

CLINICAL LABORATORIES IN THE ERA OF THE COVID-19 PANDEMIC: AN ANALYSIS OF EXPERIENCES IN SERBIA

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SAŽETAK

Pandemija KOVID-19 oboljenja predstavlja jednu od najtežih javnozdravstvenih pretnji sa kojom se naš svet suočio u novijoj istoriji. U globalnoj borbi protiv ove pandemije, značajnu ulogu imaju kliničke laboratorije. Ovaj rad se zasniva na iskustvima Centra za medicinsku biohemiju Univerzitetskog kliničkog centra Srbije. Koristeći kombinovani metod istraživanja, ovaj rad rasvetljava brojne izazove sa kojima se suočio Centar tokom pandemije, daje prikaz sprovođenja promena, kao i preporuke za funkcionisanje tokom KOVID-19 pandemije, ali i u post-KOVID eri.

Ključne reči: pandemija, kliničke laboratorije, medicinska biohemija, KOVID-19, Srbija

ABSTRACT

The COVID-19 pandemic represents one of the most serious public health threats that our world has faced in recent history. Clinical laboratories play a significant role in the global fight against this pandemic. This paper is based on the experiences of the Center for Medical Biochemistry of the University Clinical Center of Serbia. Using mixed methods research, the study sheds light on the many challenges that the Center has been facing during the pandemic, it outlines the implementation of change, and makes recommendations for functioning during the COVID-19 pandemic and in the post-COVID era.

Keywords: pandemic, clinical laboratories, medical biochemistry, COVID-19, Serbia

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UVOD

Prošlo je skoro dve godine od kako je, u decembru 2019. godine, u gradu Vuhanu, u kineskoj provinciji Hubej, identifikovan sedmi humani korona virus - SARS-KoV-2, koji izaziva težak akutni respiratorni sindrom, i koji se dominantno prenosi kapljičnim putem i kontaktom. Svetska zdravstvena organizacija je proglasila KOVID-19 infekciju javnozdravstvenom pretnjom od međunarodnog značaja 30. januara 2020. godine, a pandemiju ove bolesti 11. marta 2020. godine [1]. Od početka epidemije, registrovano je 200 miliona potvrđenih slučajeva infekcije KOVID-19 i prijavljeno više od 4,2 miliona smrtnih slučajeva u 222 zemlje širom sveta [2].

Pandemija KOVID-19 oboljenja predstavlja jednu od najtežih javnozdravstvenih pretnji sa kojom se naš svet suočio u novijoj istoriji. U globalnoj borbi protiv ove pandemije, značajnu ulogu imaju kliničke laboratorije. Od početka pandemije, laboratorijski radnici nesebično i neumorno stoje na prvim linijama borbe protiv KOVID-19 infekcije, kako u laboratorijama u javnom, tako i u laboratorijama u privatnom sektoru [3].

Kliničke laboratorije su u fokusu isključivo zbog njihove veoma značajne uloge u molekularnom testiranju, za detekciju SARS-KoV-2 RNK, i serološkom monitoringu [4]. S druge strane, radu kliničko-biohemijskih laboratorija, kao i u prethodnim pandemijama, inicijalno nije dat veliki značaj, ni u profesionalnim krugovima ni u javnosti. Ipak, tokom ove dugotrajne krize, pokazalo se da su pravovremeno pružena usluga i kvalitet kliničko-biohemijske laboratorijske dijagnostike, u smislu inicijalnih dijagnostičkih pregleda pacijenata, kao i biohemijskog praćenja biomarkera inflamacije/multiorganske disfunkcije hospitalizovanih pacijenata sa težim oblikom KOVID-19 oboljenja i komplikacijama, od neprocenjivog značaja za javno zdravlje i bezbednost.

CILJ

Cilj ovog stručnog rada je da se opišu iskustva iz prakse rukovođenja kliničkim laboratorijama tokom pandemije, sa posebnim osvrtom na iskustva Centra za medicinsku biohemiju Univerzitetskog kliničkog centra Srbije (CMB-UKCS).

METOD

Metod korišćen u radu je kombinovana deskripcija urađenog pregleda regulative i aktivnosti na terenu. Na primeru jedinice posmatranja UKCS-a, opisani su izazovi, neophodne promene i sprovođenje promena i date preporuke za funkcionisanje tokom KOVID-19 pandemije, kao i u post-KOVID eri.

INTRODUCTION

It has been almost two years since, in December 2019, in the city of Wuhan, in the Chinese province of Hubei, the seventh human corona virus - SARS-CoV-2, which causes severe acute respiratory syndrome, and which is dominantly a droplet and contact infection, was identified. On January 30, 2020, the World Health Organization declared the COVID-19 infection a public health emergency of international concern, and on March 11, 2020, it declared the pandemic of COVID-19 [1]. Since the beginning of the epidemic, 200 million cases of COVID-19 infection have been registered, while more than 4.2 million deaths have been reported in 222 countries worldwide [2].

