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UGROŽENOST STOMATOLOŠKOG OSOBLJA SARS-CoV-2 VIRUSOM TOKOM STOMATOLOŠKIH INTERVENCIJA

OCCUPATIONAL HAZARD FOR DENTAL STAFF EXPOSED TO THE SARS-CoV-2 VIRUS DURING DENTAL PROCEDURES

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Sažetak

Uvod: Stomatološka profesija je visokorizična profesija, sa aspekta mogućeg inficiranja, od skoro 100% u toku stomatoloških intervencija, od strane pacijenata koji su nosioci bakterijskih, virusnih i gljivičnih bolesti.

Cilj rada: Analiza svih podataka koji objašnjavaju mogućnost inficiranja SARS-CoV-2 virusom u stomatološkoj praksi.

Materijal i metode: Analizirana je literaturna o zastupljenosti SARS-CoV-2 virusa, njegove karakteristike i ponašanje u spoljašnjoj sredini i u živim tkivima. Korišćene su baze podataka iz biblioteka Medline, Cochrane Library, Science-Direct, EMBASE, and Google scholar, kao i drugi izvori informacija o ovom virusu.

Rezultati: SARS-CoV-2 je RNK virus, koji ima submikronsku veličinu i mogućnost da opstane u raznim sredinama. Zadržavanje virusa SARS-CoV-2 u vazduhu/aerosolu traje prosečno 3 sata, dok je poluživot ovog virusa 5 do 6 sati na nerđajućem čeliku i 6 do 8 sati na plastici. Inficirani pacijenti SARS-CoV-2 virusom razvijaju COVID-19 bolest, koja se manifestuje kroz presimptomatski, simptomatski i postsimptomatski period bolesti.

Zaključak: SARS-CoV-2 virus moguće je identifikovati u aerosolu, koji stvaraju stomatološke mašine, korišćenjem kompresorskog vazduha i radu. Zaštita stomatologa i osoblja od inficirajućeg virusa je moguća, košćenjem N95 respiratore maske sa stepenom zaštite 2 i 3, koje imaju efikasnost filtracije, tj. zadržavanja submikronskih čestica sa efikasnošću od $\geq 98\%$. Treba koristiti vodonepropusne zaštite naocare sa zaštitnim vizijom ili industrijski posebno dizajnirani facialni vizir u vidu maske za celo lice, koji ima sopstveni motor za dotok filtriranog vazduha u masku i koji sprečava kontaminaciju mukoze oka, nosa i usta putem stvorenog tečnog ili čvrstog aerosola u vazduhu. Ostala jednokratna zaštitna oprema takođe treba da bude vodonepropusna.

Ključne reči: Stomatološko osoblje, SARS-CoV-2, rizik

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Abstract

Introduction: The dental profession is a high-risk profession, considering the aspect of a possible 100% infection from patients who are carriers of bacterial, viral and fungal diseases during dental interventions.

Aim: To perform the analysis of all data that explain the possibility of a SARS-CoV-2 virus infection in dental practice.

Material and Methods: The literature data on the presence of SARS-CoV-2 virus, and its characteristics and behavior in the external environment and in living tissues was analyzed. Databases from the Medline, Cochrane Library, Science-Direct, EMBASE, and Google scholar libraries were used, as well as other sources of literature information about this virus.

Results: SARS-CoV-2 is an RNA virus, which has a submicron size and the ability to survive in various environments. The retention of SARS-CoV-2 virus in air / aerosol lasts an average of 3 hours, while the half-life of this virus is 5 to 6 hours on stainless steel and 6 to 8 hours on plastic. Infected patients with SARS-CoV-2 virus develop COVID-19 disease, which manifests itself through presymptomatic, symptomatic and post-symptomatic periods of the disease.

Conclusion: The SARS-CoV-2 virus can be found in aerosols generated by dental equipment, which uses compressed air for its work. Protection of dentists and staff from infection with the virus is possible by wearing an N95 respiratory mask with protection levels 2 and 3, which has a filtration efficiency, i.e. retention of submicron particles with an efficiency of $\geq 98\%$. Waterproof goggles with a protective visor or a special industrially designed facial visor in the form of a full face mask, which has its own motor for the supply of filtered air to the mask, and which prevents the contamination of the mucous membranes of the eyes, nose and mouth from liquid or solid aerosol in the air, need to be used. Other disposable protective equipment also must be waterproof.

Key words: Dental staff, SARS-CoV-2, risk

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Uvod

Stomatološka profesija je visokorizična profesija, sa aspekta mogućeg inficiranja, od skoro 100% od strane pacijenata, koji su nosioci bakterijskih, virusnih i gljivičnih bolesti, na kojima se izvodi stomatološka intervencija¹. Stomatološko osoblje, standardno, može biti izloženo i ugroženo sledećim patogenim mikroorganizmima i virusima: *Mycobacterium tuberculosis*, bakterijama grupe *Streptococcus* i *Staphylococcus*, citomegalovirusom (CMV), herpes virusom tipa 1 i 2, virusom hepatitis B i C, kao i drugim patogenim izazivačima različitih bolesti².

Način prenošenja ovih mikroorganizama i inficiranje stomatološkog osoblja, od strane oboleleg pacijenta, dešava se preko: direktnog kontakta sa krvlju, pljuvačkom ili preko drugog infektivnog biloškog izvora; indirektnim putem, preko kontaminiranih instrumenata, radnih površina nameštaja u ordinaciji ili preko kontamirane opreme; preko kontakta sa infektivnim kapljicama iz konjuktive oka, oralne i nazalne sluzokože, koje sadrže patogene mikroorganizme i virusе i koje se izbacuju u spoljašnju sredinu (na kratku razdaljinu) pričanjem, kijanjem ili kašljanjem; inhalacijom patogena koji borave u vazduhu u dužem vremenskom periodu³.

