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Research Article

Neoplasm Morbidity among the Population of Russia

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ABSTRACT:
This paper deals with the analysis of statistical data on the neoplasm morbidity among the population of the Russian Federation. The estimation is given to the quantitative dynamics of patients in 1970-2013 by causes. The diseases were identified with the highest number of patients, as well as the diseases most intensively developing per capita. The estimation is given to the state of the hospital fund, science and technology cluster, and the level of medical assistance to the population.

Keywords: tumor, statistics, simulation, mortality, cancer care

1. INTRODUCTION

Tumors of human and animal tissues have been known as the disease since ancient times. In Russia, in XIX century, the doctors used the term "tumor", "cancer", "neoplasm" in their medical records. Over time, the tumors began to be divided into benign and malignant ones. Today, the terms "benign tumor" and “malignant tumor" are used. The most dangerous are malignant neoplasms. They are not only difficult to cure, but also a major cause of mortality in Russia.

In the Russian Empire, after the establishment of zemstvo medicine in 1860, the press and the reports of Medical Department of the Ministry of Internal Affairs began to publish statistics on morbidity. The reports did not include oncological diseases as an individual group of diseases. Only at the turn of XIX - XX centuries, the "tumors" became a part of the list of diseases. There was also no special oncological care provided to the population. That time was characterized by a difficult situation with a high infant mortality rate (30-40% of the country's births died within a year [16]), a high mortality from epidemic diseases (up to 50% of the population died in epidemic areas [17]). This was accompanied by the high incidence of sexually transmitted diseases (from 10 to 15% of all patients [17]). That is the task of organizing the cancer care was not a priority. However, by the beginning of the XX century, the doctors, governmental bodies and the public made efforts for its establishment [16, 17]. At the beginning of the XX century, the Cancer Institute and the Institute for the treatment of tumors already started their operation in Moscow. And in 1914, the I All-Russian Congress was convened to combat cancer [15].

After the end of the World War I and the Civil War, in Russia in 1920 - 1940, training of oncologists and a system of dispensaries were established to provide cancer care to the

population [15]. Expansion of the network of oncology clinics continued after 1945. In addition to the dispensaries, several major cancer centers and clinics were also established. Medical institutions gradually opened their oncology department. The last stage of amplification of oncological care to the population began in 2009 under the national project “Zdorovie".

The Russian State Statistics Committee publishes annually Statistical data on the oncological diseases in its publications [21-24], and since 2007 - in the papers of Federal State Institution “P.A. Herzen Moscow Cancer Research Institute”, Federal Agency for high-tech medical care [26-33].

2. CANCER MORTALITY

Over the past forty years, according to the State Statistics Committee [21-24], the largest number of deaths in Russia from various diseases is caused by circulatory system diseases (about 50% of all deaths) and cancer (about 15% of all deaths). Fig. 1 shows the dynamics of mortality from all causes of diseases per 100,000 population, from the circulatory system diseases and tumors from 1970 to 2013. Mortality by causes for 1970 is taken to be 1. As can be seen from these data, the periods of increased mortality were alternating with its decrease. Mortality from all diseases and the circulatory system diseases increased by about two times from 1970 to 2004. After 2004, they started to decline, but did not reached the mortality level of 1970. Mortality from cancer during the same period increased by 1.4 times, and has remained virtually unchanged for 20 years. The number of deaths from cancer is about 90 cases per 100,000 population. This figure does not differ from its value at the beginning of the XX century – 80 people [16, 17].