The COVID-19 pandemic represents one of the most serious public health threats that our world has faced in recent history. In the global fight against this pandemic, clinical laboratories have had an important role. Since the beginning of the pandemic, laboratory workers have been, selflessly and tirelessly, on the frontline of the fight against the COVID-19 infection, both in laboratories in the public, as well as in the private sector [3].

Clinical laboratories are in the focus of attention exclusively for their very significant role in molecular testing, SARS-CoV-2 RNA detection, and serological monitoring [4]. On the other hand, initially, the operation of clinical biochemistry laboratories, just like in previous pandemics, was not given great importance, either in professional circles or in the public eye. However, during this lasting crisis, it has transpired that timely provided service and the quality of clinical biochemistry laboratory diagnostics, in the sense of initial diagnostic patient examinations, as well as biochemical monitoring of inflammation biomarkers/multiorgan dysfunction of hospitalized patients suffering from the severe form of COVID-19 and with complications, is of invaluable importance for public health and safety.

AIM

The aim of this paper is to describe the practical experiences of clinical laboratory management during the pandemic, with a special overview of the experience of the Center for Medical Biochemistry of the University Clinical Center of Serbia (CMB-UCCS).

METHODS

The method applied in this paper is a combined description of an overview of rules and regulations and the activities carried out in the field. Using the example of the observed unit of UCCS, the challenges, necessary changes, and the implementation of the changes have been described, and recommendations on functioning

IZAZOVI U RADU KLINIČKIH LABORATORIJA

U veoma turbulentnom vremenu KOVID-19 pandemije, kliničke laboratorije širom sveta su se suočile sa brojnim izazovima, koji su se prvenstveno odnosili na adekvatnu organizaciju rutinskog rada. Tokom pandemije dugogodišnje slabosti laboratorija nisu išle u prilog dobre pripravnosti i brzog reagovanja. Kada je u pitanju KOVID-19, rutinski rad kliničkih laboratorija jeste višekomponentni proces koji se sastoji od identifikacije virusa u uzorcima pacijenata, laboratorijske podrške lečenju pacijenata, ali i praćenju i prognozi kliničkog toka, kao i od učešća u istraživanjima toka bolesti i terapijskih pristupa.

Dugogodišnje slabosti laboratorija, koje su u pandemiji još više došle do izražaja, bile su: nedostatak kadra, limitirani budžeti za investicije, kao i pojačan pritisak da se poveća zadovoljstvo korisnika usluga. Dodatni izazovi, kao što su: rad sa opremom malog kapaciteta, često i zastarelom; otežan dolazak serviseru za održavanje opreme, ali i samih zaposlenih na posao, usled kontekstualnih promena, kao što je bilo „zaključavanje“; suočavanje sa mogućnošću dugotrajne ugroženosti lanca snabdevanja reagensima i potrošnim materijalom; stavljali su na probu kompetencije i pripravnost laboratorijskih struktura za upravljanje u javnozdravstvenim kriznim situacijama.

Obim i vrsta laboratorijske dijagnostike prilagođavani su potrebama korisnika usluga ustanova, često drastično smanjeni i ograničeni samo na pacijente sa akutnim i hitnim stanjima, dok je u nekim laboratorijama ograničeno analiziranje testova koji zahtevaju manuelnu manipulaciju [5]. Vrlo važan aspekt pandemije KOVID-19 infekcije je opasnost po zdravstvene radnike [6,7], uključujući tu i laboratorijsko osoblje, pa je samim tim veoma značajna i primena odgovarajućih mera zaštite, u situaciji kada infekcija i karantin smanjuju broj aktivnih zdravstvenih radnika i nameću dodatno opterećenje, već i onako preopterećenim zdravstvenim sistemima. Prostor u nekim laboratorijama je često bio nedovoljan da se održi propisana fizička distanca i zahtevao je prvenstveno fizičko restrukturiranje.

U Srbiji, u novonastaloj situaciji, kada su brzina i načini širenja bolesti, simptomi, težina i ishod bolesti bili nepoznanica, i kada se do novih saznanja dolazilo na dnevnom nivou, kliničke laboratorije su bile suočene sa velikim izazovima i sprovođenjem neophodnih promena.

Centar za medicinsku biohemiju Univerzitetskog kliničkog centra Srbije - referentne ustanove tercijarnog nivoa zdravstvene zaštite u Republici Srbiji (RS), dočekao je pandemiju KOVID-19 infekcije, organizovan na 14 lokacija, sa 225 zaposlenih, od čega 34 zdravstvena radnika sa visokom stručnom spremom i 163

during the COVID-19 pandemic, and in the post-COVID era, have been given.