U ovom trenutku, od posebnog je interesa razmotriti neke činjenice koje se odnose na pandemiju novog korona virusa, koju je proglašila Svetska zdravstvena organizacija krajem prošle godine⁴, kao i na masovno zaražavanje stanovništva novim korona virusom. S obzirom na ove dramatične zdravstvene događaje, odluka o proglašenju vanrednog stanja u Republici Srbiji, zbog epidemije korona virusa, doprinela je tome da se stomatološke intervencije sprovode u specifičnim i veoma otežavajućim okolnostima za stomatološke zdravstvene radnike i pacijente, kojima je potreban stomatološki tretman.

Biologija korona virusa

Korona virus izaziva prehladu kod ljudi, koja ima uobičajne simptome prehlade gornjih respiratornih puteva; zahvata nosnu šupljinu, a ponekad se širi i na ždrelo, larinks i sinuse^{5,6,7}. Sa druge strane, SARS-CoV-2 virus, koji je izazivač masovne/globalne virusne infekcije, ima sličnosti sa druga dva korona virusa –beta korona virusom (SARS-CoV-1) i virusom srednjeistočnog respiratornog sindroma (MERS-CoV).

Introduction

The dental profession is a high-risk profession, considering the aspect of a possible 100% infection from patients who are carriers of bacterial, viral and fungal diseases, and who are undergoing a dental procedure¹. The dental staff may standardly be exposed to and jeopardized by the following pathogenic microorganisms and viruses: *mycobacterium tuberculosis*, *streptococcus* and *staphylococcus* bacteria, *cytomegalovirus* (CMV), *herpesvirus* types 1 and 2, hepatitis B and C virus, as well as other pathogens which cause various diseases².

The transmission mode of these microorganisms and infection of dental staff by the patient who carries the disease occur through: direct contact with blood, saliva or through another infectious biological source; indirectly through contaminated instruments, equipment or work surfaces of the furniture in the office; contact with infectious droplets from the conjunctiva of the eye, oral and nasal mucosa containing pathogenic microorganisms and viruses which are released into the external environment (over a short distance), talking, sneezing or coughing; by inhaling pathogens residing in the air over an extended period of time³.

At this moment, it is of special interest to consider some facts related to the pandemic with the new coronavirus declared by the World Health Organization at the end of last year⁴, as well as the mass infection of the population with the new coronavirus. Considering these dramatic health events, the decision to declare a state of emergency in the Republic of Serbia owing to the coronavirus epidemic has contributed to dental interventions being performed in specific and highly aggravating circumstances for dental health workers and patients in need of dental care.

Biology of the coronavirus

In people, the coronavirus causes colds which have the usual symptoms of a cold of the upper respiratory tract, affecting the nasal cavity, and sometimes spreading to the pharynx, larynx and the sinuses^{5,6,7}.

On the other hand, the current coronavirus, which has caused a mass/global viral infection, is similar to two other viruses: the beta-coronavirus (SARS-CoV 1).

Ovi virusi imaju sposobnost da izazovu tešku pneumoniju i otkazivanje respiratorne funkcije pluća i na kraju dovedu do smrti pacijenta⁶.

SARS-CoV-2 virus, novi tip korona virusa, koji ima sposobnost da izazove teški akutni respiratori sindrom, sa mogućim smrtnim ishodom, dobio je početni naziv 2019-nCoV⁸, da bi ubrzo dobio i zvaničan naziv koji označava "teški akutni respiratori sindrom izazvan korona virusom 2" (eng. *severe acute respiratory syndrome coronavirus 2/ CORONA VIRUS 2(SARS-CoV-2)*)⁸, koji izaziva korona virus bolest (COVID-19)⁹. Značajno je istaći da SARS-CoV-2 pripada RNK virusima¹⁰ i da ima sličnosti sa korona virusom SARS-CoV-1.

Dimenzije SARS-CoV-2 virusa manje su od 1 mikrona i iznose 125nm, odnosno 0,125 μ m^{11,12}. Ova submikronska dimenzija SARS-CoV-2 virusa značajno smanjuje mogućnosti zaštite od transmisije virusana stomatološko osoblje, u toku svakodnevnog rada.

Načini prenošenja korona virusa

Korona virus (SARS-CoV-1) je takav tip virusa koji može da inficira slepe miševe, cibetke iz roda viverida, koji su slični mungosima, i ljude, kod kojih izaziva teški akutni respiratori sindrom (eng. *severe acute respiratory syndrome-SARS*)^{13,14}. Ovaj virus napada epitelijalne ćelije pluća kod ljudi^{15,16}, u koje ulazi putem vezivanja za ACE2 receptore (eng. *angiotensin-converting enzyme*)^{15,16}. ACE2 receptori nalaze se u bubrežima, srcu i endotelialnim ćelijama i njihova glavna uloga je regulacija renin-angitenzin sistema (RAS)¹⁷. Poslednja saznanja ukazuju na to da ACE2 reaguje sa transmembranoznom proteazom serina 2 (TMPRSS2), koji je odgovoran za aktivaciju virusnog "S" proteina SARS-CoV-2, koji reaguje sa površinskim ACE2 enzimom, skoro identično kao kod virusa SARS; aktivirani virusni material SARS-CoV-2 ulazi u citoplazmu zaražene osobe i odvija se proces umnožavanja virusa preko ćelijskih mehanizama domaćina^{16,18,19,20}.

