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Upravljanje zdravstvenim rizicima od mikrobioloških opasnosti pri korištenju voda bazena za kupanje i rekreaciju

Bogoljub Antonić[1], Branislav Mihajlović[1], Darijana Antonić[2]
[1] Panevropski univerzitet ''Apeiron'' Banja Luka
[2] Institut za javno zdravstvo Banja Luka

Korespondencija:
Bogoljub Antonić
Panevropski univerzitet ''Apeiron''
Pere Krece 13, 78000 Banja Luka, Bosna i HercegovinaE-mail: bogoljub.a@apeiron-uni.eu

Sažetak: Potreba za rekreacijom kao jednim od načina održavanja psihofizičkog zdravlja i radne sposobnosti, je bitna potreba savremanog čovjeka. Značajan broj ljudi, povremeno ili stalno, koristi u te svrhe bazene. Međutim, rekreativne aktivnosti na bazenima, ali i korištenje bazena u svrhu liječenja ili oporavka, mogu da ugroze zdravlje, tako da je neophodno odgovarajuće upravljanje bazenima kako bi se taj uticaj sveo na što manju mjeru.
Korisnici bazena izloženi su različitim opasnostima od kojih je rizik obolijevanja prouzrokovan mikrobiološkom kontaminacijom vode bazena najveći. Rizik bolesti ili infekcija zbog korištenja bazena povezan je, u prvom redu, sa fekalnom kontaminacijom vode zbog fecesa kupača ili fekalnom kontaminacijom vode sa kojom se puni bazen. Patogeni mikroorganizmi predstavljaju najčešći i najrašireniji zdravstveni rizik vezan za vodu kao sredinu zbog pojava infektivnih bolesti izazvanih bakterijama, virusima i parazitskim protozoama.
Prećišćavanje vode smanjuje dijelom taj rizik, ali se najveća mjera sigurnosti korisnika može ostvariti tek dezinfekcijom vode u bazenu. Kulatura i samodisciplina kupača su doprinosni činioci njenoj bezbijednosti.
Razmatranje problema upravljanja mikrobiološkim kvalitetom vode u bazenima, izloženo u ovom radu, bazira se najvećim dijelom na odgovarajućim Preporukama Svjetske zdravstvene organizacije (WHO, 2000).

Ključne riječi: bazeni, voda, mikroorganizmi, opasnosti, rizici

Uvod

Korištenje voda za rekreaciju ili liječenje veoma mnogo znači u održavanju zdravlja i radne sposobno-

The Management of Health Risks From Microbiological Dangers While Using Swimming Pool Water for Swimming and Recreation

Bogoljub Antonić[1], Branislav Mihajlović[1], Darijana Antonić[2]
[1] Pan-European University ''Apeiron'' Banja Luka
[2] Public Health Institute Banja Luka

Correspondence:
Bogoljub Antonić
Pan-European University ''Apeiron''
Pere Krece 13, 78000 Banja Luka, Bosnia and Herzegovina
E-mail: bogoljub.a@apeiron-uni.eu

Summary: The need for recreation as one of the ways of maintaining psychophysical health and work ability is an important need of modern man. Significant number of people, periodically or continually, uses swimming pools for those purposes. On the other hand, recreational activities at the swimming pools, as well as using swimming pools for the purposes of healing and recovery, can jeopardize health, therefore an adequate swimming pool management is necessary in order to decrease that influence to the minimum.
Users of swimming pools are exposed to various dangers, of which the risk of becoming ill by microbiological contamination of the swimming pool water is the greatest. The risk of illness or infection because of using a swimming pool is primarily connected to faecal contamination of the water because of swimmers' faeces or faecal contamination of the water used for filling a swimming pool. Pathogen microorganisms represent a most common and widespread health risk related to water as an environment because of infective disease occurrences caused by bacteria, viruses and parasite protozoa.
Water purification partially decreases that risk, but the greatest safety measure for users can be achieved only by disinfection of the water in the swimming pool. Swimmers' culture and self-discipline are factors that contribute to water's safety.
Consideration of the swimming pool water microbiological quality management problem, presented in this work, is based on the correspondent Recommendations of the World Health Organization (WHO, 2000).