CHALLENGES IN THE OPERATION OF CLINICAL LABORATORIES

At a very turbulent time of the COVID-19 pandemic, clinical laboratories all over the world have faced numerous challenges, primarily related to the appropriate organization of routine work. During the pandemic, previous long-lasting weaknesses of the laboratories have become an impediment to readiness and quick response. As regards to COVID-19, the routine work of clinical laboratories is a multicomponent process comprising the identification of the virus in patient samples, laboratory support in patient treatment, but also clinical follow-up and prognosis, as well as involvement in research of the course of the illness and therapeutic approaches.

Understaffing, limited investment budgets, as well as increased pressure to improve the satisfaction of service users with the service, have proven to be preexisting weaknesses of laboratories, which have become even more evident during the pandemic. Additional challenges, such as: working with equipment which has low capacity and is often outdated; difficulties for the medical equipment service engineer, as well as for the employees to come to the laboratory, due to contextual changes, such as 'lockdown'; facing the possibility of prolonged jeopardy to the reagents and consumables supply chain; have all put the competencies and readiness of laboratory management and staff to operate in public health crisis situations, to the test.

The scope and type of laboratory diagnostics have been adjusted to the needs of service users in the institutions, often drastically decreased and limited only to patients with acute or emergency conditions, while in some laboratories, analyses of tests requiring manual manipulation, have been limited [5]. A very important aspect of the COVID-19 pandemic is the danger to health workers [6,7], including laboratory employees, which is why the implementation of appropriate safety and protection measures is very important, in a situation where the infection and quarantine are decreasing the number of active healthcare workers and placing an additional burden on already overstrained healthcare systems. The space in some of the laboratories was often insufficient to maintain the prescribed physical distance which is why it required primarily physical restructuring.

In Serbia, in the newly arisen situation, when the speed and manner of disease spread, the symptoms, the severity and outcome of the disease, were unknown, and when new knowledge emerged every day, clinical laboratories were faced with great challenges and the implementation of necessary changes.

radnika sa srednjom/višom stručnom spremom. Osnovna delatnost ovog snažnog Centra jeste pružanje usluga savremene laboratorijske dijagnostike iz oblasti biohemije, imunohemije, laboratorijske hematologije, koagulacije i imunologije, te hitne laboratorijske dijagnostike. Svoje usluge Centar pruža klinikama i centrima UKCS-a, ambulantnim pacijentima, kao i ostalim zdravstvenim ustanovama u Beogradu i Republici Srbiji. CMB-UKCS je, kao prva laboratorija u zemlji, uveo sistem upravljanja kvalitetom prema zahtevima standarda ISO 9001, ISO/IEC 17025 i ISO 15189, a takođe je akreditovan i kod Agencije za akreditaciju zdravstvenih ustanova Srbije.

Sa organizacione tačke gledišta, očekivanje ustanova tercijarnog nivoa zdravstvene zaštite jeste da laboratorija u vreme pandemije nastavi sa radom 24 sata dnevno, a očekivanje pacijenata je, da bez obzira na vanrednu situaciju, neometano dobijaju rezultate laboratorijskih analiza. Pojačani pritisak da laboratorijske analize budu blagovremeno dostupne za veliki broj uzoraka istovremeno, da se analiza uradi brzo i kvalitetno kako bi se što pre otpočelo sa potrebnom terapijom kod pacijenata sa KOVID-19 oboljenjem, ali i održao kontinuitet pružanja usluga i hitnim ne-KOVID-19 pacijentima i pacijentima sa hroničnim ne-zaraznim bolestima, predstavlja dodatno opterećenje za laboratorijske radnike.

Jedan od najvažnijih izazova ove pandemije jeste i zaštita laboratorijskog osoblja od biološki opasnih materija (engl. *biohazard*). Iako, kao akreditovana laboratorija, CMB-UKCS ima definisanu Strategiju upravljanja rizicima, koja definiše rizike, mogućnosti njihovog nastajanja, posledice koje mogu nastati, kao i aktivnosti koje CMB, kao deo UKCS-a, preduzima sa ciljem smanjenja, odnosno eliminacije rizika od pojave štetnih događaja, KOVID-19 je pred CMB postavio brojne izazove u tom smislu. Oni su se prvenstveno odnosili na transport i postupanje sa biološkim materijalom, dekontaminaciju opreme i radnih površina, održavanje lične higijene, kao i na korišćenje lične zaštitne opreme. Dodatni izazov su predstavljala odsustva zaposlenih usled zaražavanja ili samoizolacije/karantina. To se posebno odnosilo na osoblje za održavanje higijene, koje je u čestoj komunikaciji sa više oblasti laboratorije/laboratorija.

