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Tracheotomy In Patients With Covid-19

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ABSTRACT

Relevance. The coronavirus rush, which has appeared since December 2019, has an impact on economic, medical, and social development in all countries of the world. There are still no standard diagnostic and therapeutic plans aimed at limiting this infection.

Purpose. To determine the therapeutic role of tracheostomy with patients with coronavirus infection.

Material. The prospective study of 100 patients with coronavirus infection was carried out on the basis of State Budgetary Healthcare Institution “Interdistrict Multidisciplinary Hospital” in Nartkala city. When patients were admitted to the clinic, they were randomized into 2 groups depending on the therapy: the first group (comparison, n=50) – patients received traditional therapy in intensive care; the second (main, n=50) group – patients underwent tracheostomy in addition to standard therapy. The average age was 56.2±4.8 years. The women’s average age was 55 years (55.0%), and the men’s – 45 years (45.0%).

Methods. Determination of the syndrome of endogenous intoxication, taxation of lipid peroxidation intensification. The local microcirculation was investigated by the apparatus LAKK-02. The activity of the coagulation-lytic blood system was found by thrombelastograph TEG® 5000.

Results. Early COVID-19 infection demonstrates signs of intoxication, oxidative depression, phospholipase activity, microcirculatory and hemostatic disorders. These changes were the cause of the development of life-threatening complications (neurological, pulmonary, cardiac, etc.). They were associated with the type

of treatment. Traditional treatment and the use of mask oxygen turned out to be ineffective, since the homeostasis system disorders remained throughout the investigation period. The inclusion of tracheostomy in traditional therapy makes it possible to quickly improve the course of pathology as it purposefully affects the pathogenetic links of the homeostasis system.

Conclusion. The use of tracheostomy in the scheme of standard treatment of coronavirus infection allows improving the effectiveness of general therapy of COVID-19 patients, especially with severe forms.

Keywords: *COVID-19, hemostasis, endotoxicosis, microcirculation, lipoperoxidation, tracheostomy*

1. INTRODUCTION

Since 2019 and beginning of the coronavirus pandemic, a lot of scientific papers studying different aspects (epidemiological, etiological, pathogenetic, diagnostic and therapeutic) of this disease have been published [1, 2].

COVID-19 is an acute respiratory pathology caused by RNA-containing coronavirus SARS-CoV-2. This infection can clinically declare itself both in mild and severe forms. It is noted that beta coronavirus SARS-CoV-2 can affect both respiratory and other systems causing the formation of serious complications, such as acute respiratory distress syndrome, respiratory dysfunction, multi-organ failure [3, 4].

The epidemiological data demonstrate that high incidence of COVID-19 with the risk of development of serious implications is registered in the clinic among the patients with accompanying pathologies, such as diabetes mellitus, hypertension, overweight, ischemic cardiac event, etc. [5, 6].

According to the official statistics, 5.23 million cases of COVID-19 have been registered in the Russian Federation till today, including 124 thousand lethal ones [7, 8].

Pathogenetic mechanisms of coronavirus disease have been insufficiently studied so far and are actively investigated [9, 10].

Foreign investigations revealed that when SARS-CoV-2 gets into the airway, it interacts with the receptors of angiotensin ferment of type II with the help of serine protease and S-protein.

Then the local inflammatory-immune process is activated causing the damage of alveolars, triggering of cytokine storm, endothelial change in vessels, tissue hypoxia. This, in turn, activates the system inflammatory reaction resulting in the development of multi-organ depression [11, 12].

The severe form of coronavirus pathology is accompanied by the formation of pneumonia and acute respiratory depression, which requires not only the intensive therapy but also tracheostomy to start the artificial lung ventilation (ALV). Intubation of trachea allows controlling the respiratory state of patients during their stay in the intensive care unit, on the one hand, and preventing the formation of postintubation consequences, on the other [13, 14].

Purpose

To determine the therapeutic role of tracheostomy with patients with coronavirus infection.

2. MATERIALS AND METHODS

According to the standard requirements for conducting a clinical investigation, the prospective work was carried out, in which 100 patients with coronavirus infection were examined.

The patients underwent the diagnostics and therapy in the resuscitation and intensive care unit of State Budgetary Healthcare Institution “Interdistrict Multidisciplinary Hospital” in Nartkala city.

The results obtained were processed and computed in the Department of General Surgery of Federal State Budgetary Educational Institution of Higher Education "Kabardino-Balkarian State University named afetr H. M. Berbekov".

