region from 2010 to 2019. In particular, there is a strong belief that the number of deaths from coronary heart disease has decreased significantly (the lower limit of the confidence interval has decreased from 0.63 to 0.48 points, and the upper limit - from 0.78 to 0.61 points). And the relative risk point(- QR -) dropped from 0.92 to 0.63.

It turned out that the most useful medical and rehabilitation results can be achieved only as a result of general strengthening of the personnel reserves of specialists and material and technical bases of the cardiology service. Mathematical modeling of the results of the implementation of the national prevention program showed that if the number of cardiologists increases by 0.2<sup>0</sup>/<sub>0000</sub> the number of beds, equipped with special medical equipment, will increase by 2.0<sup>0</sup>/<sub>0000</sub> as well, the share of cardiologists in the highest category will reach up to 50% of the total number of cardiologists, the risk of deaths from myocardial infarction will be reduced by 31% and the number of deaths from diseases of the circulatory system will decrease by 22%. If the availability of cardiologists increases by 0.3<sup>0</sup>/<sub>0000</sub>, the number of special beds will increase by 5.0<sup>0</sup>/<sub>0000</sub>, and the proportion of doctors with the highest category in the total number of cardiologists will increase by 70%, then the reduction of the risk of death from myocardial infarction will be 43%.

## CONCLUSION

Thus, the obtained scientific results show the effectiveness of the introduction of high-tech cardiac surgery, which significantly reduces the death rate of the population from myocardial infarction. At the same time, the effectiveness of the achieved success depends not only on the introduction of innovative technology, but also on the availability of highly qualified cardiac surgeons and basic medical material and technical resources.

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