PROMENE U RADU KLINIČKIH LABORATORIJA I NJIHOVO SPROVOĐENJE

Evidentno je da je pandemija uticala na rutinski rad CMB-a. Organizaciono, u eri KOVID-19 oboljenja, CMB je laboratorijsku delatnost ostvarivao na još jednoj dodatnoj lokaciji, u novootvorenoj KOVID bolnici UKCS-a u Batajnici. Rukovodstvo Centra imalo je veoma odgovoran

At the time of the beginning of the COVID-19 pandemic, the Center for Medical Biochemistry of the University Clinical Center of Serbia, a referral center of tertiary healthcare level in the Republic of Serbia (RS), was organized in 14 locations, with 225 employees, of whom 34 medical biochemists and 163 medical laboratory technicians. The main activity of this powerful Center is providing modern laboratory diagnostic services in the area of biochemistry, immunochemistry, laboratory hematology, coagulation, and immunology, as well as emergency laboratory diagnostics. The Center offers its services to clinics and centers of the UCCS, to ambulatory patients, as well as to other healthcare institutions in Belgrade and the Republic of Serbia. The CMB-UCCS was the first laboratory in the country to introduce a quality management system in keeping with the standards ISO 9001, ISO/IEC 17025, and ISO 15189, and it has also been accredited by the Agency for Accreditation of Health Care Institutions of Serbia.

Organizationally speaking, the expectation of the tertiary level healthcare institutions has been that the laboratory should continue its operation 24/7 during the pandemic, while the expectation of the patients has been that, regardless of the extraordinary circumstances, they should continue to receive their laboratory test results. Increased pressure that laboratory test results should be available in a timely fashion, for a large number of samples submitted at the same time; that laboratory analyses should be carried out quickly and expertly, so that necessary treatment should be administered as soon as possible in COVID-19 patients; but also, that the continuity of providing services to emergency non-COVID-19 patients and patients with chronic non-infectious diseases should be maintained; has been an additional burden for laboratory staff.

One of the major challenges of this pandemic has been the protection of laboratory staff against biohazards. Although, as an accredited laboratory, the CMB-UCCS has defined a Risk Management Strategy, which defines risks, the possibilities of their occurrence, the possible consequences, as well as the activities that the CMB, as a part of the UCCS, has been undertaking in order to lower, i.e., eliminate the risk of adverse events, COVID-19 has placed before the CMB numerous challenges in that respect. These challenges have primarily been in the domain of the transportation and handling of biological material, the decontamination of equipment and work surfaces, the maintenance of personal hygiene, and the use of personal protective equipment. The absence of a number of the staff due to infection or self-isolation/quarantine has also been a challenge. This has especially been the case with cleaning staff, who are in frequent communication with several laboratory areas/laboratories.

zadatak da, u izuzetno kratkom vremenskom roku, oformi laboratoriju prema postulatima dobre laboratorijske prakse, uz poštovanje propisanih mera upravljanja medicinskim otpadom i svih preporuka za bezbedan i zdrav rad zaposlenih. Izvršena je instalacija opreme, kao i obuka kadra za rad na istoj. Obavljena je nabavka komercijalnih reagenasa i potrošnog materijala, kao i verifikacija metoda. Izvršena je unutrašnja kontrola kvaliteta rada u laboratoriji i međulaboratorijsko poređenje sa drugim laboratorijama CMB-a, kao i međusobno umrežavanje analizatora u laboratoriji i vertikalno umrežavanje laboratorije sa odeljenjima KOVID bolnice i organizacionim jedinicama laboratorije u UKCS-u, itd. U jedinicama intenzivne nege bolnice instalirani su i pušteni u rad *POCT* gasni analizatori.

Kadrovi su raspoređivani prema trenutnim potrebama, ali je Ministarstvo zdravlja RS omogućilo i prijem novih kadrova (medicinskih biohemičara i laboratorijskih tehničara), uglavnom za potrebe laboratorije u bolnici UKCS-a, u Batajnici. Prijem novih kadrova bio je praćen intenziviranim obukama novoprimitljenog osoblja, u svim segmentima rada laboratorije.

Zbog odsustva zaposlenih, usled zaražavanja ili samoizolacije/karantina, uveden je rad u timovima kako bi se smanjila izloženost zaražavanju. Pauze za obrok koriste se u malim grupama, u prostorijama sa ograničenim brojem mesta za sedenje i prirodnom ventilacijom, uz održavanje propisanog rastojanja.

Rukovodstvo svakodnevno pravi i kontroliše operativne planove rada, kako bi se raspoloživim resursima laboratorije odgovorilo na postavljene prioritete. Distanciranje je uslovalo drugačiju komunikaciju, primopredaju i kontinuitet usluga među timovima. Održavanje radne discipline i morala, ali i rešavanje pitanja anksioznosti kod osoblja, usled fizičkog distanciranja i nemogućnosti komunikacije na pauzama, predstavljalo je za rukovodioce poseban izazov.

