

СЕКЦІЯ XXI. МЕДИЧНІ НАУКИ ТА ГРОМАДСЬКЕ ЗДОРОВ'Я

COMPARATIVE ASSESSMENT OF LIMB AMPUTATIONS IN UKRAINE, GERMANY, CANADA AND JAPAN USING MEDICAL STATISTICS METHODS

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Introduction. Amputation of a limb is still a forced measure to save the life of a patient with a chronic pathology. At the same time, it significantly reduces the quality of life and limits ability to work. Today, diagnostic studies, such as measuring the level of blood flow and subsequent surgical revascularization, allow amputation to be avoided. It can be performed in 70-90% cases for patients with a critical level of limb ischemia [1-4]. However, even in such developed countries as Germany, the availability of these medical services and the number of amputations differs from one Federal State to another [1].

Failed medical interventions to avoid amputation are often described as late and insufficient. The situation is complicated by the fact that there is no single algorithm for assessing the state of blood flow in the vessels of the limbs. And chronic limb ischemia is asymptomatic, so it is often difficult to diagnose [2, 3].

Concomitant factors (such as Covid-19), which worsen the condition of patients, for example, with diabetes, and lead to an increase in the number of amputations, play an important role. However, this statement is valid only for those countries that did not introduce additional means of optimizing the work of medical measures and patient supervision during the Covid-19 pandemic (4-6).

For example, in Ukraine, the pandemic placed a significant influence on patients with diabetes by an increase in the development of angiopathy [6]. While in Canada for 2020-2022, there were no significant changes in the statistics of limb amputations due to diabetes [4].

In addition to vascular patency problems (due to diabetes or atherosclerosis), limb loss can occur due to injuries, osteomyelitis, and malignant neoplasms. In the case of these pathologies, the situation in developed countries (Germany, Canada or Japan) is better due to widespread early diagnosis, in contrast to Ukraine [7-12, 14-16].

Among the countries presented in this article, Japan had the highest percentage of amputations because of limbs traumatic injuries. However, due to the beginning of the war 2014...2023 in Ukraine, it is natural that the statistics of removal of damaged limbs is significantly ahead of Japan and many other countries. In the territories where hostilities are taking place, the supply of necessary medicines (even mentioned above, insulin for diabetics) is deteriorating, the number of functioning hospitals is decreasing, which will be analyzed in the future. However, such statistical data are currently unavailable [5, 6].

The level of limb removal is also important. It is known [2-3, 7-9, 10, 11] that high amputations significantly worsen both the patient's life activity and his psychological state. Therefore, if it is impossible to save the limb, choosing the level of its removal is important.

Preference should be given to low amputations in which as much of the patient's leg or arm is preserved as possible. The development and implementation of interdisciplinary solutions in the future should contribute to reducing the number of high amputations to a minimum.

Methods. Generally accepted in medical statistics [18, 19, 21]: determination of the ratio indicator, correlation-regression (Spearman's) method, analysis of risk factors.

Results and Discussion. The data of patients aged 50 years were used as the starting point. For the period 2011-2019. Due to the different sample of studies conducted in different countries, all the data used were reduced to percentage values for the purpose of their matching and comparison (Table 1) [7-17].

According to the ratio of the upper and lower extremities that can be removed, the lower ones traditionally prevail. As we can see from Table 1 A, this ratio is significantly different in Ukraine and in other represented countries.

Table 1.

Cumulative statistical data on limb amputations by country

A. Ratio of upper and lower limb amputations, (%)							
Ukraine*		Germany		Canada**		Japan	
Upper extremity	Lower extremity	Upper extremity	Lower extremity	Upper extremity	Lower extremity	Upper extremity	Lower extremity
32.0	68.0	11.4	88.6	15.0	85.0	18.2	81.8
*control; **statistics for the state of Saskatchewan.							
B. Causes of lower limb amputations, (%)							
Country	Diabetes Mellitus	Osteomyelitis	Injuries	Arterial patency disorders		Tumors	
Ukraine*	22.0	15.0	10.0	31.0		22.0	
Germany	31.3	11.0	10.0	35.7		12.0	
Canada	54.0	10.4	8.7	16.3		10.5	
Japan	24.6	6.0	21.5	41.6		6.3	
C. The level of lower limb amputations, (%)							
Country	Level of amputation						
	Femur			Knee		Foot	
Ukraine*	42.6			41.1		16.3	
Germany	20.4			11.5		68.1	
Canada	24.7			31.9		43.4	
Japan	39.1			43.5		17.4	

To confirm this the ratio indicator was calculated [18]. With the help of this indicator, the semi-ratio between unrelated phenomena is analyzed according to formula:

$$IR = \frac{\text{absolute number 1st phenomenon}}{\text{absolute number 2st phenomenon}} \times \text{condition (1,10,100,1000 etc.)},$$

where:

IR – is an Indicator of the ratio.