Još uvek postoje neslaganja oko toga kako se aktuelni korona virus (SARS-CoV-2) prenosi; putem velikih respiratori kapljica, kao virus influence ili preko fine vodene izmaglice zvane aerosol, kao kod rubeola boginja²¹. Smatra se, ipak, da se SARS-CoV-2 virus primarno širi, kod ljudi, preko respiratori kapljica (eng. *droplets*), koje nastaju kada osoba koja je inficirana

and the Middle Eastern Respiratory Syndrome Virus (MERS-CoV). These viruses have the ability to cause severe pneumonia and the failure of the respiratory function of the lungs, eventually leading to the death of the patient⁶.

The current new type of coronavirus, which has the ability to cause severe acute respiratory syndrome with a possible fatal outcome, was given the initial name 2019-nCoV⁸, and soon received the official name of: "**SEVERE ACUTE RESPIRATORY SYNDROME CORONAVIRUS 2" / CORONA VIRUS 2 (SARS-CoV-2)**"⁸, which causes the coronavirus disease (COVID-19)⁹. It is important to note that SARS-CoV-2 belongs to RNA viruses¹⁰ and that it is similar to the coronavirus SARS-CoV-1.

The size of the SARS-CoV-2 virus is less than 1 micron, and is 125 nm or 0.125 μ m^{11,12}, and this submicron size of the SARS-CoV-2 virus significantly reduces the possibility of protection against virus transmission in dental staff during their daily work.

Ways of coronavirus transmission

Coronavirus (SARS-CoV-1) is a type of virus that can infect bats, civets of the genus viverida that are similar to mongooses, and people, in whom it causes severe acute respiratory syndrome (SARS)^{13,14}. This virus attacks human epithelial cells in the lungs^{15,16}, which it enters by binding to ACE2 receptors (*angiotensin-converting enzyme*)^{15,16}. ACE 2 receptors are also found in the kidneys, heart and endothelial cells, and their main role is the regulation of the renin-angitensin system (RAS)¹⁷. Recent findings indicate that ACE2 reacts with transmembrane protease-serine 2 (TMPRSS2), responsible for the activation of the viral "S" protein SARS-CoV-2, which reacts with the surface ACE2 enzyme almost identically to the SARS virus; activated viral material SARS-CoV-2 enters the cytoplasm of an infected person, and the process of virus replication takes place through cellular host mechanisms^{16,18,19,20}.

There are still disagreements over how the current coronavirus (SARS-CoV-2) is transmitted; through large respiratory droplets as an influenza virus, or through a fine water mist called aerosol, as in the case of rubella²¹. However, the SARS-CoV-2 virus is thought to spread to humans primarily through respiratory droplets which occur when a person infected with the SARS-CoV-2 virus

SARS-CoV-2 virusom energično govor, kašlje ili kija i na taj način izbacuje sekret, tj. respiratorne kapljice u vazduh i to nekoliko metara u daljinu; smatra se da je minimalna sigurna razdaljina, koja otežava zaražavanje $\geq 1,8$ m – 2m.

Takođe se smatra da je virus, koji aerosoliziran u vazduh, ipak potencijalna opasnost i može da opstane u vazduhu, kada se sprovode neke aktivnosti, kao npr. pevanje²² ili prilikom intubacija/ekstubacije pacijenata u toku opšte anestezije, kada virus može da se zadrži u vazduhu i do 3 sata²³.

Zabrinjavajuća je činjenica da je pokazana mogućnost izolovanja SARS-CoV-2 RNA iz krvi i feca; njegovo prisustvo dokazano je i na kartonu, plastici i nerđajućem čeliku^{23,24}. Poslednja istraživanja pokazala su zadržavanje virusa SARS-CoV-2 u vazduhu/aerosolu u trajanju od prosečno 3 sata; poluživot ovog virusa bio je 5 do 6 sati na nerđajućem čeliku i 6 do 8 sati na plastici²³.

Dokazano je prisustvo SARS-CoV-2 RNA virusa i na nekim drugim predmetima^{22,25}, što izaziva oprez u stručnim krugovima i upućuje na razmatranje i ovakvog načina širenja virusa.

Uticaj kliničkih manifestacija covid-19 bolesti na stomatološki tretman

U svakodnevnom stomatološkom radu postoji velika mogućnost transmisije SARS-CoV-2 virusa, s obzirom na to da stomatološki instrumenti i stomatološka oprema koji se koriste, kao što su nasadni instrumenati (turbine, kolenjaci i nasadnici), ultrazvučni skidači zubnih naslaga, ultrazvučni aparati za hirurgiju koštanog tkiva, itd., stvaraju jedva vidljivi, fini vodeni oblak odnosno izmaglicu, koja može da sadrži infektivne čestice. Korišćenjem ovih instrumenata, kao neminovna posledica javlja se i stvaranje velikih kapljica vode, pljuvačke, krvi, mikroorganizama, virusa kao i drugog mogućeg zaraznog materijala. U toku izvođenja stomatoloških intervencija, nije samo ugrožen stomatolog, koji vrši intervenciju na 30cm–40cm od usne šupljine pacijenta, već i stomatolog asistent, zatim radno angažovana stomatološka sestra i, eventualno, pomoćna sestra. Prskanje mogućih zaraznih čestica u neposrednu okolinu oko pacijenta i stomatologa omogućava da ove infektivne čestice padaju na sam tim koji obavlja stomatološku intervenciju, zatim na pod, radni pult stomatološke mašine, kao i na radni sto, odnosno nameštaj u ordinaciji.

vigorously speaks, coughs or sneezes, and in this way expels secretions, i.e. respiratory droplets, into the air, a few meters away; the minimum safe distance which makes infection difficult between an infected and a healthy person is thought to be ≥ 1.8 – 2m. It is also considered that the virus that is aerosolized in the air is still a potential hazard and can survive in the air when performing certain activities, such as singing²², or during the intubation / extubation of patients during general anesthesia, after which the virus can remain in the air for up to 3 hours²³.