CMB je sve vreme pandemije kontinuirano pružao usluge, kako pacijentima obolelim od KOVID-19 infekcije, tako i hitnim ne-KOVID-19 pacijentima i pacijentima sa hroničnim nezaraznim bolestima. CMB je pratio epidemiološku situaciju i organizaciju UKCS-a, analizirajući, od samog početka pandemije, uzorke biološkog materijala KOVID-19 pacijenata koji su lečeni u Klinici za infektivne i tropske bolesti UKCS-a, ali i u privremenim KOVID bolnicama na klinikama UKCS-a (Klinika za pulomologiju, Klinika za grudnu hirurgiju, Klinika za plastičnu i rekonstruktivnu hirurgiju, Klinika za dermatovenerologiju), kao i uzorke pacijenata koji su bili smešteni u privremenoj KOVID bolnici "Štark Arena", a od decembra 2020. godine, analize se vrše i u laboratoriji novootvorene KOVID bolnice UKCS-a, u Batajnici. Od početka epidemije, Centar je pružio oko 2,6 miliona

CHANGES IN THE OPERATION OF LABORATORIES AND THEIR IMPLEMENTATION

It is evident that the pandemic has affected the routine operation of the CMB. Organizationally speaking, in the COVID-19 era, CMB has been carrying out laboratory work at an additional location, in the new COVID hospital of the UCCS, in Batajnica, Belgrade. The management of the center had the great responsibility of establishing, within a very short time frame, a laboratory that would conform to all the principles of good laboratory practice, while observing all the required measures for medical waste management and all the recommendations for the healthy and safe work of the staff. Equipment installation, as well as staff training for operating the said equipment was carried out. The purchase of commercial reagents and consumables as well as methods verification was performed. Internal quality control of the work in the laboratory, as well as inter-laboratory comparison with other laboratories of the CMB was carried out, as was the networking of analyzers within the laboratory and vertical networking of the laboratory with the departments of the COVID hospital and the organizational units of the laboratory at the UCCS, etc. *POCT* blood gas analyzer were installed and put into operation at the hospital intensive care units.

Staff was assigned according to momentary needs, but the Ministry of Health of the Republic of Serbia also enabled the hiring of new staff (medical biochemists and laboratory technicians), mainly for the needs of the laboratory at the hospital of the UCCS, in Batajnica. The hiring of these employees was followed by intensive training of the newly employed staff in all segments of laboratory operation.

Because of staff absences, due to infection or self-isolation/quarantine, work in teams has been organized, in order to limit exposure to infection. Meal breaks are made in small groups, in rooms with natural ventilation and a limited number of seats, while maintaining the required physical distance.

Every day, the management makes and controls operational work plans which enable the laboratory to respond to set priorities with the resources that it has at its disposal. Physical distancing has necessitated a different mode of communication, handover and service continuity amongst the teams. Maintenance of work discipline and morale, as well as the management of staff anxiety, stemming from physical distancing and the inability to communicate during breaks, has been a special challenge for the management.

The CMB has maintained continuous service delivery throughout the pandemic, both to COVID-19 patients and to emergency non-COVID patients, as well as to patients with chronic noninfectious diseases. CMB

usluga KOVID-19 pozitivnim pacijentima, što čini oko 20% ukupnog broja pruženih usluga u tom periodu.

Registровано je povećanje broja urađenih automatizovanih testova, neophodnih za dijagnostiku KOVID-19 infekcije, praćenje toka bolesti i komplikacija, kao i primenjene terapije (npr. D-dimer, C-reaktivni protein, feritin, prokalcitonin, interleukin-6, gasne analize, troponin itd.). Postojanje dve totalne laboratorijske automatizacije u dve najveće organizacione jedinice Centra, omogućava da kompletan proces rada, od trenutka kada je završeno uzorkovanje krvi u laboratoriji do izdavanja rezultata, bude u potpunosti automatizovan, čime je kontakt zaposlenih sa biološkim materijalom sveden na minimum. Osim instalacije totalnih laboratorijskih automatizacija, oprema u CMB-u je obnovljena prethodnih nekoliko godina, tako da je na početku pandemije još samo instalirano nekoliko POCT analizatora u jedinicama intenzivne nege i urađena verifikacija testova. CMB je na početku epidemije obezbedio dovoljne količine reagenasa i potrošnog materijala, čime je izbegnut prekid lanca snabdevanja.

CMB je tokom pandemije obavljao venepunkciju i analizirao uzorke pacijenata sa hroničnim nezaraznim bolestima, pacijenata sa brojnim akutnim stanjima, kao i uzorke stacionarnih pacijenata UKCS-a. Transport i prijem uzoraka sa sumnjom na KOVID-19 ili sa potvrđenom dijagnozom KOVID-19 infekcije, preanalitička i analitička faza laboratorijskog procesa, skladištenje uzoraka, kao i uklanjanje otpada, obavljano je prema važećim preporukama i procedurama CMB-a [8].

