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CHARACTERISTICS AND RESULTS OF THE SPECIALIZED ANESTHESIOLOGY AND INTENSIVE CARE FOR PATIENTS WITH COVID-19 IN THE REPUBLIC OF SAKHA (YAKUTIA)

DOI 10.25789/YMJ.2022.79.12

УДК 615:616.9 (571.56)

Aim: To analyze the work in the specialized anesthesiology and intensive care unit in the Republic of Sakha (Yakutia) for patients with COVID-19 in the context of the pandemic.

Materials and methods: A retrospective observational study was conducted based on work perfomed by anesthesiology and intensive care unit (AICU) in the State Budgetary Institution of the Republic of Sakha (Yakutia) "Yakut Republican Clinical Hospital" (YRCH) for the period since March, 2020, to December, 2021.

Results and discussion: YRCH have repurposed the hospital beds and enhanced the material and technical equipment supply of the AICU. Given the epidemiological situation, the bed capacity and the staff schedule of the unit were in the scope of regulation. The medical staff level was 76.5 % in 2020 and 80 % in 2021. The level of nursing and medical attendant staff for the entire period was 100 %.

During the study period 1,796 patients were admitted (488 patients in 2020, 1,308 patients in 2021). The bed turnover was 24.4 and 28.2 patients per bed, the average rate of bed occupancy was 136 and 244.6 days, the average length of stay of patients was 5.5 and 6.0 days in 2020 and 2021, respectively. In total, 1,015 patients have died (mortality rate – 56.5 %), with 281 patients to have died in 2020 (mortality rate — 58.0 %) and 734 in 2021 (mortality rate — 56.2 %). The mortality rate of patients significantly increases with age and amounted to 71.2 % in patients older than 81 years.

The main cause for admission in AICU was acute respiratory failure (ARF), the treatment has used is stepwise respiratory therapy. Standard oxygen therapy (15-20 l/min) was effective in 64 (3.6 %) patients, high-flow oxygen therapy (HFOT) was used in 1,732 (96.4 %) patients, non-invasive mechanical ventilation (NIV) was used in 717 (39.9 %), invasive mechanical ventilation was used in 1,015 (56.5 %) patients.

Conclusion: The complex of measures for the deployment of specialized anesthesiology and intensive care for adults with COVID-19 in the YRCH has allowed to succeed with an overflow of patients suffering a severe course of the disease. The characteristics of the unit indicated the difficulties in managing patients with COVID-19 complicated by viral pneumonia with severe ARF.

Keywords: COVID-19, specialized anesthesiology and intensive care, Republic of Sakha (Yakutia).

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Introduction. The rapid spread of the novel coronavirus infection (NCVI) COVID-19, the severe course of the disease and the high mortality rate of patients led to the mobilization of all levels o health care.

In the Republic of Sakha (Yakutia) a plan for organizing medical care for patients with COVID-19 was developed and a three-level medical care system was deployed [4]. The main role for the organization and provision of specialized care for patients with COVID-19 was assigned to the State Budgetary Institution of the Republic of Sakha (Yakutia) "Yakut Republican Clinical Hospital" (YRCH) which included an infectious disease department.

The high level of extremely severe and complicated forms of the disease, the rapid progression of acute respiratory failure (ARF) demanding the use of active respiratory therapy required the anesthesiology and intensive care services of medical organizations to carry out a complex of organizational and therapeutic-tactical measures.

Purpose of the study: Analyze of the work of the specialized anesthesiology and intensive care unit in the Republic of Sakha (Yakutia) for patients with COVID-19 in the context of the pandemic.

Materials and Methods: A retrospective observational study was conducted based on work performed by anesthe-

siology and intensive care unit (AICU) in the State Budgetary Institution of the Republic of Sakha (Yakutia) "Yakut Republican Clinical Hospital" (YRCH) for the period since March, 2020 to December, 2021. The following medical documents were studied — annual reports of AICU, register of admitted, discharged, transferred patients and inpatient medical records. Analysis of the main indicators of the AICU activities (staffing level, bed occupancy, bed turnover and mortality rate) and methods of respiratory therapy used in the treatment of patients was conducted.

Study Results and Discussion: The timely and adequate treatment for patients with severe and extremely severe forms of COVID-19 has required a set of measures in the following areas:

1. Deployment of additional beds for intensive care and formation of a temporary staff schedule. Based on the orders of the Ministry of Health of the Russian Federation [4,5] and the Ministry of Health of the Republic of Sakha (Yakutia) [6] in the YRCH, the hospital beds were repurposed and the relevant material and technical equipment supply of the AICU was enhanced (increase of the number of beds and addition of the staff schedule). The unit was additionally equipped during March-April 2020 with equipment, principally with ventilators and bedside monitors at the rate of 1 device per bed, as well as an uninterrupted provision of medical oxygen was arranged.