A worrying fact is that it has been proven that it is possible to isolate SARS-CoV-2 RNA from blood and feces; its presence has also been proven on cardboard, plastic and stainless steel^{23,24}.

Recent studies have shown that the SARS-CoV-2 virus remains in the air / aerosol for an average of 3 hours; the half-life of this virus was 5.6 h on stainless steel and 6.8 h on plastic²³.

The presence of the SARS-CoV-2 RNA virus has been proven in some other inanimate organisms as well^{22,25}, which has led to caution in professional circles and the consideration of this way of spreading the virus.

Impact of the clinical manifestations of the covid-19 disease on dental treatment

In everyday dental work, there is a great possibility for the transmission of the SARS-CoV-2 virus, considering the fact that the dental instruments and equipment used, such as handpieces (turbines, contra-angle handpieces and straight handpieces), ultrasonic dental plaque removers, ultrasound devices for bone tissue surgery, etc., create a barely visible, fine water cloud or haze, which may contain infectious particles. When using these instruments, an inevitable consequence is the creation of large droplets of water, saliva, blood, microorganisms, viruses and other possible infectious material. During the performance of dental interventions, not only is the dentist who performs the intervention at 30-40 cm from the patient's oral cavity threatened, but also the dental assistant, the dental nurse who is involved in the process and possibly the assistant nurse. Spraying possible infectious particles into the immediate environment around the patient and the dentist allows these infectious particles to fall onto the team performing the dental intervention, onto the floor, the workbench of the dental machine and onto the desk or furniture in the office.

Još veća opasnost je i moguća pojava aerosola, koji može da sadrži infektivni patogeni mikroorganizam. Poznata je činjenica da hirurške maske koje nosi osoblje u toku opisanih intervencija uglavnom štiti mukozu usne šupljine i nosa od kapljica koje dolaze do zaštitne maske; medicinski problem je to što nema sigurne zaštite od udisanja iz vazduha stvorenih kontaminiranih oblaka, odnosno aerosola, koji potencijalno sadrži virus²⁶.

Sadašnja saznanja o COVID-19 bolesti nam govore da postoje tri nivoa kliničkog stanja zaraženog pacijenta, koji može da bude istovremeno i stomatološki pacijent. Standardizovane su faze razvoja COVID-19 bolesti, koja se razvija kroz presimptomatski period, simptomatski period i postsimptomatski period²⁷. Najveća opasnost od transmisije i zaražavanja SARS-CoV-2 virusom stomatološkog osoblja, tokom izvođenja stomatoloških intervencija, su pacijenti sa SARS-CoV-2 virusom, koji su u asymptomatskoj i/ili presimptomatskoj fazi razvoja bolesti COVID-19²⁸. Inkubacioni period COVID-19 bolesti traje prosečno 5 do 6 dana, mada ima podataka o tome da traje i 14 dana²⁹. Viruletost SARS-CoV-2 virusa omogućava to da 1 dan do 3 dana pre ispoljavanja svih simptoma bolesti COVID-19 pacijent bude infektivan i 40% do 50%; transmisija virusa sa zaražene osobe na zdravu osobu nastaje u toj prvoj i nemoj fazi bolesti, odnosno asymptomatskoj ili presimptomatskoj fazi bolesti^{22,30}. Smatra se da 97,5% pacijenta, koji su u simptomatskoj fazi razvoja COVID-19 bolesti, može razviti simptome bolesti i to 11,5 dana od SARS-CoV-2 infekcije³¹.

Simptomi COVID-19 bolesti su: povišena telesna temperatura, kašalj, bol i suvoća u grlu, malaksalost, bolovi u mišićima, gubitak apetita, mučnina, povraćanje, gubitak čula mirisa i ukusa, gubitak daha(kratak udisaj vazduha)^{32,33,34,35,36}. Laboratorijske analize pojedinih krvnih i biohemijskih vrednosti karakterišu se specifičnim odstupanjima, kao što su: povišena vrednost d-dimera, laktat dehidrogenaze, C-reaktivnog proteina, feritina i prisutnost limfopenija; nije retko da bolesnici imaju normalnu vrednost prokalcitonina; kod teških slučajeva Covid-19 bolesti nastaje leukocitoza sa limfopenijom, produženo protrombinsko vreme i znatno povećanje vrednosti enzima jetre, laktat dehidrogenaze, C-reaktivnog proteina, d-dimera, interleukina-6, C reaktivnog proteina i prokalcitonina^{32,37,38,39,40}.

An even greater danger is the possible appearance of an aerosol that may contain an infectious pathogenic microorganism. It is a well-known fact that surgical masks worn by staff during the described interventions generally protect the mucosa of the oral cavity and nose from the droplets reaching the protective mask; the medical problem is that there is problematic protection against inhalation from the formed contaminated clouds in the air or aerosols that potentially contain the virus²⁶.