Keywords: swimming pools, microorganisms, dangers, risks

Introduction

Using water for recreation and healing means very much for maintaining health and work ability of a popula-

sti stanovništva. Značajan broj ljudi, povremeno ili stalno, koristi u te svrhe bazene. Međutim, rekreativne aktivnosti na bazenima, ali i korištenje bazena u svrhu liječenja ili oporavka, mogu da ugroze zdravlje, tako da je neophodno odgovarajuće upravljanje bazenima kako bi se taj uticaj sveo na što manju mjeru.

Upravljanje bazenima je relativno složena problematika i ovdje neće biti obuhvaćena u cjelosti, već će težište ovih razmatranja biti na, svakako, najvažnijem dijelu te problematike, a to je upravljanje kvalitetom vode u bazenima, tačnije upravljanje mikrobiološkim kvalitetom vode.

Razmatranje problema upravljanja mikrobiološkim kvalitetom vode u bazenima, izloženo u ovom radu, bazira se najvećim dijelom na odgovarajućim Preporukama Svjetske zdravstvene organizacije (WHO, 2000).

Rizici od mikrobioloških opasnosti

Korisnici bazena izloženi su različitim opasnostima od kojih je rizik obolijevanja prouzrokovan mikrobiološkom kontaminacijom vode bazena najveći. Potencijalni rizici po zdravlje usljed prisustva različitih hemikalija su znatno manji nego što je to rizik koji nosi prisustvo mikroorganizama. Prećišćavanje vode, ako se uopšte izvodi, smanjuje dijelom taj rizik, ali se najveća mjera sigurnosti korisnika može ostvariti tek dezinfekcijom vode u bazenu.

Pošto se voda, često, javlja kao sredstvo transmisije različitih infektivnih agenasa, mikrobiološke karakteristike predstavljaju značajan parametar kvaliteta svake vode. U najširem smislu, voda je uvijek bila u osnovi pojave raznih infekcija kod čovjeka, bilo preko: digestivnog trakta (feko-oralna transmisija ingestijom kontaminirane vode) ili preko muko-kutane barijere (transmisija kontaktom se kontaminiranom vodom)$_1$.

Patogeni mikroorganizmi predstavljaju najčešći i najrašireniji zdravstveni rizik vezan za vodu kao sredinu zbog pojava infektivnih bolesti izazvanih bakterijama, virusima i parazitskim protozoama. Sem fekalnih patogena, brojni ostali infektivni mikroorganizmi mogu biti prenijeti sa bolesnih korisnika bazena na ostale korisnike. Isto tako, oprema bazena i sama voda u bazenu, kao i ventilacioni sistem ili sistem za kondicioniranje vazduha, mogu biti stanište pojedinih akvatičnih bakterija i ameba koje mogu izazvati razne infekcije i bolesti respiratornog sistema, kože pa i CNS. Pogotovo su kao stanište pogodni bazeni za terapiju sa svojom, po pravilu, toplom vodom, često, bogatom solima i ostalim nutrijentima.

tion. Significant number of people, occasionally or permanently, uses swimming pools for that purpose. On the other hand, recreational activities in swimming pools, as well as using pools with a purpose of healing or recovery, can jeopardize health so it is necessary to adequately manage swimming pools in order to decrease the bad influence as much as possible.

The pool management is a relatively complex problem and will not be included here entirely, but the focus of this consideration will be, of course, on the most important aspect of the problem, that is on the swimming pool water quality management, or more precisely, on the water's microbiological quality management.

Consideration of the swimming pool water microbiological quality management problem, presented in this work, is based on the correspondent Recommendations of the World Health Organization (WHO, 2000).

Risks of Microbiological Dangers

Users of swimming pools are exposed to various dangers, of which the risk of becoming ill by microbiological contamination of the swimming pool water is the greatest. Potential health risks because of the presence of various chemicals are significantly lesser than risk caused by the presence of microorganisms. The water purification, if it is performed at all, decreases that risk, but the greatest safety measure for users can be achieved only by disinfection of the swimming pools water.

Since water often appears as a means of transmission of various infective agents, microbiological characteristics represent a significant parameter of any water. In its broadest sense, water has always been in the centre of occurrences of various human infections, whether through digestive tract (feco-oral transmission by ingestion of contaminated water) or through muco-cutaneous barrier (transmission by contact with contaminated water)$_1$.

Pathogen microorganisms represent most common and widespread health risk related to water as an environment because of occurrences of infective diseases caused by bacteria, viruses and parasite protozoa. Besides faecal pathogens, numerous other infective microorganisms can be transferred from ill swimming pool users to other users. In the same way, swimming pool equipment and the water in the swimming pool itself, as well as ventilation system or air conditioning system, can be a habitat of certain aquatic bacteria and amoebas which can cause various infections and respiratory system, skin and even CNS illnesses. Especially suitable as a habitat are swimming pools with their, normally, warm water, often rich with salts and other nutrients.