The conditions for selecting the patients for the investigation were as follows: personal consent; the diagnosis "coronavirus infection" was confirmed; the pathology duration – less than one week; application of oxygen therapy with the mask in the comparison group and tracheostomy – in the second group; investigation methods – clinical, laboratory and instrumental, keeping the investigation record; the age – 22-65 years; sex – female and male; mild accompanying diseases.

The criteria for excluding from the investigation were as follows: personal refusal from the participation; another diagnosis; the age – over 65 years and under 22 years; violation of the investigation record, surgical treatment (tracheostoma) in the first group; severe accompanying diseases; oncological and mental pathologies; pregnancy; lactation; mask – in the second.

When being admitted to the clinic, the patients were randomized into two groups depending on the therapy:

The first group (comparison, n=50) – the patients received traditional therapy in intensive care;

The second group (main, n=50) – the patients underwent tracheostomy in addition to standard therapy.

The demographic data demonstrated that the average age was 56.2±4.8 years. The women's average age was 55 years (55.0%), and the men's – 45 years (45.0%). It is indicated in detail that the average age in the first group was 53.6±5.2 years, and in the second – 57.4±6.8 years. There were 22 men (44.0 %) in the comparison group, and 23 (46.0 %) – in the main. There were 28 women (56.0 %) and 27 women (54.0 %), respectively, in the investigation groups.

The standard therapy comprised antibiotics (ceftriaxone (2.0), anticoagulants (enixum, pentoxifylline), infusion (sterofundin, glucose, sodium chloride), hormones (dexamethasone), anti-inflammatory (ibuprofen, diclofenac), antisensitizers (loratadine), oxygen therapy (mask), symptomatic.

Tracheostomy was frequently diagnosed in the second group. The indications for tracheostomy were: ALV, constant saturation (low saturation), mental disorder, high percentage of lung affection, decrease in the breathing volume, extubation disorder. The tracheostomy technique was standard, with general anesthesia. The roll of 10-12 cm was put under the shoulders, the head was slightly thrown back. The skin cut was 2-5 cm, vertical, along the middle of the annular cartilage. The soft tissues were spread apart to trachea strictly along "white line" by blunt method controlling the trachea position. Then it was necessary to shift the thyroid gland isthmus upwards or downwards and to incise two cartilaginous (2-3 or 3-4) semi-rings. The trachea edges were stitched to the edges of the skin wound, fixed with canula.

The reference indexes were selected from relatively healthy persons (n=20), women – (n=10, 50,0 %), men – (n=10, 50,0 %), the age – from 20 up to 55 years.

It was the prospective type of investigation with unselected sampling and the second level of evidence.

When collecting the anamnesis, it was revealed that the patients had the following accompanying pathologies: digestive (ulcer disease, gastritis, diabetes mellitus, pancreatitis, etc.), cardiovascular (arterial hypertension, CHD, etc.), urogenital (urolithiasis, etc.), respiratory (tonsillitis, bronchitis, etc.). They composed 15.0, 32.1, 40.0, 12.0 %, respectively.

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Special attention was paid to the eye fundus investigation. The following changes were observed: hypertonic angiopathy (18.0 %), diabetic angiopathy (15.0 %), diabetic retinopathy (12.0 %), angiospasm (7.0 %), thrombotic retinopathy (8.0 %), hemorrhagic syndrome (30.0 %), macular edema (8.0 %).

The coronavirus infection was proved by the results of PCR-test and CT of chest organs.

3. RESEARCH METHODS

Apart from the routine, the endogenic intoxication syndrome (by the content of hydrophilic (mean weight molecules (MWM – λ=280 nm), relative units (r.u.)) and hydrophobic (albumin total concentration (ATC), and effective albumin effective concentration (AEC) in r.u., and toxicity index (TI), r.u. of toxins) was detected in the work. The taxation of intensification of lipid peroxidation (LPO) was carried out by the content of malonic dialdehyde (MDA, nMol/g of protein) and diene conjugates (DC, r.u./mg of lipids) in blood plasma. The local microcirculation was investigated by the apparatus LAKK-02 (Research and Production Enterprise "Lazma", Russia) and values of the parameters of microcirculation efficiency index (MEI, %) and microcirculation parameter (MP, pf.u.). The activity of the coagulation-lytic blood system was found by thrombelastograph TEG® 5000. The indexes – reactive time (RT, min.) and clot lysis process (CLP, %).