Current knowledge of the COVID-19 disease tells us that there are three levels of clinical conditions of an infected patient who may be a dental patient at the same time. The stages of development of the COVID-19 disease that develops through the presymptomatic period, symptomatic period and post-symptomatic period are standardized²⁷. Patients with the SARS-CoV-2 virus that are in the asymptomatic and/or presymptomatic development phase of the COVID-19 disease represent the greatest threat of transmission and infection with the SARS-CoV-2 virus to dental staff during dental interventions²⁸. The incubation period of the COVID-19 disease lasts an average of 5-6 days, although there are data that it lasts 14 days.²⁹ The virulence of the SARS-CoV-2 virus allows the patient to be infectious 1-3 days before the manifestation of all symptoms of the COVID-19 disease, and 40-50% of the virus transmission from an infected person to a healthy person occurs in this first silent phase of the disease, i.e. in the asymptomatic or presymptomatic phase of the disease^{22,30}. It is believed that 97.5% of the patients who are in the symptomatic phase of the COVID-19 disease develop symptoms 11.5 days after the SARS-CoV-2 infection³¹.

The symptoms of the COVID-19 disease are: fever, cough, painful and sore throat, muscle weakness and pain, loss of appetite, nausea, vomiting, loss of smell and taste, shortness of breath^{32,33,34,35,36}. Laboratory analyses of individual blood and biochemical values are characterized by specific deviations, such as: elevated d-dimer value, lactate dehydrogenase, C-reactive protein, ferritin and lymphopenia presence; it is not uncommon for patients to have normal procalcitonin levels; severe cases of the Covid-19 disease involve the occurrence of leukocytosis with lymphopenia, prolonged prothrombin time and a significant increase in liver enzymes, lactate dehydrogenase, C-reactive protein, d-dimer, interleukin-6, C reactive protein and procalcitonin^{32,37,38,39,40}.

Mogući način transmisije SARS-CoV-2 virusa u stomatološkoj praksi

Čekaonice su prva mesta na kojima postoji rizik od prenosa virusa sa zaraženog pacijenta na stomatološko osoblje. Zbog toga se preporučuje minimalni broj pacijenta u čekaonici, sa obaveznim razmakom većim od 1,8 m do 2m. Potrebno je da se u čekaonici nalazi minimalni broj nepotrebnih stvari, a treba ukloniti iz ordinacije časopise, igračke, knjige, itd. Po potrebi, pacijente prvo treba intervjuisati preko telefona, kako bi se utvrdilo da li su bili u kontaktu sa mogućim zaraženim osobama, da li imaju ili su imali simptome i znake COVID-19 bolesti, odnosno treba da postoji dužnost pacijenata da daju takve informacije po dolasku u stomatološku ordinaciju²⁶.

Osoblje stomatološke ustanove u toku radnog dana mora biti, iako nije u kontaktu sa pacijentima, u radnoj, čistoj odeći, a ova radna odeća menja se svakodnevno. U toku celokupnog radnog vremena, stomatološko osoblje u ordinaciji mora nositi hiruršku masku. Ukoliko je potrebno da se maska dodiruje, iz bilo kog razloga, onda pre i posle takve manipulacije treba izvršiti antiseptičko pranje ruku razredenim alkoholom u koncentraciji od 70% do 75%. Zaštita ruku od kontaminacije virusom uobičajno se sprovodi pomoću 2 para jednokratnih rukavica; kada se iz bilo kog razloga potencijalno kontaminiraju ili oštete spoljašnje rukavice, onda se prvo vrši dekontaminacija takvih rukavica razređenim alkoholom u koncentraciji od 70% do 75%, zatim se skinu spoljašnje (druge) rukavice, opet se uradi alkoholna dekontaminacija unutrašnjih (prvih) rukavica i navuku se nove rukavice za jednokratnu upotrebu. Preko radne obuće mogu se nositi zaštitne kaljače. Takođe, stomatološko osoblje koje prvo dolazi u kontakt sa pacijentima, mora da drži sigurnosnu distance od 1,8 m do 2m od pacijenta i mora da ima zaštitne naočare ili zaštitni vizir da bi se sprečila kontaminacija konjuktive ili mukoze kapljicama (eng.droplet transmission) veličine $>5\mu\text{m}$, koje mogu da sadrže virus, koje u vazduhu može da izbacuje zaraženi pacijent. Opisanim merama obezbeđujemo prevenciju transmisije virusa od strane poznatog ili nepoznatog nosioca virusa, odnosno sprečavamo moguću direktnu kontaktну ili kapljicnu transmisiju virusa ili indirektnu transmisiju virusa preko stvari²⁶.

Possible transmission mode of the SARS-CoV-2 virus in the dental practice

Waiting rooms are the first places where there is a risk of transmitting the virus from an infected patient to the dental staff. Therefore, it is recommended that there be a minimum number of patients in the waiting room with a mandatory distance greater than 1.8 to 2m. There should be a minimum number of unnecessary things in the waiting room, and magazines, toys, books, etc. should be removed from the office. If necessary, patients should first be interviewed by telephone to determine if they have been in contact with potentially infected persons, if they have or have had symptoms and signs of the COVID-19 disease, i.e. patients are required to provide such information upon their arrival at the dental office²⁶.