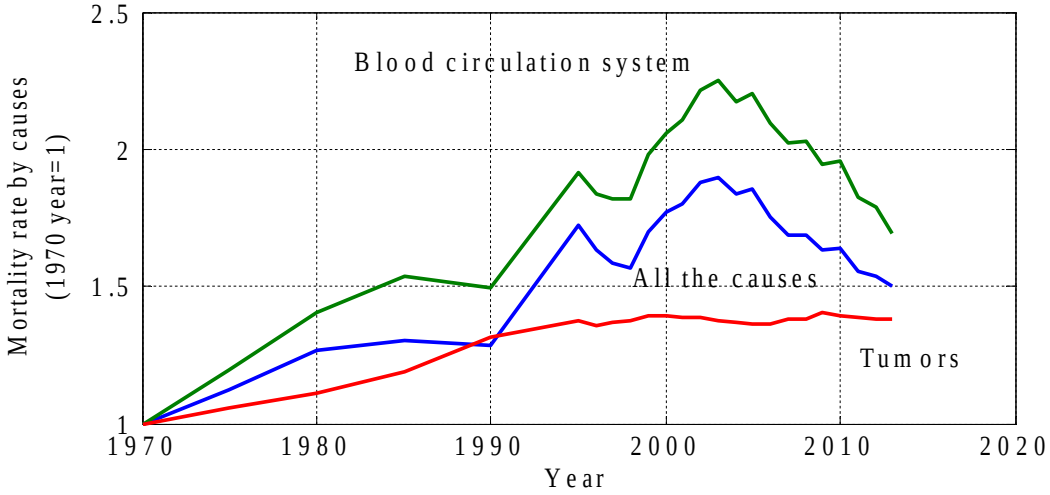

Fig. 1: Mortality dynamics by causes

3. GENERAL NEOPLASM MORBIDITY

The statistics of the total number of cancer patients accounts both all patients and new ones. The quantitative dynamics of the total number of cancer patients and those first-ever diagnosed from 1970 to 2013 is shown in Fig. 2. The value of these parameters for 1970 is taken to be a unit. Data are presented on the basis of the number of patients per 100,000 population. As it follows from Fig. 2, the number of patients from 1970 to 2013 increased by more than three times, and the newly diagnosed - twice. The growth of number of newly diagnosed people occurs linearly, that is, the growth rate is constant. The growth of number of the registered patients, starting from 1990, has been changing exponentially $y = a\exp(\mu t)$ with the index $\mu = 0.028$ (with a growth rate of about 2.8% per year), that is, the growth rate of the total number of cancer patients is proportional to the number of patients. Thus, for last 50 years, there has been growing number of cancer patients per 1000 population (Fig. 2), but the number of deaths stabilized after 1995 (Fig. 1). In 2014, there were 2.25% of patients with cancer, or 2250 people per 100,000 population. The similar figure for 1913 is much less - 412 patients per 100,000 population [16, 17].

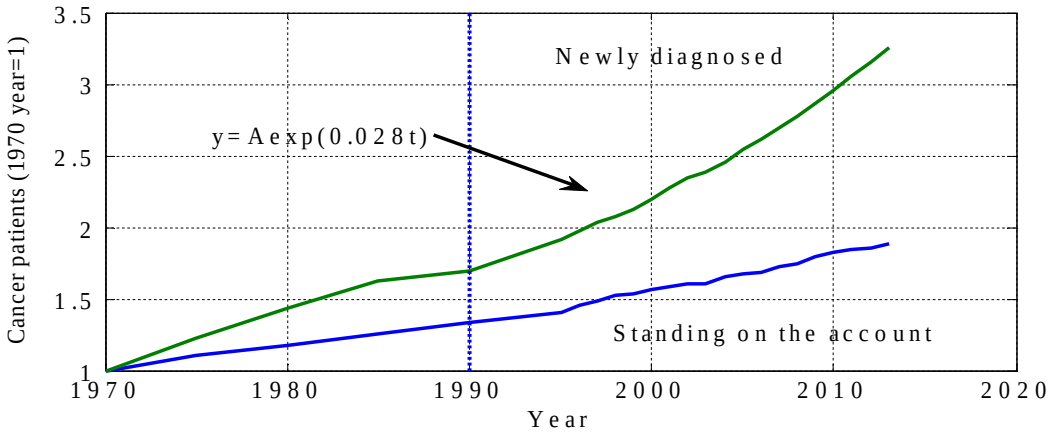

Fig. 2: Cancer case dynamics

Starting from 1990, the number of cancer children per 100,000 child population increased by 4.5 times for the reporting period. The rate of growth in the number of sick children was constant until 2011. In 2013, the number of cancer patients has not increased in a group of 100,000 children under 14 years, in comparison with the number of patients in 2012.