The investigation period – admission day (AD, first stage), fourth (second stage) and tenth (third stage) days of hospitalization.

The results were processed with the help of Microsoft Word and Excel 2013. The calculations were made using Fischer, Student and Hardy-Weinberg criteria, confidence interval (95 %, CI) and odds ratio (OR, 95 %).

4. RESULTS AND DISCUSSION

Many modern investigations reveal that a number of components participate in the coronavirus infection pathogenesis. The main link of pathogenetic processes of COVID-19 is the endogenic intoxication syndrome developed as the result of secretion of toxic metabolites into the blood current and their accumulation in excessive amounts in different organs, making the pathology progression more severe [15].

The data were similar to the abovementioned.

When the patients with coronavirus infection were admitted to the clinic, the formation of endogenic intoxication was observed. And it was also revealed that among the patients in the comparison group the concentration of MWM and TI exceeded the normal values by 47.8 and 199.1 % (p=0.01). At the same time, the concentration of ATC and AEC was decreased by 16.9 and 40.1 % (p=0.01) (Table 1).

TABLE 1: Dynamics of homeostasis system parameters

Index	Group	Norm	Observation Period, Days		
			Admission day (AD)	4th	10th
AEC, g/l	I	45.6 ±1.51	27.8 ±1.34*	23.1 ±1.24*	30.5 ±2.22*
	II		28.1 ±1.19*	25.9 ±1.21	38.4 ±2.051
TI, r.u.	I	0.15 ±0.02	0.45 ±0.02*	0.37 ±0.03*	0.31 ±0.02*
	II		0.44 ±0.01*	0.33 ±0.02*	0.25 ±0.031
ATC, g/l	I	51.2 ±1.18	42.5 ±1.12*	38.4 ±1.41*	40.7 ±2.21*
	II		43.2 ±1.18*	41.2 ±1.32*	47.1 ±2.451
MWM (λ=280 нм), r.u.	I	305.1 ±8.9	451.8 ±15.5*	415.2 ±7.9*	388.3 ±10.8*
	II		445.9 ±14.8*	394.1 ±8.3*	335.8 ±10.11

Note. * – proved difference to the norm at $p<0.05$, [1] – to the first group at $p<0.05$.

The toxemia progression was observed until the following day (4th). Here, the insignificant decrease in the mean weigh parameter and toxicity index was registered, however, in relation to the initial ones they increased by 35.9 and 146.2 % (p=0.01). The total and effective concentration of albumin continued decreasing and it was below the reference value by 24.8 and 49.3 % (p=0.01).

By the final day (8th) the hydrophilic toxins (MWM and IT) exceeded the normal values by 27.1 and 106.1 % (p=0.01). The values of ATC and AEC were also below the norm by 21.8 and 33.1 % (p=0.01) (Table 1).

The activation of lipoperoxidation and phospholipase A2 (PP A2) processes was observed in the group with the traditional therapy (with oxygen mask).

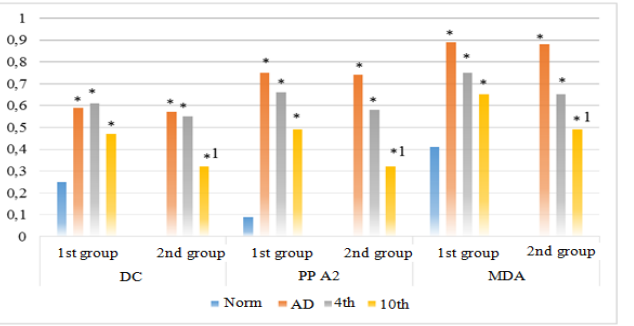

FIGURE 1. Dynamics of LPO and PP A2 parameters

At the first stage the increase in MDA, DC and PP A2 content by 102.5, 95.8 and 135.8 % (p=0.01) was demonstrated. At the second stage a slight decrease in the content of metabolites of peroxide (DC and MDA) oxidation of lipids (LPO) and phospholipase activity by 78.9, 95.3 and 101.4 % (p=0.01) was noted. At the third stage it was found out that the content of those indexes increased by 58.2, 74.5 and 85.3 % (p=0.01).

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Endogenic toxemia and activation of LPO and phospholipase reaction were accompanied by microcirculation disorder.

On the first day of staying in the clinic the value of MP and microcirculation efficiency index decreased by 29.6 and 44.9 % (p=0.01) in the first group (Fig. 2).