2. Training of employees on diagnosis, clinical course, treatment and infection safety of COVID-19 which was carried out continuously taking into account the updated clinical recommendations. At the time of preparation of this article the Ministry of Health of the Russian Federation submitted the 15th version of the Temporary Recommendations [9] and the 6th version of the Methodological Recommendations of the Federation of Anesthesiologists and Reanimatologists (FAR) [1].

3. Providing of operational assistance on the treatment of patients with COVID-19 in form of telemedicine consultations by the Federal Remote Consulting Centers of Anesthesiology and Intensive Care (FRCC) which were created by the order of the Ministry of Health of the Russian Federation [7]. So, 126 consultations in 2020 and 317 consultations in 2021 were held in the FDCC for adults on the basis of the Federal State Autonomous Educational Institution of Higher Education First Moscow State Medical University named after Sechenov I.M. of the Ministry of Health of the Russian Federation; in regard to the admission of pregnant women in 2021, 89 consultations were held in the FRCC for pregnant women on the basis of the federal state budget institution "National Medical Research Center of Obstetrics, Gynecology and Perinatology named after V.I. Kulakov" of the Ministry of Health of the Russian Federation. According to the results of consultations, the treatment was assessed as adequate, in cases of pregnant women consultations, a correction of pregnancy management and the timing of delivery was carried out.

The key work indicators of AICU are presented in Table 1.

The medical staffing level was 76.5 % in 2020 and 80 % in 2021, i.e., the shortage of medical staff was 23.5 and 20 %, respectively. The level of nursing and medical attendant staff in the unit for the entire period was 100 %. To the note, bed capacity and the staff schedule of AICU were regulated, given the epidemiological situation and depending on the number of patients in need of intensive care. Thus, during the period of the peak of morbidity the number of beds in AICU was increased to 36 and the staff of doctors was increased to 32 rates, along with a decrease in the number of admissions the number of beds was reduced to 30 and the medical rates were reduced to 24. Anesthesiologists-intensive care specialists of other medical organizations which were sent or employed during the vacation on their main job were involved for work on temporary rates. The contribution was also made by medical institute residents specializing in the anesthesiology and intensive care, which, according to the order of the Ministry of Health of the Russian Federation [8], were registered as interns after completion of a 36-hour training course on COVID-19.

In total, the period under study saw 1,796 patients admitted (488 patients in 2020 and 1308 patients in 2021). There were no re-admissions to AICU in 2020, but 23 (1.8 %) patients were re-hospitalized in 2021. When analyzing the quality of medical care provided there were no cases of underestimation of the severe patients' condition at the time of their transfer to the pulmonology department. Rehospitalization of patients in AICU occurred due to the increase of ARF on the 2nd-5th day and the ineffective standard oxygen therapy.

An increase in the incidence rate of COVID-19 among pregnant women was characteristic of 2021. Thus, 17 pregnant women and new mothers were transferred to AICU from the Perinatal Center of this hospital during May-December 2021. There were five (29.4 %) women died among those who were admitted to AICU postoperative caesarean section for invariable indications due to severe viral pneumonia and increased fetal hypoxia.

Analysis of the main indicators of the use of bed capacity reflecting the intensity of invariable indications activities showed the following. In 2020-2021 the number of patients increased from 488 to 1,308, the bed turnover was 24.4 and 28.2 patients per bed, the average period of bed occupancy was 136 and 244.6 days, and the average length of stay of patients was 5.5 and 6.0 days. Interestingly, the average bed occupancy and bed turnover are significantly different from the standards. According to Nedashkovsky, E.V., the average bed occupancy in the general profile units of intensive

Table 1

The key work indicators of AICU (2020-2021 years)

Index	Year	
	2020	2021
Medical staff level (%) Doctors Nurses Medical attendant staff	 76.5 100 100	 80 100 100
Trainee doctor (resident) (No.)	5	5
ICU admission (No.)	488	1308
Readmission (No. and %)	-	23
Total days after admission	2701	7826
Bed turnover	24.4	28.2
Average rate of bed occupancy	136	244.6
Average length of stay	5.5	6.0
Death (%)	58.0	56.2

care is within 280-320 days, the average length of stay of patients is 3.5-5.5 days [3]. Sure, these indicators of the bed capacity may vary depending on the department profile and, in fact, are formed by the clinical circumstances and the medical capabilities of the medical organization's department. Please, note that the calculation of 2020 indicators included only 10 months of the year (from March to December), the number of beds in the department changed from 30 to 36, which affected the estimated average bed occupancy and the average length of stay of patients in the department. In addition, respiratory support for up to 14 days or more is recommended for COVID-19 treatment even with positive lung function dynamics, since a recurrent deterioration in the course of interstitial pneumonia is often observed [1], which implies an extension of the period of stay of the patient in AICU.