Separate statistics provides data on the incidence among women. Fig. 3 reflects the changes in the number of women with tumors, as well as the dynamics of the disease by its types - tumors of breast and reproductive system (based on the number of cases per 100,000 women). The number of patients for 1980 is taken as unity. As it follows from this figure, neither the rate of growth of female oncological diseases, nor of individual, female-specific diseases have decreased.

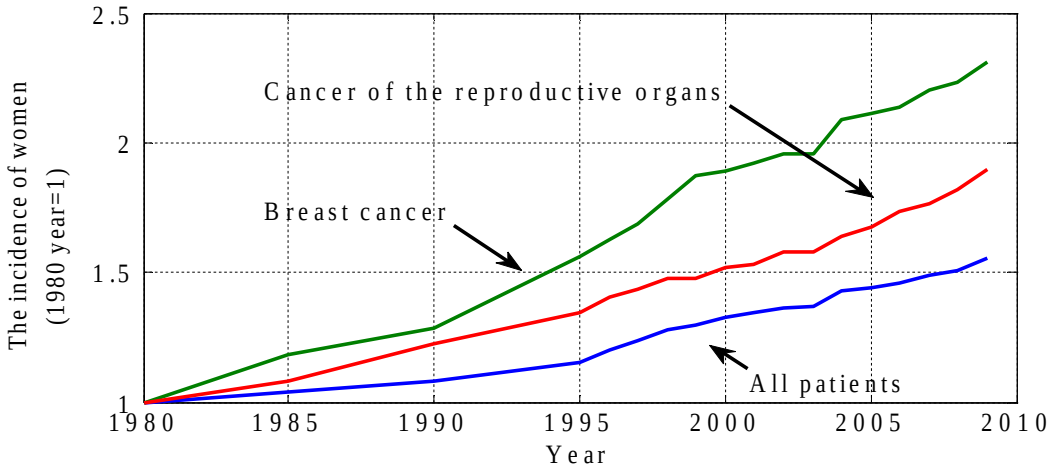

Fig. 3: Female morbidity dynamics by causes

4. DISEASES

The number of patients per 100,000 population, according to the analysis of statistical data, for some types of diseases, such as cancer of the larynx and mouth, either decreases or remains practically constant [26-33]. But for most diseases, it has grown for last twenty years. The greatest increase from 1997 to 2014 occurred in prostate tumors (6 times), bladder and thyroid (3 times), and hematopoietic tissue (2.5 times). Fig. 4 reflects changes in the number of patients with these neoplasias. The number of patients with prostatic cancer grows exponentially $y = a\exp(\mu t)$ with the index $\mu = 0.1$ (with a growth rate of about 10% per year), while the other two have constant growth rate. The rate of growth in the number of patients for most diseases remains constant and ranges from 0.088 to 0.382 1/year, depending on the diseases, and the number of oncology beds and doctors grows at a rate of 0.025 and 0.067 1/year, respectively. The most dangerous is the fact that the general incidence and the incidence of certain organs grow exponentially.