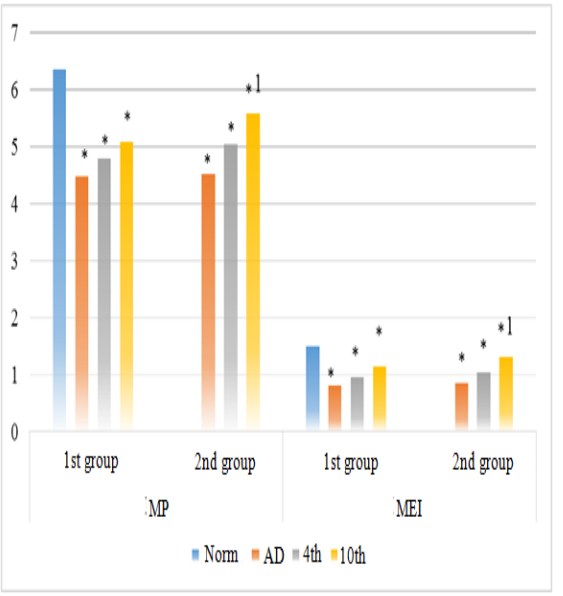

FIGURE 2. Dynamics of microcirculation parameters

On the 4th day the values of MP and MEI with patients in the comparison group relatively increased but were below the initial index by 24.7 and 36.2 % (p=0.01). By the final day (10-M) the values of microcirculation parameters increased but were below the normal value level by 20.1 and 24.5 % (p=0.01).

The examination of hemostasis state with the patients with coronavirus infection was important in the investigation. When the standardized therapy with mask oxygen was used, the decrease in the coagulation and fibrinolysis activity was observed (Fig. 3).

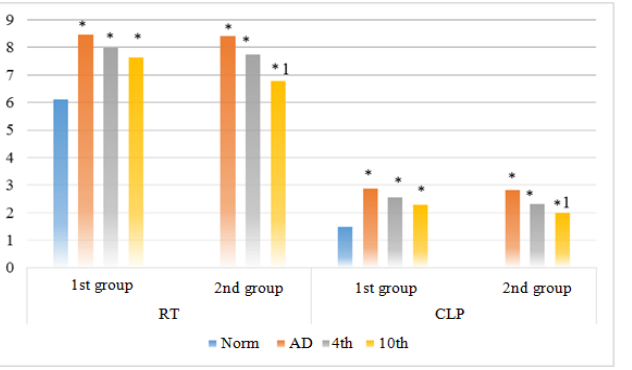

FIGURE 3. Dynamics of hemostasis system indexes

On the hospitalization day the coagulation and fibrinolysis activity time increased by 38.0 and 86.3 % (p=0.01) in the comparison group. On the 4th day the value of those indexes decreased, at the same time, they exceeded the reference parameter by 30.3 and 64.8 % (p=0.01). To the final day (9th) the coagulation and fibrinolysis state decreased. RT and CLP values exceeded the norm by 24.6 and 48.7 % (p=0.01).

Within the study period, the hemostasis system indexes during the observations in the second group demonstrated that tracheotomy at the early stage accompanied by the standard therapy significantly influenced coronavirus infection behavior.

When studying the intoxication syndrome with the patients in the main group, the increase in MWM and IT content on the first day by 45.7 and 193.1 % (p=0.01) and on the fourth day – by 29.1 and 120.6 % (p=0.01) was observed. At the same time, the decrease in hydrophobic metabolites (ATC and AEC) by 15.6 and 38.3, and 19.5 and 41.6 % (p=0.01) was revealed. To the final day (10th) the values of those indexes equaled the reference level (Table 1).

In the same group the indexes of (DA and MDA) lipoperoxidation and phospholipase activity were registered at the first observation stage at 99.8, 93.8 and 132.1 % (p=0.01).

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At the second stage the content of melondialdehyde, diene conjugates and phospholipase A2 significantly decreased but the data remained increased in comparison with the initial ones by 42.3, 67.4 and 83.3 % (p=0.01).

To the final stage the values of the abovementioned parameters evidently approached the normal index being, at the same time, elevated by 13.6, 18.4 and 23.4 % (p=0.01) (Fig. 1).

The microcirculatory state was disturbed with the patients in the main group on the admission day – MP and MEI values were decreased by 28.9 and 42.9 % (p=0.01). On the fourth day of the investigation the microcirculation index and microcirculation effective index significantly increased. However, their level was below the reference index by 20.4 and 30.8 % (p=0.01). On the tenth day the microcirculation parameters (MP and MEI) were close to the initial value (Fig. 2).

