

Assessment of Medical and Social Effectiveness of Innovative High-tech Cardiac Surgery Care for Patients with Acute Myocardial Infarction

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Abstract

The present research aims at comprehensive analysis to determine the effectiveness of cardiac surgery in patients in the acute period of myocardial infarction in comparison with patients who received drug treatment.

A comparative assessment of the level of hospital mortality was carried out in the groups of patients of senior working age, elderly and old age, dividing them into patients who received cardiac surgery (main group) and drug treatment (comparison group). Among the patients of working age, 284 were assigned to the main group and 272 to the comparison group; among the patients of elderly age, 104 were assigned to the main group and 363 to the comparison group; and among the patients of old age, there were 9 patients in the main group and 235 patients in the comparison group. For reliable difference between the compared indicators, the authors determined the relative risk of socio-hygienic factors in terms of mortality rate and the significant limit of mortality formation, taking into account that the factor the relative risk of which is more than one is significant.

The significant difference in mortality in hospital between patients who received high-tech medical services (HTMS) and the group of patients who did not undergo such high-tech heart surgery was found only in the elderly patients (65-74 years old), $p = 0.002$ (chi-square). The number of deaths in hospital from myocardial infarction in the main group increases with age.

Mathematical modeling showed that the level of hospital mortality is also influenced by the provision of the hospital with qualified cardiologists, specialized bed and special medical equipment.

The use of high-tech cardiac surgery is reliably effective in the elderly age group. To further increase the effectiveness of innovative medical care, it is necessary to improve the qualifications of cardiologists and to achieve the most complete provision of the department with specialized beds and equipment.

Key-words: Myocardial Infarction, Relative Risk Index, Cardiac Surgery, Stenting, Coronary Artery Bypass Graft (CABG), Thrombolytic Therapy, Hospital Mortality, Significance, Efficacy.

1. Relevance

Cardiovascular diseases, in particular, ischemic heart disease and hypertension are the main cause of death in people of working age and retirement age. The study of the dynamics of primary morbidity in Turkistan Region in connection with coronary heart disease in 2013-2017 showed that it increased by 7.8%, and the overall morbidity rate for this nosology increased by 9.8%. During this period, the primary and general incidence of essential hypertension increased by 1.6% and 3.7%, respectively. In addition, it becomes the main cause of persistent disability, limiting the psychological and economic activity of this social group. The main way to reduce the level of disability and mortality is the early use of cardiac surgery.

According to individual authors (1, 2, 17, 33, 36) over the past 25 years, up to 57% of deaths were caused by diseases of the cardiovascular system, including ischemic heart disease which is known to be the cause of death in 49% of the population. Timely and properly organized cardiac surgery 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 8000 high-tech operations are required per 1 million people suffering from chronic non-epidemic diseases, and 6000 of them are associated with complications of myocardial infarction. In this regard, only residents of Turkistan Region and the city of Shymkent need more than 24 thousand such operations per year. In accordance with the National Program for the Development of the Healthcare System for 2010-2019, innovative medical care is introduced into practical healthcare.

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

Analysis of the results of patient treatment and assessment of the effectiveness of innovative high-tech medical care is one of the most important scientific, practical and socio-medical problems of our time. At present, very few scientific papers are published in the country on the provision of such medical care, hence the relevance of the present research.

2. Materials and Methods

A comprehensive assessment of the effectiveness of HTMS in the field of the cardiovascular system includes an analysis of medical-statistical, sociological, financial-economic and organizational-management methods, as well as an assessment of application of the relevant regulatory acts.

To ensure the reliability of the research results, social-hygienic, clinical-statistical, variant, correlation and multivariate analysis of variance, correlation indices and methods for determining the degree of relative risk were used.

Moreover, general or sample statistical population with ensured representativeness was used. The Student's test was used to clearly show the deviation of indicators from the mean and relative values, as well as to establish the 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. To analyze the incidence and disability of the population, a system of extensive and intensive indicators was used.