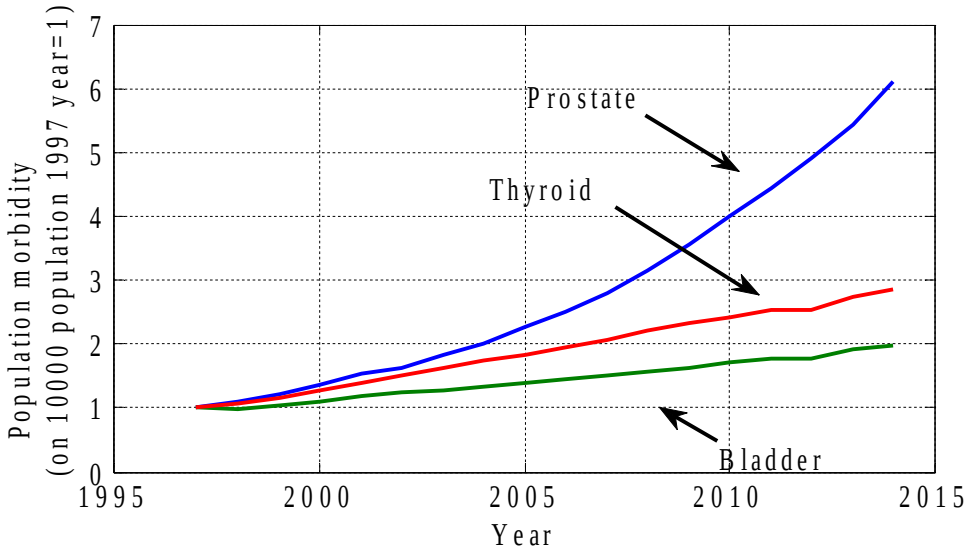

Fig. 4: Population morbidity dynamics by causes

Diseases affect all age groups. The number of patients per 100,000 under 14 is 25 people, aged 15-19 years - 28 people, aged 20-39 - 108 people, aged 40-59 - 790 people, over 60 - 2,736 people. That is, cancer diseases in most cases occur in the age group older than 40 years, or develops for decades. Generally, one of fifty people in the country suffers from cancer.

Major indicators of morbidity in the regions differ slightly from the general rate of the country [1-4, 9, 11, 19, 25, 34, 35] and of the Commonwealth of Independent States [6, 7].

5. CANCER CARE

The system of providing cancer care to the population of Russia has started its formation over a hundred years ago [15, 26]. The basis was a network of cancer clinics with inpatient units. In 2013, there were 100 dispensaries with rooms and laboratories, and 3 specialized cancer hospitals in Russia. The list of rooms [33] and the number of dispensaries in 2014 is shown in Table 1. As can be seen from the data, the major department in most dispensaries are radiographic, clinical diagnostic, ultrasound diagnostic and endoscopic ones. That is, the main efforts in dispensaries are directed primarily to diagnose diseases rather than prevent them.

Table 1: Laboratories and rooms in the dispensaries (2013)

Room	Number
Radiography	98
Endoscopy	98
Ultrasound	97
Clinical-diagnosis	96
Radiology, radiotherapy	76
Cytological	56
Morbid anatomy	54
Radioisotope diagnosis	32
Biochemical	11

In addition to the network of dispensaries, the various medical institutions have oncology offices or departments established (the list of offices and their number are shown in Table 2 [33]). In order to identify cancer patients, a network of consulting rooms has been established. In 2014, these offices accounted for 4,758, with 4,101 specialists employed. The offices have examined about 11% of the population (4% of men and 17% of women), nearly 2% of which were referred to the specialized oncological departments.

Table 2: Oncological departments in the medical institutions (2013)

Departments and rooms in the medical institutions	Number
Clinical-diagnosis	7,496
Radiography	5,808
Ultrasound	5,402
Endoscopy	4,001
Oncology	2,244
Oncology	2,244
Mammography	1,539
Morbid anatomy	1,504
Computed tomography	1,101
MRI	441
Biochemical	390
Cytological	272
X-ray endovascular diagnostics and treatment	150
X-ray surgery	147
Radioisotope diagnosis	134
Radiology, radiotherapy	126
Total	32,999

In 2013, there were 5,900 hospitals and 16,500 outpatient clinics in Russia. Therefore, most of the medical organizations, as follows from the data presented in Table 2, have rooms or departments: clinical-diagnostics, ultrasound and X-ray diagnostics. With a uniform distribution of the oncologic departments across the country, every city with a population of over 100,000 inhabitants, (165 cities in the Russian Federation in 2014 [24]), should have almost all departments or rooms listed in Table 2.

Medical institutions of Russia in 2014 employed 6,492 oncologists, 1667 radiologists, 56 X-ray physicians, and 24,531 nurses [33]. At the same time, nearly 2,000 full-time jobs remained vacant. 477 patients fall at one oncologist, and 393 patients fall at one doctor in the entire cancer care system. At the same time, 160 patients with all diseases fall at one doctor in the Russian Federation [24].