The examination of coagulation with the patients in the second group demonstrated the indications of reactive and fibrinolytic time increase on the first day by 37.4 and 86.2 % (p=0.01). On the fourth day the significantly improved congelation was observed, though RT and CLP value was longer than the norm by 26.4 and 50.6 % (p=0.01). On the tenth day the coagulation and fibrinolytic activity approached the reference level (Fig. 3).

When studying the clinical picture it was revealed that the saturation index with the patients of the second group was constantly high (95 – 98 %). In the first group (with mask oxygen) the value of this parameter varied within 80 – 93 %.

The formation of a number of complications was observed with the patients of the second group. Cerebral distress (disorder of speech and coordination of movements, panic, sleep, memory and sensitivity disorder, depression) was registered with 42 (84.0 %) patients of the first group and 20 (40.0 %) – of the second group. These indications were preserved during the observation.

Pulmonary fibrosis, pneumothorax, pneumonia, DIC syndrome, myocardial infarcts, insults, pancreatitis, colitis were registered with the patients throughout the investigation, the frequency of which was 35 (70.0 %) in the first group and 23 (46.0 %) – in the second.

The complications connected with tracheostomy in the form of bleeding were observed in 4 cases.

The lethal cases during the observation were 13 (26.0 %) among the patients of the comparison group and 8 (16.0 %) – of the second group.

5. DISCUSSION OF RESULTS

These investigations demonstrated that the early stage of coronavirus infection development is accompanied by endogenic intoxication, formation of oxidative stress, phospholipase activation, microcirculatory and hemostatic disorders.

These disorders were connected with the type of therapy applied. It should be pointed out that standard therapy, even with mask oxygen, demonstrated the evidence of the abovementioned changes in the utmost degree.

The application of tracheotomy had an essential effect on the state of the hemostasis system of the patients with coronavirus infection. The evident decrease in the indications of toxemia activity and lipoperoxidation activity, on the one hand, and regeneration of microcirculation and coagulation potential, on the other hand, was revealed starting from the fourth day already. To the tenth day the parameters of homeostatic activity approached the norm (p=0.01).

Special attention is paid to the comparative analysis results, which demonstrated that the degree of homeostatic disorders when using tracheostomy (main group) was evidently below the one in the comparison group on the tenth day (Table 1, Figs. 1, 2, 3). ATC and AEC were higher by 17.2 and 25.3 % (p=0.01), MWM and TI were lower by 13.6 and 19.2 % (p=0.01), DC, MDA and

PP A2 were lower by 12.5, 15.3 and 17.1 % (p=0.01), MP and IEM were higher by 10.5 and 14.3 % (p=0.01), RT and CLP were shorter by 11.2 and 15.6 % (p=0.01).

It was clinically pointed out that the number of complications (neurological, pulmonary, cardiac, etc.) formed during the observations of the patients with COVID-19 and mortalities were lower in the main group, when compared with the first one, by 34.2 and 38.4 (p=0.01), respectively.

The complications connected with tracheostomy procedure emerged in the form of bleedings with 4 (80 %) patients and were stopped.

6. CONCLUSIONS

The early period of COVID-19 infection is registered as the indications of intoxication, oxidative depression, phospholipase activation, microcirculatory and hemostatic disorders. These changes were the reason for the development of life-threatening complications (neurological, pulmonary, cardiac, etc.). They were associated with the therapy type. The traditional therapy and use of mask oxygen appeared to be ineffective, since the homeostasis system disorder was preserved throughout the whole investigation. The inclusion of tracheostomy into the traditional therapy allows speedily improving the pathology course as it intentionally influences pathogenetic links of the homeostasis system.

7. ACKNOWLEDGEMENTS

Authors' contributions

All authors contributed toward data analysis, drafting and revising the paper and agreed to be responsible for all the aspects of this work.

Declaration of Conflicts of Interests

Authors declare that they have no conflict of interest.

Data Availability Statement

The database generated and /or analysed during the current study are not publicly available due to privacy, but are available from the corresponding author on reasonable request.

Declarations

Author(s) declare that all works are original and this manuscript has not been published in any other journal.

