# O ZNAČAJU HIGIJENSKIH MERA U SUZBIJANJU INFEKTIVNIH BOLESTI KOJE SE PRENOSE RESPIRATORNIM PUTEM

PISMO UREDNIKU

LETTER TO THE EDITOR

# ON THE IMPORTANCE OF HYGIENIC MEASURES IN THE CONTROL OF AIRBORNE INFECTIOUS DISEASES

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Poštovano uredništvo,

Infektivne bolesti su se tokom istorije čovečanstva najviše širile u obliku epidemija, a kao odgovorni za njihovu pojavu su već duže vreme označeni patogeni mikroorganizmi. Međutim, patogeni mikroorganizmi čine samo mali deo mikrobioma ljudi, životinja i biljaka [1].

Da bismo razumeli ulogu mikroorganizama u etiologiji bolesti, moramo imati na umu da uslovi okoline u kojima se nalaze mikroorganizmi igraju odlučujuću ulogu u njihovom funkcionisanju u odnosu na životnu sredinu, a time i u odnosu na domaćine, kao njihovo specifično okruženje.

U akutnim zaraznim bolestima patogeni mikroorganizam najčešće stimuliše razne litičke, pre svega proteolitičke reakcije, pomoću različitih proteaza [2-5], pa prema tome on ima ulogu katalizatora patološkog procesa. Uloga katalizatora je samo da ubrza reakciju, pri čemu je ne može pokrenuti ili promeniti ravnotežni položaj reakcije [6]. Stoga, bar kada je reč o zapaljenskom procesu, takozvani biološki uzroci bolesti nisu stvarni uzroci, već samo katalizatori već postojećeg patološkog procesa, dok su stvarni neposredni uzroci po svojoj prirodi samo fizički ili hemijski faktori. Otuda ekstremna varijabilnost lokacije i intenziteta patoloških procesa sa istim biološkim uzročnikom kod različitih jedinki iste vrste domaćina. Otuda i jasno određenje većine mikroorganizama koji mogu da „izazovu" bolest kao oportunističkih patogena, za razliku od takozvanih striktnih patogena [7]. Međutim, „striktni" patogeni

Dear Editors,

Infectious diseases have spread primarily in the form of epidemics throughout the history of mankind and pathogenic microorganisms have long been held responsible for their occurrence. However, pathogenic microorganisms make up only a small portion of the microbiome of humans, animals and plants [1].

In order to understand the role of microorganisms in disease etiology, we have to remember that the environmental conditions in which microorganisms are found play a decisive role in their functioning in relation to the environment, and thus in relation to their hosts, as their specific environment.

In acute infectious diseases, the pathogenic microorganism most commonly stimulates various lytic, primarily proteolytic reactions, through various proteases [2-5], thus it has a role of catalyst in the pathological process. The role of catalyst is only to accelerate the reaction, it cannot initiate the reaction, nor can it change the equilibrium position of the reaction [6]. Therefore, at least when it comes to the inflammatory process, the so-called biological causes of disease are not the actual causes, but only catalysts of an already existing pathological process, while the real immediate causes are, by their nature, only physical or chemical factors. Hence, the extreme variability of both the location and intensity of pathological processes with the same biological causative agent in different individuals of the same host species. Consequently, the clear designation of most microorganisms that can "cause" the disease as

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su u osnovi takođe oportunistički, uslovni patogeni, u smislu da su im potrebni odgovarajući uslovi okoline da bi se manifestovala njihova patogenost, ali se oni razlikuju od uslovnih patogena samo po tome što ne mogu da prežive u različitim uslovima, zbog loše prilagodljivosti promenama u svojem okruženju. Dakle, patogenost i virulentnost mikroorganizama nisu njihova inherentna i nepromenljiva svojstva, već su samo rezultat patogenosti neživih faktora okoline koji deluju na domaćina i koji često ostaju van fokusa medicinskih istraživanja.

„Učiteljica života", istorija, daje nam odgovor na pitanje od glavne praktične važnosti - kako sprečiti pojavu zaraznih bolesti? Čak i pre otkrića zaraznih agenasa i specifičnih antimikrobnih lekova, mnoge higijenske mere bile su dovoljne da suzbiju većinu zaraznih bolesti, poput kolere i kuge u ranijim vekovima, koje su se javljale u obliku epidemija koje su desetkovale ljudsku populaciju. One su svedene na zanemarljivu učestalost u sredinama u kojima su primenjene takve mere. Konkretno, uvođenje kanalizacionog sistema i stalno uklanjanje čvrstog, posebno organskog otpada iz naseljenih područja doprineli su da nekadašnje epidemije kolere i kuge padnu u zaborav. Tako je, na primer, kuga uspešno kontrolisana direktnim merama deratizacije i dezinsekcije [8], a redovno uklanjanje čvrstog otpada sigurno je doprinelo kontroli vektora i kuge i drugih opasnih zaraznih bolesti, jer je uklonjeno plodno tlo za održavanje i umnožavanje odgovarajućih vektora. Suzbijanje kolere ostvareno je uvođenjem higijenski bezbednog snabdevanja vodom za piće [9], a u Srbiji je, 1915. godine, eliminisana stravična epidemija pegavog tifusa razvojem i sistematskim korišćenjem takozvanog srpskog bureta, a bez značajnog doprinosa bilo kakvih specifičnih antimikrobnih ili imunostimulišućih lekova [10].

