

## The Dynamics of The Development of the Load on the Anesthesiology and Critical Care Services in a Large City

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### Abstract

*Purpose of the study: To identify areas for improving the conditions of effective work of the anesthesiology and critical care service.*

*Materials and methods: The authors performed a comprehensive analysis of data from 75 inpatient medical organizations in St. Petersburg (continuous observation) on the number and structure of critical care and anesthetic support and personnel resources of anesthesiologists and critical care physicians for the period between 2015 and 2019 (1,309,700 cases of anesthetic support and 759,696 cases of critical care). The obtained data were statistically processed, and the average values, extensive and intensive parameters, the significance of differences in parameters according to Student's t-criterion, parameters of the time series, and correlation analysis were calculated.*

*Results: The study showed an increase in the load on the anesthesiology and critical care services in recent years. The number of patients had increased by 13.8%, the volume of critical care and anesthetic support provided had increased by 9.4% and 14.8%, respectively. At the same time, the increase in the volume of manipulations performed by anesthesiologists and critical care physicians was not accompanied by an influx of specialists to work in that field or by staffing of hospitals with medical personnel in sufficient volume, which is confirmed by parameters characterizing the workload per 1 specialist of that profile in a hospital (in 2015, 1 specialist on average performed 101.4 anesthetic support manipulations, and in 2019, that number rose to 109.1 ( $t = 3.7$ ,  $p < 0.05$ )). The critical care load ratio in 2015 was 61.43, and in 2019, it equaled 63, 06 ( $t = 4.5$ ,  $p < 0.05$ ).*

*Conclusion: The anesthesiology and critical care services, as the most vulnerable due to the increased psychological, emotional, and physical stress of doctors, require special approaches to human resources. The growing general "volumetric" workload of anesthesiologists and critical care physicians is accompanied by factors that significantly complicate the conditions of their work (the prevalence of interventions carried out in the context of emergency and urgent medical care). These*

*circumstances must be taken into account when implementing measures to improve the organization of work of anesthesiologists and critical care physicians.*

**Keywords:** Human Resources of Anesthesiology and Critical Care Service, Anesthetic Support and Critical Care, Activities of Anesthesiology and Critical Care Services in a Large City.

## **1. Introduction**

As part of the implementation in the Russian Federation of the "Health" national project, following Decree No. 204 "On national goals and strategic objectives of the development of the Russian Federation for the period until 2024" of the President of the Russian Federation dated 07.05.2019 [7] a phased qualitative development of the medical industry is being carried out, including the search for measures to attract qualified personnel to work in medical organizations and their further retention in medical organizations, as a foundation that allows ensuring effective highly professional work of the entire field. In this regard, recently in the healthcare system of the Russian Federation, the issues of creating stable working conditions for specialists in various areas are seen as extremely urgent [3, 7]. Anesthesiology and critical care should be considered one of the fields requiring increased attention of health authorities since the activities of specialists in this area require special conditions of theoretical and practical training and, at the same time, it is associated with increased psychological, emotional, and physical stress and occupational hazards [2, 4, 5].

Managing the workload of anesthesiologists and critical care physicians allows timely and sufficient measures to be taken to neutralize the negative factors in the activities of doctors in this field [1, 6]. In this regard, the analysis of the load on the anesthesiology and critical care services is one of the most urgent tasks in the field of healthcare.

## **2. Methods**

A comprehensive analysis of data on the number, structure, and cost of critical care and anesthetic support was carried out by copying information on the activities of inpatient medical organizations in terms of medical care in the compulsory health insurance system in St. Petersburg, as well as information contained in official reporting form No. 30 "Information on the activities of a medical organization" approved by order No. 412 of the Federal State Statistics Service dated

04.09.2015 (75 inpatient medical organizations, 1,309,700 cases of anesthetic support and 759,696 cases of critical care for the period from 2015 to 2019 (continuous observation)).

The obtained data were statistically processed, and we performed calculations of average values, extensive and intensive parameters. To assess the statistical significance of the differences in parameters, Student's t-test was used. Evaluation of the dynamics of the bed capacity of critical care and intensive care services and its activities over five years was made by calculating the parameters of the dynamic series. The assessment of the relationship between the parameters of the inpatient medical facility activities was carried out using correlation analysis.

