Personalized Prognosis of Oncosurgical Patients Using Standard Tool Microsoft Access

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Abstract. The most common treatment for oncological diseases is using of surgery. Despite successful methods of surgery, the problem of a personalized prediction of the outcome of hospitalization is an important and fundamental problem in the treatment of a noncosurgical patient with five or more concomitant diseases. This is due to the fact that at present the choice of an unified approach to the decision to conduct a planned surgical intervention in the case of oncological pathology with appropriate recommendations puts the physician before a difficult choice of treatment tactics for each case separately. There are many prognostic models, both implemented and not implemented in the form of various computer and mobile applications that allowed physician to assess the severity of the patient's condition and predict the outcome of treatment. Therefore, to support the physician of a medical decision, simple and accessible tools are needed, allowing divide patients according to individual selection of the treatment regimen. Nevertheless, the introduction of specific models for predicting therapeutic measures (for example, surgical intervention) in patients, in particular elderly patients, in clinical practice often remains at the level of basic research and is used only in a few clinics related to that studies. The purpose of our work is to implement a decision rule as the Microsoft Access software, which allowed ranking patients with oncological diseases by the probability of lethal outcome before surgical intervention. The software implementation methodology was implemented using elements of the standard Access database. The result of our research was the implementation of a decision rule in the form of Microsoft Access software Oncoprognosis 1.0, which allows physician to rank oncosurgical patients according to the likelihood of death in oncology.

Keywords. decision making support model, prognostic score, prognosis of lethal outcome of oncosurgical patients, personalized prognosis of patient outcome, Microsoft Access
1. Introduction
In the world, on average, there are 5.5 surgical diseases per one senile patient, where 20-30% of which more are performed for oncological diseases [1]. Postoperative lethality rates in planned surgery depend on the complexity of the operation, ranging from 7 to 20%, when for the population these values vary from 1.4% to 5.5%, and do not tend to decrease [2-4]. Scientists (K.Y. Tan (2009), Y.K. Yanov (2015)) believe that the complications and lethality that occur in patients who had surgical treatment are largely predetermined by many objective factors: the nature of the main disease features of the clinical manifestations, comorbidity, immune status, blood loss or shock [5-8]. At the same time, the high lethality rates in the elderly patients, both during the operation and in the early postoperative period, are explained by the fact that surgeons often do not take into account the features of the aging organism of the patient with the presence of a large number of comorbidities [9].

Thus, the main obstacle to adequate surgical treatment of a geriatric patient is the doctor's doubt about the prospects of surgical intervention [5,10,11]. So, the main problem emerging in surgery of oncological patients with a big amount of comorbidities (five or more) is the question of the use of surgical intervention in the subcompensation of aggravated clinically significant diseases [12,13].

One of the ways to reduce the rates of postoperative lethality is the question of the objective use of surgical treatment of oncological patients with comorbid pathology [10-12]. The solution of the problem is to predict the probability of lethal outcome of patients by using modern mathematical methods and information technologies [14,15]. There are many prognostic models, both implemented and not implemented in the form of various computer and mobile applications that allow you to assess the severity of the patient's condition and predict the outcome of treatment [16,17].

At the moment, there are more than a hundred different computer and mobile applications that allow for fast and relevant support for making medical decisions in various fields of medicine based on such mathematical models. That prognostic models allowed you to assess the severity of the patient's condition and predict the outcome of treatment [18,19].

Thus, such applications include tools for assessing the severity of the condition of patients in general, for patients with injuries, patients with heart diseases, etc. Applications allow not only to assess the severity of the patient’s condition, but to make a prognosis of treatment and hospitalization, to stratify patients into different groups when analyzing and conducting various studies [20,21].

Nevertheless, the introduction of specific models for predicting therapeutic measures (for example, surgical intervention) in patients, in particular elderly patients, in clinical practice often remains at the level of basic research and is used only in a few clinics related to these studies [22].

Therefore, to support the physician of a medical decision, simple and accessible tools are needed, allowing dividing patients according to individual selection of the treatment regimen [17,20].

The purpose of our work is to implement a decision rule as the Microsoft Access software, which allowed ranking patients with oncological diseases by the probability of lethal outcome before surgical intervention.

2. Material and methods
The study included patients who received treatment in the Surgical Department in State Research Center - Burnasyan Federal Medical Biophysical Center of Federal Medical Biological Agency from January 2009 to July 2017. The study was conducted in 112 patients, 42 of whom (37.5 %) were men and 70 (62.5 %) women, aged 25 to 85 years (59.6 ± 13.2). At the end of hospitalization after surgical treatment, 51 patients were discharged (45.5 %), and 61 (54.5 %) died. In all patients, the parameters of the functioning of various organs and systems were collected, including taking into account the anamnestic data of oncological patients, with differentiation in the final outcome of surgical treatment (age, Body mass index (BMI), heart rhythm disorders in the history of an electrocardiogram, hemoglobin level (Hb, g / ml), presence of protein in the urine, international normalized ratio of coagulograms (INR), duration of the operation, hour). To implement the decision rule as Microsoft Access software, which allows ranking patients with oncological diseases according to the probability of a lethal outcome during a surgical intervention, we took a predictive model representing logistic
regression, that allow to estimate the probability that an event will occur for a particular patient (survived / deceased) [23-25]. The prognostic model equation was:

\[
p = \frac{1}{1 + e^{-z}}
\]

where \( p \) – probability that an event will occur (in this article, it is lethal outcome); \( e \) – base of the natural logarithms 2.71…; \( z \) – standard regression equation.