The staff of the dental institution must wear clean clothes intended for work during the working day even if they are not in contact with the patients, and the clothes intended for work are to be changed daily. During the entire working hours, the dental staff in the office must wear a face mask, i.e. a surgical mask. If it is necessary to touch the mask for any reason, hands are to be washed with an antiseptic with diluted alcohol in a concentration of 70-75% before and after such manipulation. Protection of the hands from virus contamination is usually performed with 2 pairs of disposable gloves; when, for any reason, the outer gloves are potentially contaminated or damaged, such gloves are first decontaminated with diluted alcohol in a concentration of 70-75%, then the outer (second) gloves are removed, and the decontamination is done again with alcohol on the inner (first) gloves. Finally, new disposable the outer (second) gloves are put on again. Protective disposable shoe cover can also be worn over the shoes worn at work. Furthermore, dental staff who first come into contact with patients must keep a safety distance of 1.8 to 2 m from the patient, and must wear goggles or a protective visor to prevent the contamination of the conjunctiva or mucosa from droplet transmission $> 5 \mu\text{m}$, which may contain a virus that can be released into the air by an infected patient. With the described measures, the prevention of virus transmission from a known or unknown virus carrier is ensured, i.e. possible direct contact or droplet transmission of the virus, or indirect transmission of the virus from things is prevented²⁶.

Stomatološke pacijente treba razvrstati u 2 grupe: 1. grupa–pacijenti kod kojih prilikom intervencije neće nastati mašinom stvoreni aerosol; i 2. grupa–pacijenti kod kojih će prilikom intervencije nastati mašinski stvoreni aerosol.

1. grupa– pacijenti kod kojih prilikom intervencije neće nastati mašinom stvoreni aerosol

Prilikom rada sa pacijentima u 1. grupi, na kojima se sprovode stomatološke intervencije, koje ne zahtevaju upotrebu nasadnih instrumenta, koje ne mogu da proizvedu aerosol korišćenjem kompresorskog vazduha za svoj rad, primenju se sledeće zaštitne mere: nošenje respiratornih maski, koje imaju sposobnost zaustavljanja čestica veličine od $0,3\mu$, sa procentom efikasnosti od 95%; ove se maske različito označavaju (i ako su u karakteristikama jednake), u zavisnosti od zemlje porekla: N95 (USA kod), KN95 (Kina kod), KF94 (Koreja kod), i FFP2 (EU kod i UK kod)^{41,42}. Ove maske su za jednokratnu upotrebu i menjaju se svakih 20 do 30 minuta, ako su izložene intezivnom prskanju tečnostima, aerosolima, itd., ili posle 1 sata u normalnim "suvim" radnim okolnostima^{43,44}. Ovaj tip maski takođe ima sposobnost da štiti od aerosola i velikih kapljica tečnosti, koje se inače stvaraju u stomatološkom radu^{2,45,46,47}. Efikasnost zaštite ovim maskama ogleda se i u činjenici da maske zadržavaju čestice veličine od 1μ do 5μ sa 95% uspeha^{2,48}, što ukazuje na to da mogu da osiguraju zaštitu za stomatološko osoblje. Treba istaći da one ne pružaju takvu zaštitu ako se nepravilno stavljuju, ne adaptiraju intimno na lice i ako ih nosi osoba koja ima bradu⁴⁹.

Zaštitni vizir i naočare obavezni su delovi lične zaštitne opreme stomatologa i ostalog osoblja. Poželjno je da zaštitne naočare budu vodonepropusne, a vizir ergonomski oblikovan, budući da je stomatolog u svom radu u veoma bliskom kontaktu sa licem pacijenata, pa zbog toga neadekvatne dimenzije vizira i neadekvatni oblik smetaju u stomatološkom radu. Najfunkcionalnije su kombinacije vodonepropusnih naočara i prema licu oblikovanih vizira (Slika 1).

Ostali zaštitni material za jednokratnu upotrebu obuhvata zaštitni mantil, zaštitnu kapu, 2 para rukavica za jednokratnu upotrebu⁵¹, kao i zaštitne jednokratne navlake za obuću.

Dental patients should be divided into 2 groups: Group 1 – patients for whom there will be no machine-generated aerosol, and Group 2 – patients for whom there will be a machine-generated aerosol.

Group 1 – patients for whom there will be no machine-generated aerosol

For patients in Group 1, where dental interventions are performed that do not require the use of handpieces, which cannot produce aerosol through the use of compressed air for their work, the following protective measures are applied: wearing a respiratory face mask that has the ability to stop particles the size of 0.3μ with an filtration efficiency of 95%; these masks are marked differently (although they are the same in characteristics), dependent on the country of origin: N95 (USA code), KN95 (China code), KF94 (Korea code), and FFP2 (EU code and UK code)^{41,42}. These masks are disposable and changed every 20-30 minutes if exposed to intense spraying with liquids, aerosols, etc., or after 1 hour in normal "dry" working conditions^{43,44}. This type of mask also has the ability to protect against aerosols and large droplets of fluid, which are created in dental work^{2,45,46,47}. The effectiveness of protection with these masks is reflected in the fact that they retain particles the size of $1-5\mu$ with 95% success^{2,48}, and indicates that they can provide protection for dental staff. It should be noted that they do not provide such protection if placed incorrectly, if not applied close-fitting to the face and if worn by a person with a beard⁴⁹. The use of protective visors and goggles are mandatory parts of the personal protective equipment of dentists and other staff. It is desirable that the goggles be waterproof and the visor ergonomically shaped, because the dentist is in very close contact with the patient's face in the course of their work, so the inadequate dimensions of the visor and its shape interfere with dental work. Combinations of waterproof glasses and face-shaped visors are the most functional (Figure 1).