### **3. Results**

In the period from 2015 to 2019 in St. Petersburg, there was an increase in the load on the anesthesiology and critical care service, expressed in an increase in the number of patients who received inpatient medical care of this profile by 13.8% and an increase in the volume of critical care and anesthetic support provided in medical institutions by 9.4% and 14.8% respectively. The increase in anesthetic and critical care is generally proportional to the increase in the volume of medical care provided to citizens: the share of the volume of medical care in the field of anesthesiology and critical care in the total volume of medical care provided to patients during the study period ranged from 0.15% to 0.17% ( $t < 2$ ) for critical care and from 0.25% to 0.29% ( $t < 2$ ) for anesthetic support.

A significant increase in the volume of critical care and anesthetic support, as well as the use in recent years of more and more expensive medicines and consumables for their provision, entails a systematic increase in the costs of the healthcare system for their implementation. In 2019 alone, the total costs of the St. Petersburg healthcare system for the provision of critical care and anesthetic support amounted to 6,581.3 million rubles (4,763.7 million rubles and 1,817.550 million rubles, respectively), which corresponded to a share equal to 7.4% in the total expenditures of the healthcare system in the corresponding period. It should be noted that the growth in the costs of the healthcare system for the provision of medical care in the profile of "anesthesiology and critical care" is ahead of the growth rate of the corresponding volumes of medical care. The growth rate of financial costs increased between 2015 and 2019 in terms of the provision of critical care by 38.6%, while the volume of treatment increased by only 9.4%. The volume of financial costs of the healthcare system in terms of providing anesthetic support increased by almost 1.5 times during this period (an increase

of 53.9%), while the volume of these kinds of support increased only by 14.8%. However, annually, in the total cost structure of medical care, the costs of providing it by specialists in the field of anesthesiology and critical care remain stable and range from 2.0% to 2.4% ( $t < 2$ ).

The provision of critical care is the most laborious and costly kind of treatment from the point of view of the psychological and emotional components of a doctor's work. Among all kinds of critical care, unfortunately, a significant share is occupied by critical care of newborn children (26.1% in the structure of all medical services of this type).

The most demanded kinds of manipulations that the adult population undergoing treatment in medical institutions needs fall under critical care of the 1st category of complexity (up to 24 hours inclusive) and critical care of the 2nd category of complexity (Table 1).

Table 1 - Structure of critical care manipulations performed in 2019 in hospitals of St. Petersburg, in %

Critical care manipulation type	absolute value	%
Critical care with differential diagnosis of critical conditions of the brain	74	0.05
Critical care of the 1st category of complexity (up to 24 hours inclusive)	63,283	39.6
Critical care of the 2nd category of complexity (from 25 to 72 hours inclusive)	34,863	21.8
Critical care of the 3rd category of complexity (from 4 to 5 days inclusive)	9,329	5.8
Critical care of the 4th category of complexity (from 6 to 9 days inclusive)	5,897	3.7
Critical care of the 5th category of complexity (from 10 days)	4,488	2.8
Critical care for patients with severe complicated forms of influenza (from 14 days)	19	0.01
Neonatal critical care, 1 patient day	41,686	26.1
All kinds of critical care	159,639	100.0

More labor-intensive critical care measures had to be carried out in a significantly smaller proportion of patients: in 5.8% of cases, it was necessary to carry out critical care of the 3rd category of complexity (4 to 5 days), in 3.7% cases, critical care of the 4th category of complexity (6 to 9 days), in 2.8% cases, critical care of the 5th category of complexity (up to 10 days). Critical care for patients with complicated forms of influenza (up to 14 days) was required only in 0.01% of cases.

In the structure of financial costs for paying for medical care in terms of providing medical services in anesthesiology and critical care, the largest share was occupied by critical care of the 1st category of complexity (up to 24 hours) (21.1%) and critical care of the 2nd category of complexity (from 25 to 72 hours ) (24.9%). Significant volumes of financial costs were also allocated to critical care of newborns (17.7% in the total structure of financial costs).