Osnovna mjera smanjenja rizika je izbjegavanje uslova i situacija koje vode povećanoj pojavi opasnosti, a jedna od najvažnijih preventivnih mjera je, svakako, upoznavanje osoba sa smanjenim imunitetom da izbjegavaju bazene zbog povećanog rizika za svoje zdravlje.

Najveća opasnost po zdravlje ljudi predstavlja kontaminacija vode humanim ili animalnim ekskretima, odnosno direktna ili indirektna fekalna kontaminacija[5]. Rizik pojave bolesti ili infekcije vodom iz bazena u suštini je najviše povezan sa: fekalnim zagađenjem od samih kupača ili sadržanim u samoj vodi izvorišta kojom se bazen napaja. Mnoge bolesti dobijene u bazenu, posljedica su slabog izvođenja dezinfekcije ili njenog potpunog izostanka[1].

Mnogi mikroorganizmi u vodi bazena vode porijeklo od samih kupača, odnosno korisnika (sa kože, sekreta iz nosa ili grla). Inficirani korisnici bazena mogu direktno da kontaminiraju vodu cijelog bazena, kao i površine objekta i materijala koje time neposredno postaju izvor zaraze za druge osobe koje dolaze u kontakt sa zagađenom sredinom.

Za pojave nekih epidemija sa sigurnošću je utvrđeno da vode porijeklo iz bazena, pri čemu se kao najveći krivci smatraju navike ljudi da koriste bazene i onda kada su bolesni, pa često ovi objekti za osvježenje i rekreaciju postaju leglo različitih bolesti i infekcije. Najčešće se kao uzročnici epidemija navode virusi, iako se u posljednje vrijeme incidenti dešavaju zbog prisustva bakterija i protozoa. Određene vrste gljiva takođe predstavljaju vrlo ozbiljne agense i uzročnike mnogih površinskih infekcija kože, kose, prstiju kupača.

Ukratko korištenje bazena (bilo otvorenog ili zatvorenog tipa) nosi sa sobom i određeni zdravstveni rizik povezan sa mikrobiološkim kvalitetom vode[1].

Dva su osnovna razloga mikrobiološke neispravnosti vode u bazenima i rizika koji se time javlja, a to su: neadekvatan tretman vode (prije svega neadekvatna dezinfekcija) i prisusvo samih korisnika (bilo bolesnih, bilo onih sa deficitarnom ličnom higijenom i nedovoljno edukovanih za ponašanje u takvim vodama), pa je u bazenskim vodama moguća identifikacija mikroorganizama u osnovi fekalnog i nefekalnog porijekla, kao što su virusi, bakterije gljive, parazitske protozoe.

Mikroorganizmi fekalnog porijekla

Kao najveći uzročnici pojave **virusnih infekcija** vezanih za vode navode se Adenovirusi, iako se često idetifikuju i virus Hepatitis A, Norwalk virus i Ecshvirus 30. Izvori ovih infektivnih agenasa su većinom nepoznati, dok se za neke pretpostavlja da su vezani za

The basic measure for risk reduction is avoiding conditions and situations that lead towards increased occurrence of dangers, and one of the most important preventive measures is, of course, informing people with lower immunity to avoid swimming pools because of increased risk for their health.

The greatest danger for people's health is water contamination by human or animal excretions, i.e. direct or indirect faecal contamination. The risk of occurrence of disease or infection by swimming pool water is essentially mostly connected to faecal pollution by swimmers themselves or present in the source of water by which the swimming pool is supplied. Many diseases caught in a swimming pool are a consequence of poorly performed disinfection or its total omission [1].

Many microorganisms in swimming pool water have origin from swimmers – that is users themselves (from their skin, nose secretion or throat). Infected users of a swimming pool can directly contaminate water of the whole swimming pool, as well as the surface of the object and materials which then become the source of infection for other people who come into contact with the polluted environment.

It is identified with certainty that some epidemics originated from swimming pools, whereby the habits of people who use swimming pools even when they are sick are recognized as main culprits, so these objects for refreshment and recreation become hotbed of disease and infection. Viruses are most often mentioned as the cause of epidemics, although recently there has been incidents caused by bacteria and protozoa. Certain types of fungi also represent the serious agents and a cause of many surface infections of swimmers' skin, hair or fingers.