A detailed study of the duration of patients' stay in the department shows that 70.3 % of patients stayed for 4-20 days — 38.2 % of patients stayed for 4-10 days, 32.1 % stayed for 11-20 days (Fig. 1).

In total, 1,015 patients died (mortality rate – 56.5 %) of which 281 patients died in 2020 (mortality rate — 58.0 %) and 734 in 2021 (mortality rate — 56.2 %).

The monthly dynamics in admission of patients and deceased for the period under study is shown in Fig. 2.

The presented chart shows an increase in admissions of patients in AICU in October 2020, in May and October 2021. The same months accounted for the largest number of deaths.

The mortality rate of patients increases with age and amounted to 71.2 % in the age group of 61-80 and 71,2 % (Fig. 3) in patients older than 81.

Treatment of patients in AICU was carried out in accordance with the recommendations of the Ministry of Health of the Russian Federation and the recommendations of the Federation of Anesthesiologists and Reanimatologists and included etiotropic, pathogenetic and symptomatic treatment [1,8]. The prevailing syndrome and the main indication for admission of patients in AICU was ARF, the treatment whereof has used a stepwise approach among the methods of respiratory therapy (Table 2).

Standard oxygen therapy (15-20 L/min) was effective only in 64 (3.6 %) patients. High-flow oxygen therapy (HFOT) was used in 1,732 (96.4 %) patients. Subsequently, 717 (39.9 %) patients underwent the non-invasive ventilation along with an increase in ARF. Increase in hypoxemia despite HFOT, non-invasive ventilation with prone position in 1,015 (56.5 %) patients served as an indication for tracheal intubation and switching to invasive ventilation in protective modes.

To increase the efficiency of ventilation and adequate sanitation of the tracheobronchial tree, 113 (11.1 %), patients with invasive ventilation on day 2-3 underwent tracheostomy. The proportion of respiratory therapies in 2020 and 2021 did not differ significantly.

These results are consistent with foreign and domestic studies. Thus, in the international study "UNITE-COVID", which included 240 centers from 46 countries and 5 continents, it was indicated the beginning of the COVID-19 pandemic led to an emergency increase in the bed stock of intensive care units of medical organizations by an average of 155% [12]. The FRCC of Anesthesiology and Intensive Care for