U tom smislu, radilo se na smanjenju neracionalnog straha, sprovođenjem obuke o individualnoj zaštiti i merama bezbednosti u kliničkim laboratorijama, i uvođenjem pojačane opreznosti (svakodnevno merenje telesne temperature, itd.) i mera za sprečavanje zaražavanja (obaveza nošenja lične zaštitne opreme kao što su maske, rukavice, naočare, viziri, mantili, pojačana lična higijena, dezinfekcija ruku i dezinfekcija radnih površina, rastojanje od dva metra među zaposlenima u laboratoriji, itd.). Svi zaposleni se redovno upoznaju sa svim dopisima i preporukama Ministarstva zdravlja RS, koje se odnose na KOVID-19 (protokol lečenja, mere zaštite na radu, vakcinacija, itd.).

Tokom pandemije KOVID-19 infekcije, CMB-UKCS je bio prinuđen da promeni način sprovođenja kontinuirane medicinske edukacije. Kongresi koje tradicionalno, svake godine, organizuje CMB, a koji okupe više od 3.000 učesnika, zamenjeni su *online* testovima akreditovanim od strane Zdravstvenog saveta Srbije, čime je učesnicima omogućeno da steknu nova znanja iz veoma aktuelnih oblasti (biohemijska, serološka i molekularna dijagnostika u KOVID-19 oboljenju, biomarkeri intersticijskih bolesti pluća i pneumonije),

has kept abreast of the epidemiological situation and the organization of the UCCS, analyzing, from the very beginning of the pandemic, the samples of biological material taken from COVID-19 patients treated at the Clinic for Infectious and Tropical Diseases, and at the provisional COVID hospitals at the UCCS clinics (Clinic for Pulmonology, Clinic for Thoracic Surgery, Clinic for Plastic and Reconstructive Surgery, Clinic for Dermatovenereology), as well as the samples of patients hospitalized at the provisional COVID hospital *Štark Arena*, and, as of December 2020, laboratory analyses are being performed at the laboratory of the new UCCS COVID hospital in Batajnica. Since the start of the epidemic, the Center has provided approximately 2.6 million tests to COVID-19 positive patients, which is roughly 20% of the overall services delivered in this period.

An increase in the number of automatized tests, necessary for COVID-19 diagnostics, follow-up of the course of the disease and complications, as well as the therapy applied (e.g., D-dimer, C-reactive protein, ferritin, procalcitonin, interleukin-6, blood gas analyses, troponin, etc.) has been registered. The existence of two total laboratory automations, in the two largest organizational units of the Center, enables that the complete work process, from the moment of blood sampling completion in the laboratory to the moment when the test results are issued, is fully automated, which reduces contact of the staff with biological material to a minimum. Apart from the installation of total laboratory automation, the equipment in the CMB was renewed in the previous several years, which is why, at the beginning of the pandemic, only several more POCT analyzers were installed in intensive care units and test verification was performed. At the beginning of the epidemic, the CMB provided sufficient supplies of reagents and consumables, thus avoiding the disruption of the supply chain.

During the pandemic, the CMB has been performing venipuncture and analyzing samples from patients with chronic noninfectious diseases, patients with different numerous acute conditions, as well as in-patients of the UCCS. The transport and receipt of samples from patients with suspected or confirmed COVID-19 infection, the pre-analysis and analysis phase of the laboratory process, sample storage, as well as waste disposal, have been carried out in keeping with the current recommendations and procedures of the CMB [8].

In this context, efforts have been made to reduce irrational fear, through personal protection and laboratory safety measures training, and through introducing increased caution (daily body temperature check, etc.), as well as transmission prevention measures (mandatory personal protective equipment - face masks, gloves, goggles, face shields, gowns, increased personal hygiene,

ali i da obezbede dovoljan broj bodova neophodan za obnavljanje licence.

PREPORUKE ZA FUNKCIONISANJE TOKOM KOVID-19 PANDEMIJE I U POST-KOVID ERI

Borba sa KOVID-19 pandemijom i dalje traje i nosi nove izazove za sve, uključujući i laboratorije. Globalno, KOVID-19 prethodi da ugrozi napredak postignut u dostizanju trećeg cilja održivog razvoja Ujedinjenih nacija, koji se odnosi na obezbeđivanje zdravog života i dobrobiti za sve ljude [9]. Stoga je opšti cilj da se ova pretnja zaustavi, poveća dostupnost zdravstvene zaštite, ojačaju kapaciteti za proširenje zdravstvene zaštite, pravovremeno pruže potrebne zdravstvene usluge, da se zaštite i sačuvaju ljudi i smanje troškovi posledica KOVID-19 oboljenja u budućnosti, u kojoj će dominantno osetiti efekti sadašnje zdravstvene krize. Rukovodstveno iskustvo UKCS-a nam govori da bi, u cilju ublažavanja uticaja KOVID-19 infekcije na zdravstvene sisteme, trebalo obratiti pažnju na pet oblasti javnih politika, a to su:

1. zaustavljanje prenošenja infekcije,
2. upravljanje budžetima,
3. zaštita osetljivih grupa pacijenata,
4. obezbeđivanje pružanja usluga, i
5. oporavak do nivoa koji se smatra novom normalnošću [10].