\[
z = -0.427 + 1.961 \times \text{Age} - 1.317 \times \text{BMI} + 3.372 \times \text{Abnormality. ECG} + 0.955 \times \text{Hb} + 0.579 \times \text{P} + 2.352 \times \text{INR} - 0.749 \times \text{Duration of the operation}
\]

where BMI - body mass index, ECG - electrocardiogram, Hb - hemoglobin, P - protein, INR - International Normalized Ratio of coagulograms, Duration of the operation - estimated duration of the operation

Estimation of the accuracy of the prognostic model and the determination of threshold values with maximum sensitivity and specificity were carried out by constructing an area under the Receiver Operating Characteristic (ROC) curve and its analysis. The prognostic model was considered perfect for an area under the characteristic curve (ROC-area) of more than 0.9, at ROC-area from 0.8 to 0.9 - satisfactory, from 0.7 to 0.8 - acceptable, and with ROC-area less than 0.7 - unsatisfactory [26].

To design a decision rule for the prognostic model, two cut-off points were identified, that allowed to divide patients into groups with favorable and unfavorable outcomes. The cut-off point, determined at the level of the optimum sensitivity and specificity of the method, was determined so that the sensitivity value was higher than 0.700 and the specificity value was not lower than 0.700 (this method of selecting the cut-off point allowed detecting the vast majority of patients with unfavorable outcomes (70%)) [22,27].

The software implementation methodology was implemented using elements of the standard Access Microsoft. Information storage tables were developed, patient data input forms were developed using the form designer, reports were generated using queries using calculation formulas based on the prognostic model and embedded macros in Access. Consistent user work is organized in the Oncoprognosis program v.1.

Description and processing of the data was carried out in Excel and SPSS 17.0.

3. Results

The data of parameters of the functional state of organs and systems for predicting lethal outcome of oncosurgical patients (with five or more comorbidities) based on the collection of information on the functioning of various organs and systems, including taking into account the patient's anamnestic data and analysis of scientific literature data, allowed to determine the factors that influence the outcome of a surgical patient with oncopathology. The factors, which allowed classifying patients into the group of deceased or survivors, are: age, body mass index, presence of heart rhythm disorder, Hb level, presence of protein in urine, and level of INR coagulogram. The selected parameters were collected to calculate a prognosis of outcome for patients by prognostic model.

For analyze of the chosen mathematical models by construction of ROC curves (AUROC=0.916±0.026) were obtained sensitivity (Se) and specificity (Sp) for each patients (table 1, figure 1).
Based on the chosen mathematical model by analyzing sensitivity and specificity, a decision rule was designed according to the type of the traffic light: Green, Yellow, Red, by defining two cut-off points.

The first cut-off point was chosen at the level of the probability of lethal outcome, at which the sensitivity value was above 0.900, and the specificity value was not less than 0.700. It allowed to select patients with a low probability of lethal outcome - the Green Zone. The second cut-off point was chosen at the level of the probability of lethal outcome, at which the sensitivity value was above 0.700, and the specificity value was not less than 0.900. It allowed to select patients with a high probability of lethal outcome - the Red Zone [18]. In the Yellow Zone, intermediate cases between these two points were assigned - patients requiring preoperative correction of the condition (table 2).

To implement the decision rule as a program was used the standard Access Microsoft Office Access 2007. The implementation performed as software as the Oncoprognosis 1.0 software, which allowed to make calculations on any personal computer that has the application data.

This program consisted of tabs:
- Beginning of work;
- Instructions;
- Windows for calculating the probability of a lethal outcome;
- Print output windows of the received results in the form of a traffic light;

The obtained implementations were as follows (see figure 2).