Do sada je zajednica učinila puno na unapređenju higijenskih standarda ličnog i porodičnog stanovanja, procesa u proizvodnji hrane i stočarstvu, sigurnog odlaganja komunalnog čvrstog i tečnog otpada, kao i na higijeni poslovnih objekata i procesa. Međutim, jedan važan segment higijenske prakse ostao je, do danas, prilično nerazvijen i zanemaren, a to je briga o higijeni atmosfere, pre svega atmosfere ljudskih naselja. Danas se atmosfera neprekidno i sistematski zagađuje određenim gasovima, parama, kao i česticama, uključujući radioaktivne, toksične i zarazne čestice. Direktni rezultat ovog stanja razvoja higijenske prakse je da su danas jedina vrsta epidemije koja pogađa opštu populaciju, epidemije koje se šire putem atmosfere, naime respiratorne epidemije. I dok veći deo javnosti vidi specifičnu vakcinu kao jedinu nadu za spas od trenutne respiratorne pandemije COVID-19, malo ko razume da bi to mo-

opportunistic pathogens, as opposed to the so-called strict pathogens [7]. However, "strict" pathogens are basically also opportunistic, conditional pathogens, in the sense that they need appropriate environmental conditions in order to manifest their pathogenicity. However, they differ from conditional pathogens only in that they cannot survive in different conditions, due to their poor adaptability to changes in their environment. Thus, pathogenicity and virulence of microorganisms are not their inherent and invariable properties, they are merely the result of pathogenicity of inanimate environmental factors, which act on the host, and which usually remain out of the focus of medical research.

"Life's teacher" – history, offers the answer to the question of key practical significance: how do we prevent the occurrence of infectious diseases? Even before the discovery of infectious agents and specific antimicrobial drugs, many hygienic measures were sufficient to reduce most infectious diseases, such as cholera and plague in earlier centuries, which broke out in the form of epidemics that decimated the human population. These infections were reduced to a negligible incidence in the environments where such measures were applied. In particular, the introduction of the sewage system and the regular removal of solid, especially organic waste from populated areas have contributed to the past epidemics of cholera and plague falling into oblivion. Thus, for example, plague was successfully controlled by direct deratization and disinsection measures [8], and regular solid waste removal certainly contributed to the control of vectors of both plague and other dangerous infectious diseases, by removing the substrate necessary for the preservation and the multiplication of the appropriate vectors. The control over cholera was established by the introduction of a hygienically safe supply of drinking water [9] and, in Serbia, in 1915, a terrible epidemic of spotted fever was eliminated by developing and systematically using the so-called Serbian barrel, without significant contribution of any specific antimicrobial or immunostimulating drugs [10].

So far, the community has made significant strides in the improvement of hygienic standards of personal and family housing, processes in food production and animal husbandry, the safe disposal of municipal solid and liquid waste, as well as in the domain of the hygiene of business facilities and processes. However, one important segment of hygiene practice has remained quite undeveloped and neglected to this day, and that is the care for the hygiene of the atmosphere, primarily the atmosphere of human settlements. Today, the atmosphere is constantly and systematically polluted with specific gases, vapors as well as particles, including radioactive, toxic and infectious particles. The direct result of this state of development of hygiene practice is that, nowadays, the only type of ep-

glo biti samo privremeno rešenje problema. Na primer, nedavno je javno izneto mišljenje nekih medicinskih stručnjaka da bi, čak i nakon eventualne eliminacije COVID-19 samo vakcinacijom, mogao kasnije da sledi neki COVID-22, -23 ili -24, i tako u nedogled. Ovakvo predviđanje se može izvesti direktno iz lekcija istorije, uključujući i one prethodno spomenute. Šta bi se, na primer, dogodilo kada bismo se danas borili protiv kuge i kolere samo vakcinama i antibioticima, a s druge strane nastavili da živimo u naseljima u kojima se neprestano nagomilavaju ljudski i životinjski izmet i čvrsti organski otpad? Odgovor je da bismo u tom slučaju sigurno mogli očekivati stalnu pojavu novih, otpornijih sojeva patogenih bakterija ili drugih patogena i ponovnu pojavu bolesti u drugim oblicima, jer same vakcine i antibiotici ne bi bili dovoljni da poništе povoljne uslove za održavanje i razvoj bolesti.