In the five years studied from 2015 to 2019, the number of anesthetic support provided to patients in hospitals in St. Petersburg had increased by 14.7% (Table 2).

In the structure of anesthetic support provided to patients, along with intravenous anesthesia, which accounted for 37.1% of all manipulations of this kind in 2019, a significant share was occupied by rather complex kinds of anesthetic support. Thus, the share of combined general anesthesia in the structure of all anesthetic treatments carried out in hospitals of St. Petersburg amounted to 32.5%, and that of combined general and regional anesthesia and inhalation anesthesia was 13.5% and 7.2%, respectively.

Table 2 - The structure of the types of anesthetic support used in St. Petersburg in 2019, in % of the total

Type of anesthetic support	Number of anesthetic support manipulations provided	
	absolute value	%
Intravenous anesthesia	102,400	37.1
Combined general anesthesia	89,803	32.5
Combined general and regional anesthesia	37,356	13.5
Inhalation anesthesia	19,920	7.2
Spinal anesthesia	15,196	5.5
Epidural anesthesia	8,450	3.1
Conduction (truncal) nerve block and plexus block anesthesia	1,801	0.7
Spinal and epidural anesthesia	1,286	0.5

In the dynamics over the past 5 years, there has been a certain change in the priority methods of providing anesthetic support. Thus, in the structure of the types of anesthetic support used in 2015, compared to the structure of 2019 ( $t = 4.0$ ,  $p < 0.05$ ), combined general anesthesia (37.0%), intravenous anesthesia (31.6%), and combined general and regional anesthesia (13.6%) prevailed. Other types of anesthesia (inhalation, conduction, spinal, and epidural) were used only in 17.8% of cases.

The workload of the anesthesiologist is not limited to critical care and anesthetic manipulations. In the course of more than a third of the anesthetic treatments carried out in 2019 (97,361, 35.3%), additional patients required the use of respiratory support with invasive mechanical ventilation. The cost of the healthcare system for its implementation in 2019 amounted to 60.5% of the total cost of anesthesiology. At the same time, it should be noted that the volume of patients requiring anesthetic support with artificial lung ventilation is increasing annually. In 2015, it was only 35.3%, which is lower than the level of 2019 ( $t = 2.2$ ,  $p < 0.05$ ). It should also be noted that the workload of anesthesiologists requires more and more skills from them: only every third (34.9%) performed anesthetic support manipulations in 2019 are a part of planned medical intervention. 47.4% of the support manipulations were performed as part of emergency care, and another 17.7% were urgent. At the same time, the average duration of anesthetic support in St. Petersburg hospitals

was on average  $75 \pm 15$  minutes, and the proportion of patients requiring follow-up in the critical care and intensive care unit was at least 24.7%.

The positive dynamics of the volume of medical care provided by the anesthesiology and critical care service entails a steady increase in the burden on medical personnel (Table 3). A retrospective analysis showed that the number of critical care and critical care beds served by specialists in the period from 2015 to 2019 remained relatively stable and ranged from 1.32 beds per 1 position of relevant specialists to 1.30 ( $t < 2$ ). However, the number of anesthetic and critical care services provided by specialists has increased significantly. Thus, in 2015, 1 specialist conducted an average of 101.4 anesthetic support manipulations, and in 2019, this number rose to 109.1 ( $t = 3.7$ ,  $p < 0.05$ ). The critical care load ratio also increased and amounted to 61.43 manipulations per doctor in 2015 and 63.06 in 2019 ( $t = 4.5$ ,  $p < 0.05$ ).

Table 3 - Dynamics of the workload of anesthesiologists and critical care physicians in medical organizations of St. Petersburg in the period from 2015 to 2019.