REFERENCES

1. Gong Y., Ma T.C., Xu Y.Y., Yang R. Early Research On Covid-19: A Bibliometric Analysis. Innovation (Camb). 2020, 1(2),100027. Https://Doi.Org/10.1016/J.Xinn.2020.100027
2. Giannos P., Kechagias K.S., Katsikas Triantafyllidis K, Falagas Me, Spotlight On Early Covid-19 Research Productivity: A 1-Year Bibliometric Analysis, Front Public Health. 2022 31 10, 811885. Https://Doi.Org/10.3389/Fpubh.2022.811885
3. Pal M., Berhanu G., Desalegn C., Kandi V., Severe Acute Respiratory Syndrome Coronavirus-2 (Sars-Cov-2), An Update. Cureus. 2020 Mar 26, 12(3), E7423. Https://Doi.Org/10.7759/Cureus.7423
4. Chu G, Jiao W, Xie F, Zhang M, Niu H., Severe Acute Respiratory Syndrome Coronavirus 2 (Sars-Cov-2)-Associated Urogenital Disease, A Current Update. World J Mens Health. 2021, 39 (3), 444-453. Https://Doi.Org/10.5534/Wjmh.200168
5. Sahni S., Gupta G., Sarda R., Pandey S., Impact Of Metabolic And Cardiovascular Disease On Covid-19 Mortality: A Systematic Review And Meta-Analysis, Diabetes Metab Syndr. 2021, 15(6), 102308. Https://Doi.Org/10.1016/J.Dsx.2021.102308

6. Li X., Guan B., Su T., Liu W., Impact Of Cardiovascular Disease And Cardiac Injury On In-Hospital Mortality In Patients With Covid-19: A Systematic Review And Meta-Analysis, Heart. 2020, 106(15),1142-1147. Https://Doi.Org/10.1136/Heartjnl-2020-317062
7. Rodkin M.V., On Statistics Of Covid-19 Epidemic Spreading In Russia And Italy, Attempt To Forecast With The Methods Of Mathematical Geophysics, Ural Geological Journal. 2020, 2 (134), 3-11.
8. Loginova N.N., Semina I.A., Peretochenkova O.U., Demographic Development Of Russian Regions With The Emphasis On Republic Of Mordovia Against The Background Of The Statistic Of Covid-19 Pandemic, State Service. 2021, 23, 4 (132), 78-84. Https://Doi.Org/10.22394/2070-8378-2021-23-4-78-84
9. Bohn M.K., Hall A., Sepiashvili L., Jung B., Steele S., Adeli K., Pathophysiology Of Covid-19: Mechanisms Underlying Disease Severity And Progression, Physiology (Bethesda). 2020, 35(5), 288-301. Https://Doi.Org/10.1152/Physiol.00019.2020
10. Wiersinga W.J., Rhodes A., Cheng A.C., Peacock S.J., Prescott H.C., Pathophysiology, Transmission, Diagnosis, And Treatment Of Coronavirus Disease 2019 (Covid-19): A Review, Jama. 2020, 324(8), 782-793. Https://Doi.Org/10.1001/Jama.2020.12839
11. Kumar M., Al Khodor S., Pathophysiology And Treatment Strategies For Covid-19, J Transl Med. 2020, 18(1), 353. Https://Doi.Org/10.1186/S12967-020-02520-8
12. Singh S.P., Pritam M., Pandey B., Yadav T.P., Microstructure, Pathophysiology, And Potential Therapeutics Of Covid-19: A Comprehensive Review, J Med Virol. 2021, 93(1), 275-299. Https://Doi.Org/10.1002/Jmv.26254
13. Sasidharan S., Singh V., Singh J., Madan G.S., Dhillon H.S., Dash P.K., Shibu B., Dhillon G.K., Covid-19 Ards: A Multispecialty Assessment Of Challenges In Care, Review Of Research, And Recommendations, J Anaesthesiol Clin Pharmacol. 2021, 37(2), 179-195. Https://Doi.Org/10.4103/Joacp.Joacp_14_21
14. Robba C., Battaglini D., Ball L., Pelosi P., Rocco P.R.M., Ten Things You Need To Know About Intensive Care Unit Management Of Mechanically Ventilated Patients With Covid-19, Expert Rev Respir Med. 2021, 15(10), 1293-1302. Https://Doi.Org/10.1080/17476348.2021.1906226
15. Weiss S.R., Leibowitz J.L., Coronavirus Pathogenesis, Adv Virus Res. 2011, 81, 85-164. Https://Doi.Org/10.1016/B978-0-12-385885-6.00009-2