Da bi se postigla trajna kontrola širenja respiratornih epidemija, potrebno je uvesti trajne i sistematske mere za održavanje higijene atmosfere ljudskih naselja. Za početak, bilo bi potrebno da se usredsredimo na uklanjanje zagađenja česticama, jer ne zaboravimo da su virusi i bakterije koje prouzrokuju respiratorne bolesti čestice u svom fizičkom obliku. Ali, važnije od fizičkog uklanjanja zaraznih mikroorganizama iz atmosfere bilo bi uklanjanje otrovnih čestica u atmosferi, koje same po sebi izazivaju patološki proces, koji mikroorganizmi onda samo ubrzavaju. Što se tiče štetnih sastojaka u atmosferi savremenih gradova, grupa stručnjaka američke Agencije za zaštitu životne sredine zaključila je da su trenutni standardi za sadržaj čestica PM2,5 u vazduhu nedovoljni za zaštitu javnog zdravlja, a ovaj zaključak je zasnovan na značajnim i sveobuhvatnim dokazima iz epidemioloških studija, toksikoloških studija na životinjama i studija kontrolisane izloženosti ljudi [11].

Iako se javno zdravstveni odgovor na toksičnost čestica, kao nejasan rizik koji uglavnom ima posledice u dužem vremenskom periodu, može odložiti na neko vreme, nedavna istraživanja pokazuju da toksične čestice u atmosferi igraju ključnu ulogu u širenju trenutne pandemije COVID-19 i da stoga njihovo sistematsko uklanjanje predstavlja cilj visokog prioriteta za javno zdravlje. Tako je, na primer, utvrđena nesporna i visoka korelacija između koncentracije čestica PM2,5 u vazduhu, s jedne strane, i incidencije i mortaliteta od COVID-19, s druge strane [12-15].

Najveće površine na kojima se talože čestice organskog i neorganskog porekla su otvoreni javni prostori, ulice, trgovi, parkovi itd. Nataložene čestice se prirodnim padavinama ispiraju i odvode na niži teren, tako da naselja na uzvišenjima imaju prednost u odnosu na naselja u ravnici. Ali, u sušnim periodima, bez obidemic affecting the general population are epidemics of diseases that spread through the atmosphere, i.e., epidemics of respiratory (airborne) diseases. While the majority of the public sees the specific vaccine as the only hope of salvation from the current respiratory COVID-19 pandemic, very few understand that the vaccine might be only a temporary solution to the problem. For example, some medical professionals have recently publicly expressed the opinion that, even after the possible elimination of COVID-19 solely by means of vaccination, subsequently, a COVID-22, -23 or -24, may follow, and so on, indefinitely. This prediction can be deduced directly from the lessons of history, including those mentioned above. For example, what would happen if, at this day and age, we fought plague and cholera only with vaccines and antibiotics, and on the other hand continued to live in settlements where human and animal excrements and solid organic waste accumulated continuously? The answer is that in that case we could certainly expect a constant emergence of new, more resistant strains of pathogenic bacteria or other pathogens and the reappearance of diseases in altered forms, because vaccines and antibiotics alone would not be sufficient to nullify the favorable conditions for disease persistence and development.

For the purpose of achieving permanent control over the epidemics of airborne diseases, there is a need to introduce permanent and systematic measures to maintain the hygiene of the atmosphere of human settlements. For a start, we should focus on removing particle pollution, as we mustn't forget that viruses and bacteria causing respiratory diseases are, in their physical form, particles. However, what would be more important than physically removing infectious agents from the atmosphere is the removal of toxic particles from the atmosphere, which themselves cause a pathological process, which is then merely accelerated by microorganisms. Regarding harmful ingredients in the atmosphere of modern cities, a group of experts of the US Environmental Protection Agency concluded that the current PM2.5 standards are insufficient to protect public health, and this conclusion was based on substantial and comprehensive evidence from epidemiologic studies, toxicologic studies on animals, and controlled human exposure studies [11].