Kada su u pitanju laboratorije, pandemija KOVID-19 infekcije nam je jasno ukazala na ciljeve četiri velike interesne grupe:

- a) za pacijente - da dobiju pravovremenu i kvalitetnu uslugu;
- b) za laboratorijske radnike - da imaju sve uslove za bezbedan i kvalitetan rad sa manje stresa, a sa više motivacije;
- c) za rukovodioce laboratorija - da rade prema unapred definisanim procedurama, bez potrebe za *ad hoc* odlukama i stihijskim delovanjem, da trpe manji pritisak i ostvare bolje rezultate za svoje ustanove; i
- d) za distributere - da na vreme nabave opremu i potrošni materijal i da ih neometano distribuiraju svojim korisnicima.

Tek će napredak u borbi protiv pandemije moći da ukaže na prednosti i slabosti laboratorija. Kratkoročne mere reagovanja na vanredne okolnosti treba da se upotpune dugoročnim planiranjem. Da bi sistemi bili spremni za buduće pandemije, i odgovorili na ciljeve pacijenata i drugih interesnih grupa, laboratorije treba da imaju proaktivan pristup. Neophodno je formirati timove za krizne situacije iz redova laboratorijskog osoblja sa odgovarajućom obukom. Na primer, trebalo bi formirati timove za venepunkciju najosetljivijih grupa građana u uslovima smanjenog kretanja. Time bi se smanjili

hand disinfection, work surface disinfection, a two-meter physical distance between employees in the laboratory, etc.). All staff are regularly informed on all the memos and recommendations of the Ministry of Health of the Republic of Serbia pertaining to COVID-19 (treatment protocol, workplace safety measures, vaccination, etc.).

During the COVID-19 pandemic, the CMB-UCCS has been forced to change the mode of implementing continuous medical training. Congresses, traditionally organized by the CMB, every year, which usually host more than 3,000 participants, have been replaced with online tests, accredited by the Health Council of the Republic of Serbia, whereby the participants were provided with the opportunity of gaining new insights into current topics (biochemical, serological, and molecular diagnostics in COVID-19, biomarkers of interstitial lung disease and pneumonia), as well as procuring the requisite number of points necessary for their license renewal.

RECOMMENDATIONS FOR FUNCTIONING DURING THE COVID-19 PANDEMIC AND IN THE POST-COVID ERA

The fight against the COVID-19 pandemic is ongoing and it brings with it new challenges for all, including laboratories. Globally, COVID-19 is threatening to jeopardize the progress made in achieving the third goal of sustainable development of the United Nations, which is related to ensuring healthy lives and promoting well-being for all people [9]. Thus, the common goal is to stop the existing threat, increase accessibility of health care, strengthen capacities for expanding health care, provide necessary health services in a timely manner, protect and save people, and decrease costs resulting from COVID-19 in the future, when the effects of the health crisis occurring now will be dominant. The UCCS managerial experience tells us that, in order to lessen the effect of COVID-19 on healthcare systems, five public policy areas should be focused on:

1. stopping the infection spread,
2. budget management,
3. protection of vulnerable patient groups,
4. ensuring service provision, and
5. recovery to the level that is considered the new normal [10].

As far as laboratories are concerned, the COVID-19 pandemic has clearly shown us the goals of the four major stakeholders:

- a) for patients – to receive timely quality service;
- b) for laboratory staff – to have all the necessary conditions for safe and quality work involving less stress and a higher level of motivation;

javnozdravstveni troškovi za unajmljivanje usluga privatnih laboratorija. Laboratorije treba da izrade standardne operative procedure za upravljanje rizicima, u skladu sa politikama za rad u vanrednim situacijama. Time bi se predupredilo i ugrožavanje lanca snabdevanja.

Neophodno je da se uradi strategija laboratorijskog testiranja zasnovana na jasnim naučnim dokazima, u čijem sklopu treba da postoji optimizacija lanca snabdevanja, pružanja usluga i odlaganja biološkog otpada. Ovo je prava prilika da se strateški uradi procena potreba za kadrovima, na osnovu radnog opterećenja pre i tokom krize (korišćenjem *WISN* metode), i time podigne pripravnost za krizu i smanji iscrpljivanje resursa tokom krize. Strah od gubitka posla i smanjenja prihoda, stvara dodatni pritisak ionako već promejenog mentalnog statusa većine zaposlenih, koji svakodnevnim radom u ovim okolnostima rizikuju svoje živote i živote svojih najbližih. Rukovodioci treba da imaju podršku u svom radu kako bi mogli da održavaju visoku motivisanost za efikasno funkcionisanje, koristeći nematerijalne i materijalne strategije motivacije. Generalno, trebalo bi budžetska izdvajanja preusmeriti na obezbeđivanje podsticaja i naknada i osiguravanje bezbednosti i zdravlja zaposlenih.