According to the IR data we received, the IR of upper and lower limb amputations in different countries varies from 47% (in Ukraine) to 22%, 17% and 13% in Japan, Canada and Germany.

The IR of the total number of upper limb amputations and the reason due to the tumor are the most frequent. In particular, in Germany (a value close to 99%), in Canada and Ukraine – 70.0% and 68.7%. In Japan, the percentage is lower (34.6%) because there are other reasons, for example, injuries. However, arm neoplasms occur rarely in comparison to all other risk of limb loss.

For example, the ratio (IR) of amputation of the lower limb due to neoplasm is much lower (in Ukraine it is 32.3%, in Germany and Canada 13.5%, 12.3% and only 7.7% in Japan), but it is significantly higher due to diabetes mellitus complications, such as angiopathy (63.5% in Canada, 35.3% in Germany, 32.4% in Ukraine and 30.0% in Japan).

Important to note [10, 14, 15, 17], that a high amputation is more common for arterial obstruction, and a low amputation is more common for diabetes mellitus complications. Mentioned two are the most frequent reasons of lower limb loss (Table 1B).

Other less frequent but significant reason of amputations, accept mentioned above is osteomyelitis, which is more actual problem for Ukraine than for other studied countries [7-9, 12].

Spearman's method [19] was used to identify the correlation between the data on the level of resection (Table 1C) depending on the country and the causes of occurrence (diabetes mellitus complications, arterial occlusion). This is the so-called method of ranks and it refers to the non-parametric criteria for an approximate assessment of the reliability and strength of the relationship between various features.

To evaluate the obtained result of the reliability criterion, the table of values of the Student's criterion (20) was used. The obtained Student coefficient (1.9) exceeds the tabulated coefficient (1.869) with a probability of 95%, but does not reach the tabulated coefficient (2.306) with a probability of 97.5%. The revealed correlation dependence is direct and strong in connection strength, which confirms our conclusions on scientific sources review.

In medical statistics, is established four main groups of risk factors for humans health loss are known (21) with average values: lifestyle (52-51%), environment (21-20%), biological factors (20-19%), medical factors (9-8%).

At least three of them (environment, biological factors and lifestyle) hardly may change. In particular, for all countries biological risk factors (age, sex of people) stay stable, others (like genetics), in combination with unhealthy lifestyle, often lead to diabetes mellitus, atherosclerosis and high risk of lower limb loss.

Environmental factor may change rarely. It happens in case of natural disaster or war.

The most variable is forth - medical risk factor, which depends on healthcare system of each country. It includes a possibility to have an access to early diagnostics, efficiency of treatment protocols, microinvasive procedures and multidiscipline solutions availability, sufficiency of medicaments for all population. Medical risk is higher for Ukraine and also for Canada. But in this case, we have data from only one Canadian province (Saskatchewan) (14, 16) against the background of other articles describing the situation with complications from diabetes mellitus as controlled, even during the Coronavirus pandemic (4). Therefore, it can be assumed that, in general, the situation in the country is more prosperous. Medical risk for a Germany is not the same and depends on every federal state.

Conclusions. Ukraine has a higher percentage of amputations of the upper limb, which, according to the statistical results, is removed most often due to neoplasms and injuries. Osteomyelitis plays an important role in amputation of the lower limb compared to other countries.

The lower limb loss is much more common for all countries and often happens due to vessels insufficiency because of diabetes mellitus complications, atherosclerosis. The correlation-regression method of medical statistics made it possible to establish a direct strong connection (with a probability of 95%), amputation of the foot due to angiopathy caused by diabetes mellitus and hip (femur) amputation due to arterial occlusion.

One of four, medical risk factor is the most various and depends on level of the medical system support in each country. The limbs loss can be prevented by a multidisciplinary

approach, a sufficient level of examination, in particular determination of blood flow in the lower extremities, microinvasive limb-saving vascular interventions. These medical manipulations should be available to the majority of the country's population.

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