While public response to particulate matter toxicity, as an obscure risk that mainly has consequences in the long term, may be delayed for some time, recent research indicates that toxic particles in the atmosphere play an essential role in spreading the current COVID-19 pandemic, and that therefore their systematic removal is a high public health priority. Thus, for example, an undeniable and high correlation was found between the concentration of PM2.5 particles in the air, on one hand, and both incidence and mortality from COVID-19, on the other [12-15].

zira na konfiguraciju tla, čestice ostaju na tlu i zatim se strujanjem vazduha neprestano podižu u atmosferu. U prošlosti su javna komunalna preduzeća povremeno prala ulice, prvenstveno kolovoze, što je očigledno retka praksa u današnje vreme. Danas je golim okom vidljivo da se u većim naseljima neprestano stvara prašina, kako u saobraćaju, tako i tokom aktivnosti građevinskih firmi, tokom procesa sagorevanja goriva u toplanama i preduzećima, kao i sagorevanjem čvrstih materija u kućama, na privatnim i javnim površinama. Zbog toga postoji potreba za redovnim (npr. svake noći posle suvog dana, a bez jakog vetra) pranjem javnih površina. Poželjno je da se to izvodi hlorisanom ili ozonovanom vodom da bi se izvršila kako dezinfekcija zarazne prašine, tako i detoksikacija toksičnih organskih čestica [16,17]. Ovo svakako podrazumeva stalni porast obima redovnog rada, kao i standardizaciju kvaliteta rada javnih komunalnih preduzeća, odnosno preduzeća čiji bi se zadatak zasnivao na javno-privatnom partnerstvu, uz trajnu javnu kontrolu kvaliteta rada ovih preduzeća.

Pored redovnog čišćenja javnih površina od čvrstih čestica, neophodno je obavezati najvažnije generatore čestica (građevinska preduzeća, toplane, vozila) na sve moguće mere zadržavanja čestica na izvoru, uz njihovo sigurno odlaganje. Takođe treba posvetiti dužnu pažnju redovnoj dezinfekciji zatvorenih javnih prostora (zgrade javne uprave, bolnice, škole, kulturne institucije, itd.). Trenutno, kao moguća praktična opcija, postoji postupak noćnog ozoniranja prostorija ozonizatorima na bazi električnog luka [18] ili UV lampama od 185 nm [19]. Ove mere svakako treba pažljivo planirati i pripremiti za sprovođenje, a po verifikaciji njihovog efekta u manjim oglednim zajednicama, ne bi trebalo da ih i dalje posmatramo kao privremene mere, već kao mere koje su trajne i održive isto kao i mere lične higijene, vodovoda i kanalizacije i odlaganja čvrstog otpada.

Zdravstveni radnici i saradnici bi svakako trebalo da se založe i pomognu u uvođenju ovih i drugih neophodnih higijenskih mera za zaštitu atmosfere i odbranu od respiratornih infekcija, i da tako na najbolji način doprinesu daljem unapređenju javnog zdravlja.

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The largest areas where particles of organic and inorganic origin are deposited are open public spaces, streets, squares, parks, etc. The deposited particles are washed away by natural precipitation and drained to lower areas, so that the settlements on elevated terrain are at an advantage, in that respect, over the settlements located on lower terrain. However, in dry periods, regardless of the ground surface configuration, particles remain on the ground and are then constantly lifted into the atmosphere by air flow. In the past, public utility companies occasionally washed the streets, primarily roads, which is obviously a rare practice nowadays. Today, it is visible to the naked eye that dust is constantly being generated in larger settlements, both in traffic, as well as during the activities of construction companies, during processes of burning fuel in heating plants and companies, as well as by burning solid materials in houses, private and public areas. Therefore, there is a need for regular (e.g., every night after a dry day with no strong wind) washing of public areas. It should preferably be done with chlorinated or ozonated water so as to inactivate infectious dust, as well as to detoxify toxic organic particles [16,17]. This certainly implies a permanent increase in the extent of regular work as well as the standardization of performance quality of public utility companies, or companies whose task would be based on public-private partnership, with permanent public control of the performance quality of these companies.

In addition to the regular cleaning of public areas from particulate matter, it is necessary to compel major particle generators (construction companies, heating plants, vehicles) to apply all available measures for retaining particles at their source, and safely disposing of them. Due attention should also be paid to regular disinfection of closed public spaces (public administration buildings, hospitals, schools, cultural institutions, etc.). As a current practical option, there is a procedure of night ozonation of rooms with arc-based ozonizers [18] or UV lamps of 185 nm [19]. These measures should certainly be carefully planned and prepared for implementation, and, upon verification of their effect at sentinel sites, they should cease to be seen as temporary measures, but rather measures that are as permanent and sustainable as personal hygiene measures, water supply, and sewage system and solid waste disposal.

Health professionals should certainly take every possible step to advocate and help to introduce these and other necessary hygiene measures aimed at protecting the air we breathe and defending against airborne infections, and thus contribute in the best way to the further improvement of public health.

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