**Table 1.** Value of sensitivity (Se) and specificity (Sp) for mathematical model.

| №  | Probability of lethal outcome obtained by prognostic model | Sensitivity (Se) | Specificity (Sp) |
|----|----------------------------------------------------------|------------------|------------------|
| 1  | 0                                                        | 1                | 0                |
| 2  | 10,2                                                     | 0,984            | 0,353            |
| 3  | 13,9                                                     | 0,967            | 0,431            |
| 4  | 16,3                                                     | 0,967            | 0,529            |
| 5  | 20,6                                                     | 0,951            | 0,549            |
|   |   | 23,7 | 0,885 | 0,667 |
|---|---|-----|-------|-------|
| 7 |   | 27,5 | 0,885 | 0,686 |
| 8 |   | 33,4 | 0,885 | 0,706 |
| 9 |   | 36,3 | 0,869 | 0,784 |
|10 |   | 38,2 | 0,836 | 0,843 |
|11 |   | 42   | 0,82  | 0,863 |
|12 |   | 49,1 | 0,82  | 0,882 |
|13 |   | 56,3 | 0,803 | 0,882 |
|14 |   | 60,9 | 0,787 | 0,922 |
|15 |   | 63,8 | 0,77  | 0,922 |
|16 |   | 67,7 | 0,754 | 0,922 |
|17 |   | 72,9 | 0,738 | 0,941 |
|18 |   | 77,4 | 0,721 | 0,941 |
|19 |   | 80,9 | 0,705 | 0,941 |
|20 |   | 83,7 | 0,689 | 0,941 |
|21 |   | 85,2 | 0,672 | 0,961 |
|22 |   | 85,7 | 0,656 | 0,961 |
|23 |   | 86,7 | 0,623 | 0,961 |
|24 |   | 88,3 | 0,607 | 0,98  |
|25 |   | 89,7 | 0,574 | 0,98  |
|26 |   | 90,5 | 0,492 | 1     |
|27 |   | 91,4 | 0,475 | 1     |
|28 |   | 92,1 | 0,459 | 1     |
|29 |   | 92,7 | 0,443 | 1     |
|30 |   | 93,4 | 0,426 | 1     |
|31 |   | 94,1 | 0,41  | 1     |
|32 |   | 94,6 | 0,377 | 1     |
|33 |   | 94,8 | 0,361 | 1     |
|34 |   | 95,5 | 0,311 | 1     |
|35 |   | 97,2 | 0,279 | 1     |
Table 2. Cut-off points for designing of a decision rule.

| Mathematical model | Choice Cut-off | Se   | Sp   | Probability of lethal outcome, % | Zone       |
|---------------------|----------------|------|------|---------------------------------|------------|
|                     | Se>0,9; Sp>0,7 | 0,885| 0,667| p<=23,7                         | Green      |
|                     | 0,7<Se<0,9; Sp<0,9 | >0,705| <0,667| 23,7<p<80,9                     | Yellow     |
|                     | Se>0,7; Sp>0,9 | 0,705| 0,941| p>=80,9                         | Red        |

p- probability of lethal outcome, Se-sensitivity, Sp-specificity.

The developed program for the prediction of the complicated course of the early postoperative period in somatically burdened patients allowed not only to predict a lethal outcome with a sensitivity of more than 90% and specificity of more than 70%, but also motivated to refuse surgery, offering alternative methods of treatment, but also provides an opportunity to identify a group of patients who need preoperative preparation.
4. **Discussion**

The presented mathematical model allows physicians to divide patients into groups with favorable and unfavorable probability of lethal outcome with outstanding prognostic accuracy (AUROC=0.916). Based on the analysis of the ROC curve, the decision rule was designed by determining the cut-off point that allows patients to be divided into groups at the final outcome of surgical treatment with the sensitivity of more than 0.9 and the specificity of at least 0.7.

The implementation program was intended for preliminary prediction of the probability of a lethal outcome of a surgical patient of an oncological profile based on the functional state of organs and systems. It allowed you to assess the severity of the patient's condition on the basis of anamnesis, objective examination, and assessment of laboratory and instrumental indicators. The software product, by applying the obtained decision rule, allows you to rank patients according to the risk of death in three groups:

- "Green" - a group with a minimum risk of lethal outcome;
- "Yellow" - a group requiring preoperative preparation;
- "Red" is a group with a maximum risk of lethal outcome, for which the treatment tactics must be determined individually at a consultation.

Thus, the introduction of the results of fundamental scientific work in medicine in the form of various computer programs and applications allows physicians to use mathematical models as decision-making support in patients' treatment. Also, such an implementation allowed the use of such programs not only in the narrow band of doctors who were relevant in its creation, but also used in a wide range, and if there is a language adaptation in world practice.

A further prospect is to expand the internal cancer risk model by clarifying the nature of the disease of the cardiovascular system with ranking on the contribution to the lethal outcome. Also interesting is
the generalization of independent databases of the results of applying the program with a multiplicative assessment of the reliability of the result.

The Oncoprognosis 1.0 can be used as decision making support the practice as simple and accessible tools needed to physician, allowing to divide patients according to individual selection of the treatment regimen

5. Proof

The program should be used to address the issue of conducting surgery at the prehospital stage, with the possibility of identifying ways to further diagnose and correct rejected indicators at the stage of preoperative preparation. The program provides the following functions: predicting, ranging, patients, the choice of patient management tactics. The Oncoprognosis 1.0 can be used by physician of any specialties at the stage from the initial contact with the oncological patient with five or more comorbidities to surgery.

The using of the current model allowed to reduce the average duration of hospitalization 1.28 times in three medical institutions. The number of non-surgical complications of the early postoperative period decreased from 37.8 to 22.9%, and the number of deaths due to correction of the pathology of comorbidities in this group of people decreased to 46% in the group without correction and decreased to 16% in the group with correction.

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