To compare health indicators in each administrative territory, empirical data on the level of morbidity and disability indicators were used which were calculated for 10,000 and 100,000 people. To establish the main risk factors for the development of stationary mortality, multiple analyses were carried out using the logistic regression method. The quality of the model was determined using ROC analysis. To determine the reliability of the difference in the mortality rate of the two compared groups, the relative risk indicator and its confidence interval were used. The long-term viability curves were qualitatively assessed using the Cox regression model and the Kaplan-Meier method. The Log-rank test was used to assess the accuracy of the difference between the survival curves. For all the analyzes, the difference $p < 0.05$ between the two levels was considered correct.

3. Research Results

Numerous studies reveal that almost all cases of myocardial infarction occur in people of middle and senior working age, as well as in the elderly and old people.

Analysis of changes in demographic indicators of Turkistan Region over the past 10 years (1999-2019) shows that the number of people of middle and senior 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

share of children aged 0-14 years in the demographic indicators (counted by the birth rate) decreased by 2.0% (Figure 1).

Figure 1- Dynamics of Change in the Proportion of People Belonging to Various Social Groups in Turkistan Region (%)

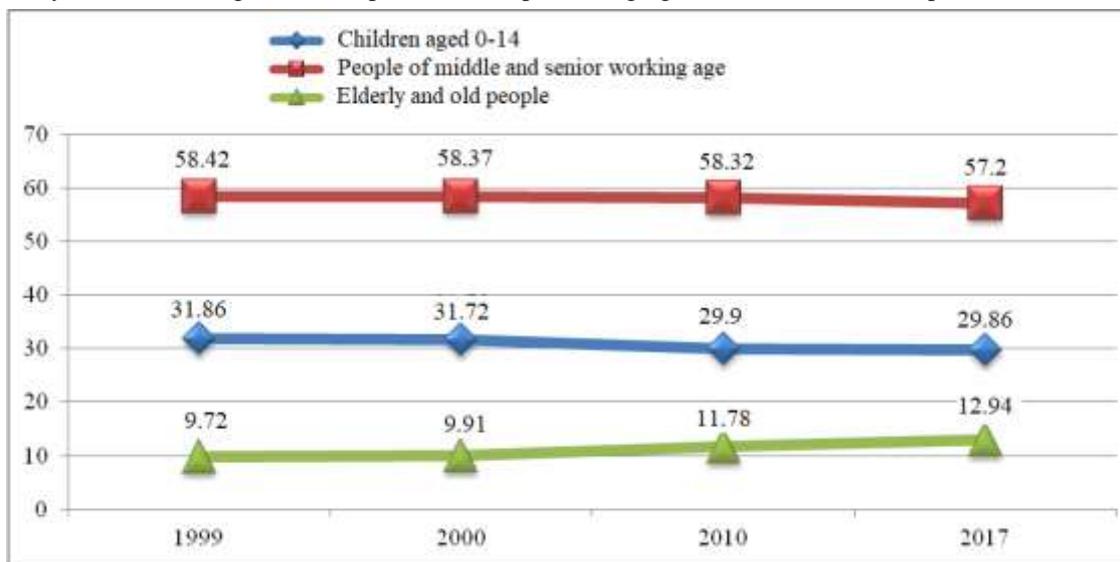


Table 1 - Dynamics of the Level of Primary and General Incidence of Diseases of the Cardiovascular System in 2013-2017 (per 100,000 Population)

	Nosology	Primary incidence					General incidence				
		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	15326.55	14892.74
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 disease	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

The results obtained reveal an increase in the dynamics of primary and general morbidity in the population due to an increase in the incidence rates of the cardiovascular system diseases. In 2013-2014, the level of primary morbidity of the population with diseases of the circulatory system was 26268.9-26269.6% 000, and in 2015-2017, it increased to 27782.3-2849.9% 000. Thus,

economic and social stagnation led to a sharp increase in the incidence of the circulatory system diseases in 2015-2017. The same is observed with the levels of other nosologies of diseases. The average incidence of essential hypertension in 2013-2014 increased from 8611.8% 000 to 8748.4% 000. The greatest concern is the incidence of coronary heart disease, the level of which in the studied years increased from 3127.4% 000 to 3372.8% 000. As a result, the incidence of acute myocardial infarction (3.4%) and stroke (15.9%) significantly increased; this leads to disability or causes premature mortality of the population.