Hospital beds in medical institutions are divided into 4 types: oncology (70.6%, 24 per 10,000 population), hematologic (11.1%, 0.4 beds per 10,000 population), radiologic (16.0%, 0.54 beds per 10,000 population) and child (2.3%, 0.7 beds per 10,000 of the child population). Occupation of hospital beds for all types is 320-350 days per year [33]. The number of hospital beds grows much more slowly than the number of patients and the number of new cases. While the number of patients in 1970 increased by more than 3 times, and the number of new cases - by 2 times (Figure 2), the number of hospital beds increased by only 1.5 times.

The disease is divided into four stages. At the first diagnosis of the disease, nearly 50% of patients have a first or second stage of the disease, about 20% have the third stage, and 20% - the fourth. About 2% of newly diagnosed patients refuse specialized treatment, and about 7% have contraindications for treatment. The proportion of patients with I-II stages of the disease is 46% of all those who refuse treatment, and 34% of patients with contraindications for treatment. High percentage (40%) of newly diagnosed patients with the third and fourth stages of the disease troubles.

The proportion of the different methods being used in recent years in the treatment of patients with malignant neoplasms:

- surgical treatment only – 52.1%;
- combined – 31.9%;
- X-ray only – 11.1%;
- pharmacotherapy only – 3.1%;
- chemoradiotherapy – 1.8%.

Despite the development of new treatment technologies for neoplastic diseases, especially in chemotherapy [20], the main treatment still remains surgery.

Thus, for last 20 years, the oncological service of the country has managed to achieve two positive results:

- the growth of the number of deaths per capita has been stopped in patients with tumors;

- the growth of the number of sick children aged 0 to 14 years has been stopped.

Along with this, there is a constant growth in:

- the number of newly-diagnosed population;
- total number of female oncologic diseases;
- the number of diseases of the female reproductive system;
- the number of diseases of "sensitive" organs, such as breast, thyroid, bladder, and other diseases;
- there is no tendency observed to the reduction of growth rate of most diseases.

6. MALIGNANT NEOPLASM AND MATHEMATICAL SIMULATION

Live tissues are composed of cells. The main form of cell reproduction is a mitotic division. Mitosis includes several phases, after which a new cell begins its functioning until the start of its division. All cells, depending on their functions in the body, can fission a certain number of times. After that, their life cycle ends. The mechanism of cell death is innate in itself. If this mechanism is impaired, the cell will continue to fission all the time. As a result, the excess cells are accumulated in the diseased tissue, gradually forming a tumor. With the growth of the tumor, the cells are combined and form various three-dimensional structures. Growth process can be accompanied by the penetration of continuously dividing cells into the surrounding tissue with the formation of new foci of cell growth. The accumulation of these foci can become irreversible and cause death. Based on this model of the growth process of the dividing cells the mathematical models of cancer growth have been developed [5, 8, 36]. We used the methods of population biology able to present a mathematical model of the tumor as a boundary value problem for a system of differential equations [12, 13, 18, 37]. Growth models remain open to the construction of the mathematical models of treatment. This approach allows us to predict the dynamics of the tumor growth and evaluate the potential effectiveness of one or the other method of treatment, and to assess the scope and material resources [10] needed to provide cancer care. An important factor in the construction of the mathematical models is the availability of experimental data on the biochemistry and morphology of the growth process. In Russia, the number of current research is not sufficient [14]. This applies not only to the very diseases, but also to the identification of cancer causes. This is apparently due to insufficient research funding, both on the part of the budgetary expenditure items, and on the part of commercial structures. In general, the scientific results obtained by Russian investigators have been highly respected by the scientific community [14].

7. CONCLUSION

The advances of the Oncology Service of the Russian Federation in certain areas of provision of cancer care to residents of the country have not yet stopped the growing number of patients with different types of tumor. The rate of growth in the number of patients per capita for most diseases has remained largely unchanged over the past 40 years, and in some cases, the number of patients increases exponentially. In general, cancer care provided to the population only inhibits the growth of mortality from neoplasms. Stopping an increase in the number of patients, despite the considerable efforts made in this direction, have failed yet. Presumably, the efforts by health care system are inadequate to address this kind of problem.

CONFLICT OF INTERESTS

The author declares that the provided information has no conflicts of interest.

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