Other disposable protective materials include a disposable protective coat, a protective cap, 2 pairs of disposable gloves⁵¹, as well as protective disposable shoe covers (overshoes).



Slika 1. Vodonepropusne zaštitne naočare i prema licu anatomske oblike oblikovani vizir⁵⁰

Figure 1. Waterproof goggles and anatomically shaped face visor⁵⁰

2. grupa – pacijenti kod kojih će prilikom intervencije nastati mašinski stvoreni aerosol

Stomatološke procedure kao što su: preparacija zuba (brušenje zuba) u protetskim intervencijama, preparacija kavita zuba, restaurativna stomatologija, endodontska terapija kanala korena zuba, korišćenje ultrazvučnih skidača naslaga sa zuba, mašinsko poliranje zuba, parodontalna hirurgija, implantološke operacije, kompleksne operacije iz oralne i maksilofacijalne hirurgije predstavljaju visoko rizične intervencije. U toku izvođenja rizičnih procedura, stvara se obilje tečnosti i aerosola, uz moguću pojavu krvi u aerosolu, koji se potpomognuti vazduhom pod pritiskom iz stomatoloških nasadnih instrumenata i mašina, šire u vazduhu oko stomatološkog tima, na radni sto stomatološke mašine, na enterijer u ordinaciji, ispunjavajući radni prostor ordinacije. Zbog toga je potrebno koristiti N95 respiratorne maske sa najvećim stepenom zaštite, stepenom zaštite 2 i 3, koje imaju efikasnost filtracije, tj. zadržavanja submikronskih čestica, od $\geq 98\%$ ⁴². Maske se menjaju posle svakog pacijenta, posle produženih procedura i nakon svakih 20 minuta, u visoko aerosoliziranim sredinama⁴². Zaštita očiju i lica, odnosno mukoze očiju i nosa, mora biti urađena vodonepropusnim zaštitnim naočarima i, dopunski, zaštitnim vizirom. Moguće je da se zaštita mukoze očiju, nosa i usta, odnosno kompletног lica stomatologa, uradi i industrijski posebno dizajniranim facijalnim vizirom u vidu maske za celo lice, koji ima sopstveni motor za dotok filtriranog vazduha u masku i koji sprečava kontaminaciju mukoze oka, nosa i usta putem stvorenog tečnog ili čvrstog aerosola u vazduhu (Slika 2).



Slika 2. Vodonepropusna zaštitna maska celog lica sa posebnim filterom za vazduh i mikromotorm za ubacivanje filtriranog vazduha u masku⁵²

Figure 2. Specially designed facial visor in the form of a mask for the whole face with a special air filter and a motor for inserting filtered air into the mask⁵²

Group 2 – patients for whom there will be a machine-generated aerosol

Dental procedures, such as: tooth preparation (tooth grinding) in prosthetic interventions, tooth cavity preparation, restorative dentistry, endodontic therapy of tooth root canals, use of ultrasonic dental plaque removers, machine tooth polishing, periodontal surgery, implant surgery, complex oral and maxillofacial surgeries, represent high-risk interventions. During the performance of the described procedures, an abundance of liquid and aerosol or blood in aerosol is formed, which, aided by compressed air from dental handpieces and equipment, under pressure, spreads into the air around the dental team, onto the dental equipment workbench, onto the interior in the office, filling the working space of the office. For this reason, N95 respiratory masks with the highest degree of protection, protection levels 2 and 3, which have filtration efficiency, i.e. retention of submicron particles with an efficiency of $\geq 98\%$, need to be used⁴². Face masks are changed after each patient, after extended procedures and after each 20 minutes in highly aerosolized environments⁴². Protection of the eyes and face, i.e. mucous membranes of the eyes and nose must be done with waterproof goggles and additionally with a protective visor. It is possible to protect the mucous membranes of the eyes, nose and mouth, i.e. the entire face of the dentist with a special industrially designed facial visor in the form of a full face mask, which has its own motor for filtering

Poželjna je i upotreba koferdama²⁶, u cilju smanjenja mogućnosti transmisije virusa, kao i jačih stomatoloških usisnih aspiratora²⁶. Ostali zaštitni materijali za jednokratnu upotrebu obuhvataju vodonepropusni zaštitni mantil, vodonepropusnu kapu, 2 para rukavica za jednokratnu upotrebu⁵¹, kao i zaštitne jednokratne kaljače (nazuvice), koje su takođe vodonepropusne.

Sve ove zaštitne mere odnose se i na asistente, stomatološke sestre i ostalo osoblje koje je u ordinaciji u toku rada sa pacijentima. Poželjno je da se sa pacijentima dogovori više intervencija u toku jedne posete stomatologu, kada god je to moguće^{9,26}.