The increase in primary morbidity affected the level of the general morbidity of the population. In 2013, the total morbidity from pathologies of the circulatory system was 43349.3% 000, and in 2017, its level increased to 44987.1% 000. In 2016, the level of these pathologies becomes even higher (45,379.7% 000). Essential hypertension has a significant impact on the development of myocardial infarction and stroke. Over the years of study, the level of this pathology also increased from 14358.8% 000 to 14892.7% 000. Ischemic heart disease among the population of Turkistan Region over the years increased from 5323.5% 000 to 5849.4% 000. This is reflected in the formation of acute myocardial infarction (from 298.4% 000 to 311.9% 000) and stroke (from 379.7% 000 to 452.8% 000) among the population. The obtained statistics show that the prevalence of the cardiovascular system diseases and ischemic heart disease among the population of Shymkent and Turkistan Region is constantly increasing.

The results of the logarithmic test showed that coronary stenting and CABG significantly reduced hospital mortality in patients with myocardial infarction in all the age groups. The reliability of the decrease in the hospital mortality rate among middle and senior working age patients who received high-tech cardiac surgery and the decrease in the mortality rate among patients in the control group who did not receive HTMS was not established. There was no statistically significant association between coronary artery stenting in myocardial infarction and hospital mortality in patients of working age. In addition, the relationship between HTMS and hospital mortality associated with myocardial infarction in old people is not statistically significant if patients had chronic kidney disease and the level of blood fraction at <40% with the development of acute myocardial infarction.

Table 2- Comparative Assessment of the Level of Hospital Mortality in Patients with Myocardial Infarction Who Received and Did Not Receive HTMS

Age groups	Working age people, n=556			P	Elderly people, n =467			P	Old people, n =244		
	Absolute amount	Number of deaths	Hospital mortality, %		Absolute amount	Number of deaths	Hospital mortality, %		Number of deaths	Hospital mortality, %	Absolute amount
Comparison 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
p, chi-square	0.127				0.002				0.779		

The hospital mortality rate among patients of the main age group who received HTMS was 0.96%, and among patients of the control group who did not receive HTMS was 11.84% ($p = 0.002$). There was no significant reduction in mortality in the old age group ($p = 0.779$). Thus, the greatest difference in hospital mortality between the study and control groups was found only in the elderly patients, $p = 0.002$ (chi-square).

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

The hospital mortality rate in elderly patients was 11.92% ($p = 0.000$), which is four times higher than in patients of middle working age. In contrast, hospital mortality in old patients was twice as high as in elderly patients ($p = 0.026$). The authors of the present research 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 in the control group with increasing age and HTMS. Thus, the level of hospital mortality among people of middle and senior working age is 0.74%, among the elderly it is 0.96%, and among old patients it is 11.1%; $p = 0.717$ and 0.424. The difference in the mortality rate of middle-aged and elderly patients was $p = 0.205$, and the correlation coefficient was $r = 0.866$, $p = 0.333$. The obtained results can be explained by the relatively low mortality rate among the elderly and old patients who received HTMS. To reduce mortality from these diseases in the Republic of Kazakhstan, the state program ‘Densauylyk’ was introduced for 2016-2019. Within the framework of this program, a model for improving medical care was determined, aimed at preventing 5 socially significant diseases which especially affect the demographic situation in the country. Since 2010, a high-tech cardiac surgery service is launched to prevent deaths from coronary heart disease, including vascular stenting and CABG to restore patency

of thrombosed coronary vessels. Consequently, the risk of hospital mortality (-QR-) began to decline, and the overall risk of mortality in the population 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). The relative risk (-QR-) was reduced from 0.92 to 0.63 points. As can be seen from the table, HTMS is very effective from the medical, demographic and social points of view. Reconstructive operations on the heart valves are also regularly carried out in the cardiac surgery department of the city of Shymkent. However, their volume is significantly less than that of stenting and CABG. The effectiveness of measures taken to prevent mortality from myocardial infarction shows that these innovative operations should be widely performed in district hospitals. At present, cardiovascular centers are being opened in all the districts of the region, and cardiac surgeons are being trained in cardiac surgery research centers of the Russian Federation, Germany and Israel.