Period	Number of doctors' positions held	The ratio of hospital bed capacity load		Coefficient of anesthetic load		The ratio of critical care unit load	
		Number of average annual critical care and intensive care beds	Number of beds per doctor	Number of anesthetic support manipulations	Per doctor	Number of critical care manipulations	Per doctor
2015	2,375.0	1,794	1.32	240,764	101.4	145,902	61.43
2016	2,438.5	1,935	1.26	258,545	106.0	149,659	61.37
2017	2,456.25	2,027	1.21	259,653	105.7	149,694	60.94
2018	2,441.0	1,924	1.27	274,526	112.5	154,802	63.42
2019	2,531.5	1,939	1.31	276,212	109.1	159,639	63.06

#### 4. Discussion

The analysis of the activities of the hospitals in St. Petersburg indicates a systematic increase in the volume of work of the service of anesthesiology and critical care in recent years. The increase

in the load is due to the annually increasing volumes of medical care provided in the city healthcare system since the share of anesthetic and critical care benefits in the overall structure of types of medical care remains relatively stable. Along with this, a significant increase in the costs of the healthcare system for the provision of medical care in the profile of anesthesiology and critical care was established, outstripping the growing growth in the volume of medical care provided to patients. However, it should be noted that a significant increase in the cost of medical care provided is due to an increase in the costs of medical institutions to provide care to patients in general, since in recent years more and more expensive medicines and consumables have been used, and the depreciation of equipment is subject to revaluation in a fairly short time. In general, the increase in the cost of providing medical care in the profile of anesthesiology and critical care is proportional to the increase in the cost of the healthcare system for the provision of medical care: a significant increase in the cost of financial costs for the provision of services in the anesthesiology and critical care field in St. Petersburg correlates with the growth of overall cost of providing medical care to patients ( $\rho = +0.77$ ,  $p < 0.01$ ).

The structure of the critical care manipulations carried out in the healthcare system showed that the corresponding service worked very effectively (Table 1) since the most significant shares of manipulations fell under critical care of the 1st and 2nd categories of complexity carried out in a limited amount of time the successful outcome of which contributed to the speedy transfer of patients under the supervision of intensive therapists and attending physicians. However, these kinds of critical care manipulations are the main expenditure components of the healthcare sector, since they absorb the largest share of the financial costs of providing medical care in this field.

The growth in the volume of anesthetic support testifies to the active development of surgical activity in hospitals of St. Petersburg, including operations carried out in the context of providing emergency medical care. Along with this, the largest share among all anesthetic measures belongs to intravenous anesthesia, which is typical for minor surgical interventions performed, including in a day hospital. It is interesting to note that the volume of time input of an anesthesiologist, expressed in the financial costs of the healthcare system to pay for the manipulations performed by them, indicates that intravenous anesthesia, which occupies the largest volume of anesthesia support manipulations provided to patients, does not require serious financial costs of the healthcare system. Payment for this type of anesthetic support in the structure of financial costs for anesthetic support amounts only to 21.4%. The largest share in the cost structure among all anesthetic support manipulations falls on

combined general anesthesia (53.1%). For other types of anesthetic support, the size of financial costs generally corresponds to their volumes ( $\rho = + 0.64$ ;  $p < 0.01$ ).

The analysis showed that the increase in the volume of manipulations performed by anesthesiologists and critical care physicians has not been accompanied in recent years by an influx of specialists to work in the field or by staffing of hospitals with medical personnel in sufficient volume, which is confirmed by parameters of the number of critical care and critical care beds served per 1 specialist of the relevant profile in a hospital, as well as by a significantly increased volume of anesthetic support and critical care workload on specialists. At the same time, the growing general "volumetric" workload of anesthesiologists and critical care physicians is accompanied by factors that significantly complicate the conditions of their work (the prevalence of interventions carried out in the context of emergency and urgent medical care).

## 5. Conclusion

Thus, in the course of the study, it was found that in recent years, the load on doctors of anesthesiologists and critical care physicians has steadily increased in conditions of limited staffing with doctors of this qualification.

The increase in the workload is due to the systematically increasing number of patients who need the help of anesthesiologists and critical care physicians, including patients admitted to hospitals for emergency indications who need surgical interventions.

Besides, there is an increasing demand from the healthcare system for anesthetic support and critical care services.

These circumstances should be taken into account when assessing the implementation of measures to improve the organization of work of anesthesiologists and critical care physicians.

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