In short, using swimming pools (whether open or indoor type) carries a certain health risk related to water's microbiological quality [1].

There are two main reasons for the microbiological contamination of swimming pool water and the correspondent risk, and these are: inadequate water treatment (primarily inadequate disinfection) and presence of users themselves (whether sick, with deficient personal hygiene or undereducated about how to behave in the water), so it is possible to identify microorganisms of faecal and non-faecal origin, such as viruses, bacteria, fungi and parasitic protozoa in swimming pool waters.

Microorganisms of Faecal Origin

Adenoviruses are mentioned as the greatest cause of **virus infection** occurrences, though there is also a frequent identification of the Hepatitis A virus, Norwalk virus and

fekalno zagađenje ili sekrete iz očiju i grla, odnosno vezani su za same korisnike bazena. U većini slučajeva, kod pojave virusnih infekcija, dokazano je da nivo hlorisanja nije bio djelotvoran, ili da sam sistem nije dobro funkcionisao[5].

Adenovirusi, najčešće će dati kod kupača groznicu, faringitis i konjuktivitis, ponekad glavobolju i anoreksiju.

Kontrola virusa u bazenima za kupanje uobičajeno se sprovodi ispravnom aplikacijom hlora ili drugiuh dezinfektanata, održavanjem koncentracije rezidualnog hlora od 0,4 mg/l. Uprkos tome što je ovaj nivo hlora efektivan, veće koncentracije organskih materija, koje dospijevaju u vodu bazena sa kože velikog broja kupača, mogu povećati potrebu za hlorom, što smanjuje ili sprečava dezinfekciono djelovanje. Slučajevi jakog zagađenja vode u bazenu, nastalog iznenadnom fekalnom kontaminacijom (izlučivanjem fecesa) od strane kupača ili povraćanjem se takođe ne može uspješno držati pod kontrolom sa normalnom koncentracijom hlora. Ako se voda bazena, inače, ne dezinfikuje (čest slučaj kod bazena i kada za terapiju) tada iznenadno fekalno zagađenje ili povraćanje, predstavlja još veći problem.

Jedini siguran pristup očuvanju sigurnog korištenja bazena u slučaju iznenadnog fekalnog zagađenja ili povraćanja je zabrana korištenja bazena, sve dok se kontantaminacija ne savlada.

Edukacija roditelja male djece kao i ostalih rekreativaca, je takođe od značaja, s obzirom da dobro higijensko okruženja bazena znači prevenciju u zaštiti i redukciju pojave akcidentalnih situacija vezanih za fekalno zagađenje.

Korisnici bazena, tebalo bi da se uzdrže od boravka u bazenu ukolko su oboljeli od infektivnih bolesti, pošto virusni patogeni mogu da se putem vode iz bazena prenesu na druge korisnike.

Bakterije fekalnog porijekla

Kao uzročnici raznih infekcija i akcidentnih situacija u bazenskim vodama bakterijske etiologije, najčešće, se spomnju dvije bakterije (Shigela spp i E. Coli) koje se uspješno kontrolišu hlorisanjem i drugim dezinficijensima pod normalnim uslovima rada bazena. Najveća opasnost potiče od iznenadnog fekalnog zagađenja, tako da je osnovna mjera odgovarajuća edukacija korisnika bazena. Međutim, ako do iznenadnog fekalnog zagađenja dođe, osnovna mjera je prekid korištenja bazena i pojačanje dezinfekcije. Problem je međutim kod bazena koji se ne dezinfikuju. Tu je zabrana korištenja jedina sigurna mjera, te pražnjenje bazena i njegova dezinfekcija.

Echovirus 30. The sources of these infective agents are mostly unknown, while for some it has been presumed to be related to fecal pollution or eye and throat secretions, i.e. are related to swimming pool users themselves. In most cases, when virus infection occurs, it has been proved that the level of chlorination was not effective, or that the system itself was not functioning well [5].

Adenoviruses will most commonly give users a fever, laryngitis and conjunctivitis, sometimes a headache and anorexia.