4. Discussion

Cardiovascular system diseases, including coronary heart disease, are more common in people of senior working age, as well as elderly and old people. In the last decade, the share of the elderly and old people in the total population of Turkistan increased from 9.72% to 12.94%. It is understood that in these social groups, myocardial infarction is the leading cause of death and a threat that significantly shortens the average life expectancy which is taken into account by WHO experts when compiling the development index of each country. Meanwhile, the mortality rate of the adult Kazakhstan population from circulatory system diseases is almost twice as in developed European countries and North America. Therefore, to reduce mortality in Kazakhstan, As mentioned above, the National Program ‘Densaulyk’ for 2016-2019 is aimed at reducing mortality from myocardial infarction with the help of the development of high-tech cardiac surgery [1, 2, 12].

The level of primary morbidity from the cardiovascular system diseases in 2013-2017 ranged from 26268.92% 000 to 28432.97% 000, and coronary heart disease from 3127.41% 000 to 3372.87% 000. During this period, the level of general incidence of coronary heart disease increased from 43349.31% 000 to 44987.16% 000, and for coronary heart disease from 5323.59% 000 to 5849.46% 000. This was reflected in the incidence rate of acute myocardial infarction which over the years of study increased from 298.4% 000 to 311.9% 000.

In accordance with the National Program for Mortality Reduction, the authors of the present study monitored the effectiveness of innovative high-tech heart surgeries introduced in Shymkent and Turkistan in 2010-2019, and assessed their impact on the mortality rate in each age and social group.

The results of the study showed that HTMS significantly reduce hospital mortality in patients with myocardial infarction in all the age groups. The hospital mortality rate among elderly patients who received HTMS was 0.96%, and among patients in the control group who did not receive innovative cardiac surgical care was 11.84% ($p = 0.002$). However, there was no significant reduction in mortality in the group of old patients ($p = 0.779$).

Thus, a significant difference in hospital mortality in patients who received and did not receive HTMS was found only in the elderly patients (65-74 years old), $p = 0.002$ (chi-square). The number of hospital deaths from myocardial infarction in the study group increases with age.

Hospital mortality among people of working age was 0.74%, among the elderly - 0.96%, and among people of old age - 11.1%, $p = 0.717$ and 0.424. The difference in the mortality rate of middle-aged and elderly patients was $p = 0.205$, the correlation coefficient was $r = 0.866$, $p = 0.333$. The results obtained can be explained by a clear decrease in the mortality rate among the elderly and old patients who received HTMS. In connection with the development and implementation of the Republican program to reduce mortality from myocardial infarction, in Turkistan Region from 2010 to 2019, the risk of death (-QR-) among the population due to cardiovascular and ischemic heart diseases began to decrease. In particular, there is a strong belief that the number of deaths from coronary heart disease decreased significantly (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). The relative risk index (-QR-) of mortality from myocardial infarction decreased from 0.92 to 0.63 points.

It turned out that the most useful medical and rehabilitation results can be achieved only due to the general strengthening of the personnel reserves and the material and technical bases of the cardiological service. Mathematically modeling the results of the implementation of the national preventive program revealed that if the number of cardiologists increases by 0.2% 00, the number of beds with special medical equipment will increase by 2.0% 000; if the proportion of high-category cardiologists reaches 50% of the total number of cardiologists, the risk of deaths from myocardial infarction will decrease by 31%, and the number of deaths from the circulatory system diseases decreases by 22%. If the availability of cardiologists increases by 0.3% 00, the number of special beds will increase by 5.0% 00, and if the proportion of highest category doctors in the total number of cardiologists increases by 70%, the reduction in the risk of mortality from myocardial infarction will be 43%.

Thus, the obtained scientific results show the effectiveness of HTMS which significantly reduce the mortality rate of from myocardial infarction. At the same time, the achieved successes

depend not only on innovative technology but also on the level of providing highly qualified cardiac surgeons and equipment with basic medical material and technical resources.

5. Conclusions

1. The mortality rate from myocardial infarction has a direct correlation with the proportion of elderly and old people in the structure of the region's population. HTMS significantly reduce the level of hospital mortality in elderly patients, and among patients of senior working age and old patients, the decrease in hospital mortality is insignificant.
2. The effectiveness of innovative technology depends on highly qualified cardiac surgeons and the provision of the necessary basic material and technical resources.

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