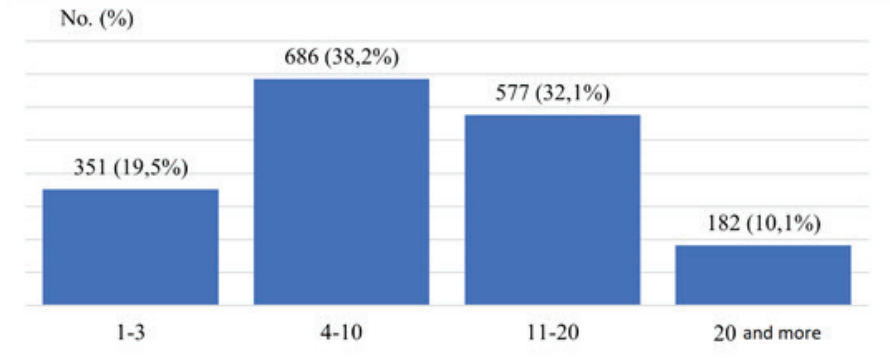

Fig. 1. Days after admission in ICU

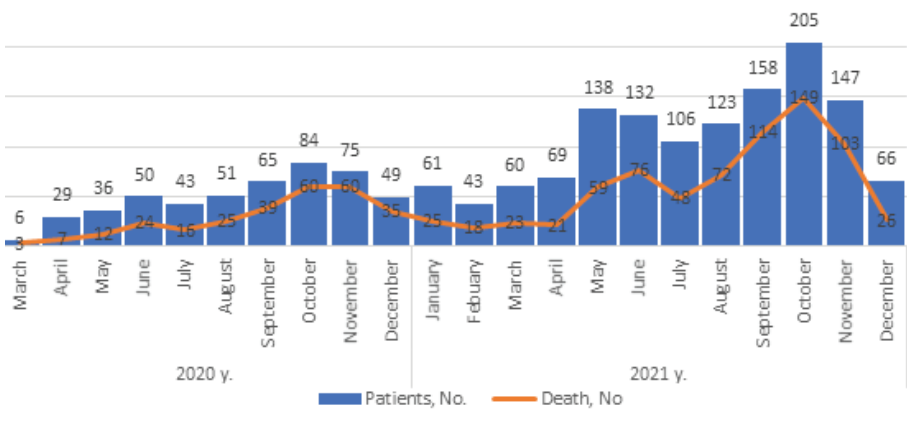

Fig. 2. ICU admission in 2020-2021 years

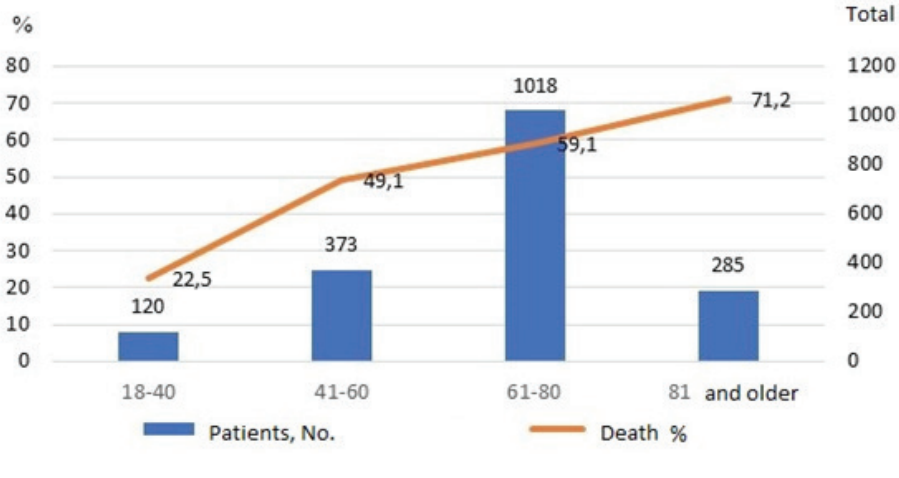

Fig. 3. Inhospital mortality in age groups

Table 2

Respiratory support

Method of respiratory support	Patients. No. (%)		Total
	2020 г.	2021 г.	No. (%)
Standard oxygen supplementation	19 (3.9)	45 (3.4)	64 (3.6)
High-flow oxygen therapy	469 (96.1)	1263 (96.5)	1732 (96.4)
Non-invasive mechanical ventilation	188 (38.5)	529 (40.5)	717 (39.9)
Invasive mechanical ventilation	281 (57.6)	734 (56.1)	1015 (56.5)
Total	488 (100)	1308 (100)	1796 (100)

Adult patients with COVID-19 analyzed treatment of 1,522 patients with severe COVID-19 in the ICU of hospitals in Moscow, the Moscow region and 70 regions of the Russian Federation and indicated that 80% of patients needed a mechanical ventilation [2]. Two large studies – COVID-ICU and UNITE-COVID, covering more than 8000 ICU patients, identified that the need for mechanical ventilation increased to 80-85,8% [11, 12].

High mortality in COVID-19, its association with age and comorbidity is confirmed in all studies. One of the first studies with COVID-19, presented by Chaomin Wu et al., was demonstrated a high mortality rate in patients with severe pneumonia, which was 52.4% [13]. According to the FDCC of Anesthesiology and Intensive Care for Adult the mortality rate of patients with severe COVID-19 was 65.4% and its main cause was acute respiratory distress syndrome - 93.2%. The mortality rate of patients undergoing oxygen therapy was 10.1%, noninvasive mechanical ventilation – 36.8%, invasive mechanical ventilation – 76.5%, with signs of septic shock – 86.6% [2].

Conclusion. Therefore, the complex of well-timed measures for the deployment of specialized anesthesiology and intensive care for adult patients with NCVI COVID-19 in the YRCH has made it possible to cope with a large flow of patients with a severe course of the disease. It took a short time to repurpose the hospital beds, enhance the material and technical equipment supply of AICU, implement a system of continuous training of doctors in diagnostics, clinical course, treatment and infectious safety, as well as consultations with the Federal Centers for Anesthesiology and Intensive Care. The indicators of the department demonstrate evidence of difficulties in managing patients with COVID-19 complicated by bilateral multisegmented viral pneumonia with severe ARF.