Skidanje zaštitne opreme

Posle završenog rada sa pacijentom sledi postupak skidanja zaštitne opreme, koji treba sprovesti disciplinovano i po određenom redosledu. Tokom postupka mora biti prisutna osoba koja je zadužena samo za ovaj postupak. Prvo se sestri, koja je učestvovala u radu, prskaju spoljašnje rukavice dezificijensom (alkohol 70% – 75%, 0,5% sveže napravljenim natrijum-hipohlorit-varikinom, benzalkonijum-hloridom-asepsolom $\geq 1\%$), zatim se pozadi otkopčava vodonepropusni zaštitni mantil i svlači u celosti sa spoljašnjim rukavicama i ostavlja u kontejner za kontaminirani material, skidaju se jednokratne zaštitne navlake za obuću (kaljače) i takođe odlažu u kontejner za kontaminirani material. Zatim se skidaju zaštini vizir i naočare i prskaju dezificijensom i odlažu u kontejner za dezinfekciju. Sledi prskanje unutrašnjih rukavica dezificijensom i na kraju se skida maska, i to tako što se otpozadi, iza uva, hvata vrpca maske i skida sa lica i odlaže u kontejner za otpad. Sledi ponovni postupak dezinfekcije prskanjem unutrašnjih rukavica i navlačenje novih spoljašnjih nekontaminiranih rukavica, odlazak u svlačionicu, skidanje rukavica, antiseptičko pranje ruku i presvlačenje angažovanog zdrastvenog radnika u novu, čistu radnu bluzu i čiste radne pantalone, dok se korišćena radna odeća odlaže u kontejner za medicinski veš. Treba napomenuti da zdrastveni radnici koji rade sa rizičnim pacijentima menjaju radnu odeću svakog dana. Isti postupak odnosi se na stomatologa, kao i na svakog od članova stomatološkog osoblja, koje je učestvovalo u radu. U nastavku sledi kompletan dezinfekciju ordinacije i instrumenata, po uobičajnom postupku sprečavanja infekcije putem transmisije mikroba, virusa i gljivica u zdrastvenim ustanovama²⁶.

air into the mask, and which prevents contamination of the mucosa of the eyes, nose and mouth from the liquid or solid aerosol formed in the air (Figure 2).

The use of rubber dams²⁶, as well as stronger dental suction aspirators²⁶, is also desirable in order to reduce the possibility of virus transmission. Other disposable protective materials include a waterproof protective coat, a waterproof cap, 2 pairs of disposable gloves⁵¹, as well as protective disposable shoe cover that need to be water resistant.

All these protective measures also apply to assistants, nurses and other staff who are in the office while working with patients. It is advisable to arrange several interventions with patients during one visit to the dentist, whenever possible^{9,26}.

Removal of protective equipment

After finishing the work with the patient, the procedure of removing the protective equipment follows, which needs to be carried out in a disciplined manner and in a certain order. During this procedure, there must be a person who is responsible only for this procedure. Firstly, the outer gloves of the nurse who participated in the work are sprayed with disinfectant (alcohol 70-75%, 0.5%, freshly made sodium-hypochlorite – bleach, benzalkonium chloride – asepsol $\geq 1\%$), then the back of the protective coat is unbuttoned and fully taken off with outer gloves, and outer shoe cover and disposed of into a container for contaminated material. The protective visor and goggles are then removed, sprayed with disinfectant and placed into a disinfection container. This is followed by spraying the inner gloves with disinfectant. In the end, the mask is removed by taking the tape of the mask behind the ear, removing it from the face and placing it into a waste container. This is followed by a re-disinfection procedure by spraying the inner gloves, removing the inner shoe cover, and disposing of them into a container for contaminated material. This is followed by re-spraying the inner gloves with disinfectant, putting on new uncontaminated gloves, going to the locker room, removing the gloves, antiseptic hand washing and changing into a new, clean work blouse and pants for the health worker involved in the work, while the used work clothes are to be stored in the medical laundry container. It should be noted that health workers who work with high-risk

Zaključak

Od izuzetne je važnosti sprovođenje jedinstvene doktrine zaštite stomatološkog osoblja od mogućeg zaražavanja SARS-CoV-2 virusom, kao i sprečavanje zaražavanja drugim patogenim uzročnicima bolesti, u toku izvođenja stomatoloških intervencija. Ovaj postupak je izuzetno delikatan, s obzirom na to da je stomatološka profesija najugroženija profesija, sa mogućnošću zaražavanja od 100%. Glavne zaštitne mere stomatološkog osoblja odnose se na zaštitu od mašinom stvorenog aerosola, koji može da sadrži SARS-CoV-2 virus zaraženog pacijenta. Korišćenje vodonepropusne jednokratne zaštitne opreme, zajedno sa vodonepropusnim naočarima, zaštitnim vizirima, respiratornim maskama N95, sa visokim stepenom zadržavanja submikronskih čestica, sa efikasnošću od $\geq 98\%$, kao i korišćenje vodonepropusne maske za celo lice, predstavljaju moguće sigurnosne mere u sprečavanju transmisije SARS-CoV-2 virusa na stomatološko osoblje.

patients need to change their work clothes every day. The same procedure applies to the dentist, and to each of the staff members who participated in the work. What follows is a complete disinfection of the office and instruments according to the usual procedure for preventing the transmission of microbes, viruses and fungi in healthcare facilities²⁶.

Conclusion

It is extremely important to implement a unique doctrine for the protection of dental staff from possible infection with the SARS-CoV-2 virus, as well as the prevention of infection with other pathogens that cause diseases during dental interventions. This procedure is extremely delicate, considering the fact that the dental profession is the most endangered profession with the possibility of infection of 100%. The main protective measures of the dental staff are related to the protection against machine-generated aerosols that may contain the SARS-CoV-2 virus of an infected patient. The use of waterproof disposable protective equipment, along with waterproof goggles, protective visors, N95 face respirators with a submicron particle retention rate of $\geq 98\%$, and the use of a full-face waterproof mask are possible safety measures for preventing the SARS-CoV-2 transmission to the dental staff.

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