Norme ponašanja tokom KOVID-19 pandemije, kao što je fizičko distanciranje, osim što smanjuju izloženost riziku, modifikuju i radnu kulturu. *Online* sastanke i konsultacije bi trebalo uključiti u svakodnevne aktivnosti, a proslave i druženja na radnom mestu obustaviti. Pauze za obrok treba da se koriste u grupama, u prostorijama sa ograničenim brojem mesta za sedenje i uz konzumiranje unapred bezbedno upakovanih obroka.

ZAKLJUČAK

Izazovi i promene nastale usled KOVID-19 pandemije su podsetnik da, uz svoj osnovni zadatak, moramo kontinuirano da se unapređujemo na različitim poljima. Zaposleni u laboratoriji danas imaju jedinstvenu priliku da primene sva znanja koja su stekli u vreme pandemije, kako bi transformisali način na koji rade i ublažili efekte budućih pandemija.

Iz sadašnje perspektive, osnovni uslov je da laboratorije imaju dovoljno osoblja, kako bi mogle da budu fleksibilne u svom radu, a zatim da osoblje ima i odgovarajuću zaštitnu opremu i resurse za rad, kao i da je rukovodstvo iskusno i spremno da efikasno radi u kriznim situacijama, vodeći računa o primeni strategija motivacije i promovisanju mentalnog i fizičkog zdravlja.

Poučeni ovim iskustvima, kada se pandemija konačno završi, trebalo bi da možemo da zaključimo da su laboratorije stručno i organizaciono jače nego ikad ranije i spremne za brojne izazove koji nas očekuju u budućnosti.

Sukob interesa: Nije prijavljen.

c) for laboratory management – to operate according to predefined procedures, without the need for ad hoc decisions, and to be under less pressure while achieving better outcomes for their institutions; and

d) for distributors – to purchase equipment and consumables on time and to distribute them to their customers without any difficulties.

It is only the progress in the fight against the pandemic that will be able to reveal the strengths and weaknesses of laboratories. Short-term measures of reacting to extraordinary circumstances should be completed with long-term planning. In order for the systems to be prepared for future pandemics and ready to respond to the goals of the patients and other stakeholders, the laboratories should apply a proactive approach. It is necessary to form teams for crisis situations made up of laboratory staff with the appropriate training. For instance, teams for venipuncture of the most vulnerable citizen groups in conditions of reduced mobility, should be formed. This would reduce public health costs for procuring the services of private laboratories. Laboratories should establish standard operational procedures for risk management, in keeping with the policies for operating in extraordinary situations. This would also ensure that the supply chain is not threatened.

It is necessary to design a strategy of laboratory testing based on clear scientific evidence, which should also include the optimization of the supply chain, service delivery, and biological waste disposal. This is a real opportunity to strategically perform a needs assessment regarding staff, based on the workload prior to and during the crisis (use of the *WISN* method), and thereby raise the level of readiness for a crisis situation and decrease the draining of resources during a crisis. The fear of losing one's job and suffering a wage cut creates additional pressure in staff, whose mental status is, in most cases, already altered, as their everyday work in the current circumstances puts their lives and the lives of their loved ones at risk. Managers should be supported in their work, in order to be able to maintain high motivation for efficient functioning, by applying monetary and non-monetary motivation strategies. Generally speaking, budget funds should be redirected into providing incentives and different forms of compensation, as well as ensuring the safety and health of the staff.

The norms of conduct during the COVID-19 pandemic, such as physical distancing, not only reduce risk exposure, but they also modify the work culture. Online meetings and consultations should be included into everyday activities, while celebrations and social

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events in the workplace should be discontinued. Meal breaks should be taken in groups, in rooms with a limited number of seats and the meals should be safely preprepared and prepackaged.

CONCLUSION

The challenges and changes resulting from the COVID-19 pandemic are a reminder that, in addition to our main task, we must continuously improve in different areas. At the present time, laboratory staff have the unique opportunity of applying the knowledge and insights they have gained during the pandemic into transforming the way that they work and reducing the effects of future pandemics.

From today's viewpoint, the main precondition is that laboratories should have the sufficient number of staff, in order to be flexible in their work. It is also important that the staff is equipped with the appropriate personal protective equipment and resources for work, as well as that the management is experienced and prepared for efficient operation during a crisis, while applying motivation strategies and strategies for promoting mental and physical health.

Having learned from this experience, once the pandemic is finally over, we should be able to conclude that the laboratories have become stronger than ever before, both organizationally and professionally, and ready for numerous challenges that lie ahead.

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