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HYGIENE, SANITATION, EPIDEMIOLOGY AND MEDICAL ECOLOGY

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STUDY OF 1-HYDROXYPYRENE PAH EXPOSURE IN URINE OF WORKERS OF THE ALUMINUM SMELTER IN EASTERN SIBERIA

DOI 10.25789/YMJ.2022.79.13

УДК 612.461:[547.6:66-05]

Aim: to study the content of the biomarker of PAH exposure – 1-hydroxypyrene (1-OHPyr) in the urine of workers in modern aluminum production in Eastern Siberia.

Materials and methods. 159 workers of electrolysis workshops with the technology of self-baked and pre-baked anodes were examined. The I group included 142 workers of the main professions engaged in the servicing of electrolyzers, anodes and cranes, the group II included 17 workers of auxiliary professions for pouring metal. The control group consisted of 14 people. Determination of 1-OHPyr was carried out by chromato-mass-spectrometry on an Agilent 7890A gas chromatograph. The data was processed in the Statictica 6.1 program.

Results. Significant differences were established between the median levels of 1-OHPyr in urine among workers of the main (2.2–75.2 μg/l) and auxiliary (0.48–7.6 μg/l) occupations in comparison with the values of the control group (0.17 μg/l) and Biological Exposure Index (2.5 μg/l, AGGIH 2020). The concentrations of 1-OHPyr in anodes workers were 6.4-20.9 times higher than those of electrolyzers workers and crane operators, and 9.9-156.7 times higher than the levels of auxiliary professions. The lowest concentrations of 1-OHPyr were found in urine samples of workers - operators of workshops with the technology of pre-baked anodes.

Conclusion. The research results confirmed the increased professional impact of PAHs on aluminum production workers. The highest levels of 1-OHPyr in urine, characterizing the internal loads of PAHs and the associated high risk of health disorders, were found in operators servicing anodes of workshops with the technology of self-baked anodes.

Keywords: polycyclic aromatic hydrocarbons, 1-hydroxypyrene, aluminum production, workers.

Introduction. Polycyclic aromatic hydrocarbons (PAHs) belong to the group of persistent toxic substances, which can accumulate in the environment and in the body, have high toxicity, carcinogenic and mutagenic activity, and have a harmful effect on human health and his offspring [7, 9]. The increased content of PAHs and oncological diseases are noted in such carcinogenic industries as smelting of aluminium, cast iron and steel, coal gasification, getting coke, bitumen and asphalting of roads etc. The impact of PAHs on workers in these industries is usually due to a different chemical mixture of PAHs. They include known (group 1), probable (group 2a) and possible (group 2b) carcinogenic compounds: benz(a) pyrene, dibenz(ah)anthracene, benz(a) anthracene, chrysene, benz(h)flurentene etc. Entering the body, chemical compounds of PAHs are biotransformed mainly by the monooxygenase enzyme system of the liver, forming specific indicative hydroxylated metabolites [13].

Based on a large number of studies conducted, it has been shown that the level of PAHs metabolites in urine can be used as a biological indicator of the adverse effects of PAHs. 1-hydroxypyrene (1-OHPyr) is recognized as a particularly preferred parameter for assessing the effects of PAHs among a number of metabolites, since pyrene is the main component in PAHs mixtures, and its metabolite correlates well with the total PAHs content in the air and DNA damage in persons exposed to benz(a)pyrene [5, 10, 11, 16]. The available foreign publications provide separate information about the levels of excretion of 1-OHPyr in urine and the risk of health disorders in workers of aluminum smelters in a number of countries [8, 11, 14], however, in Russia, such studies, to date, have not been properly reflected in the literature.

In this regard, the aim of the work was to study the content of the biomarker of PAH exposure – 1-OHPyr in the urine of workers of modern aluminum production in Eastern Siberia.

Materials and methods. The present study involved 159 workers of electrolysis workshops using the traditional technology of producing aluminum with self-baked anodes (TTSBA) and modernized – with pre-baked anodes (MTPBA). All employees participating in the study were classified into professional activity groups: group I consisted of the main professions engaged in maintenance electrolyzers, anodes and lifting cranes (average age 37.4–37.5 years and average experience 6.7–9.0 years), group II included auxiliary professions working the metal pouring and ladle farming (average age 40.3 years, average experience 5.8 years). The control group consisted of 14

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