Virus control in swimming pools is usually conducted by correct application of chlorine or other disinfectants, by maintaining residual chlorine concentration at 0.4 mg/l. Despite the fact that this level of chlorine is effective; greater concentration of organic matter, which come off from the swimmers' skin into the swimming pool water, may increase the need for chlorine. Cases of severe pollution of swimming pool water, caused by sudden faecal contamination (faeces excretion) by swimmers or by vomiting, cannot be held under control by normal concentration of chlorine. If the swimming pool water is not disinfected (frequent case with swimming pools and therapy baths) then faecal pollution or vomiting represent even greater problem.

The only safe approach to preserve a safe use of swimming pools in the case of a sudden faecal pollution or vomiting is to ban the use of a swimming pool, as long as the contamination is not overcome.

Education of little children's parents as well as other recreational swimmers is also of importance, considering that good hygiene of a swimming pool means prevention and reduction of accidental situations related to faecal pollution.

Swimming pool users should abstain from staying in a swimming pool if they are sick from infective disease, since virus pathogens can be transferred by water to other users.

Bacteria of Faecal Origin

As a cause of various infections and accidental situations in swimming pool waters of bacteria aetiology, two bacteria are mentioned most frequently (Shigela spp and E. coli) which are successfully controlled by chlorination and other disinfectors under normal work conditions of a swimming pool. The greatest danger comes from a sudden faecal pollution, so that the basic measure is an adequate education of swimming pool users. However, if a sudden faecal pollution occurs, the basic measure is to stop using a swimming pool and increase disinfection. But the problem is swimming pools which are not disinfected. In such case, the ban of use is the only safety

Epidemije diareje među kupačima su nerijetka pojava, pri čemu su upravo sami oboljeli kupači izvori zaraze. Prema procjeni epidemiologa, samo jedan oboljeli korisnik bazena može da kontaminira cijeli bazen i to na duži period. Iz tih razloga ljudi ne bi smjeli da koriste bazene bar dvije nedjelje pošto budu izliječeni od diareje[5]. Jedna od primarnih intervencija za smanjenje rizika je redukcija akcidentalnih fekalnih zagađenja, pri čemu je na prvom mjestu edukacija korisnika bazena. U svakom slučaju, na bilo koji način da se javi fekalno zagađenje, jasno je da ovi organizmi ne mogu biti trenutno eliminisani, i da je potrebno vrijeme za siguran dezinfekcioni efekat. Zaštita zdravlja pod ovim okolnostima uključuje zabranu korištenja bazena i edukaciju korisnika[1].

Rizik od bolesti u bazenima, povezan sa **patogenim protozoama** feklanog porijekla, najčešće, uključuje dva parazita Giardia i Cryptosporidium. Ova dva organizma slična su u mnogim pogledima: imaju nisku infektivnu dozu i prisutne su u velikoj gustini u individuama koje su oboljele od gardizitisa i kriptosporidiazisa. Posjeduju ciste ili oociste koje su visokorezistentne na prirodne stresove i na dezinficijsense, tako da se mora koristiti mnogo jače dezinfekciono sredstvo, kao što je ozon. Međutim, pošto ozon nema rezidualnog djelovanja na vodu u bazenu, mora se obezbijediti poslije ozonizacije neko dezinfekciono sredstvo sa rezidualnim djelovanjem.

Najsigurniji način borbe protiv protozoa je preventivno djelovanje, da do iznenadnog fekalnog zagađenja ne dođe, tako što će se korisnici upoznati sa posljedicama nepridržavanja dobrih higijenskih navika.

- Patogene protozoe kao što su Giardia nalaze se intrastinalnom traktu ljudi i nekih životinja u trofozoičnom stadijumu. Kada se ovi organizmi izbace u prirodnu sredinu, kao što je npr. voda, prelaze u stadijum ciste (4-12μdezinfekcijom u cilju uklanjanja ili uništenja infektivnih mikroorganizama, tako da u bazenu ne bude prenosioca bolesti;
- odgovarajućom hidroulikom bazena koja će u prvom redu obezbijediti optimalnu distribuciju dezinficijensa po cijelom bazenu;
- odgovarajućim prečišćavanjem vode u cilju uklanjanja polutanata;
- čestim dodavanjem svježe vode kako bi se razblažile materije koje ne mogu da se uklone uobičajenom obradom vode.

U zatvorenim (pokrivenim) bazenima, održavanje kvaliteta vazduha je isto tako važno, kako se pojedini mikroorganizmi (kao Legionela) i isparljivi sporedni proizvodi dezinfekcije ne bi nakupljali u vazduhu iznad samog bazena[4].

measure, followed by emptying the swimming pool and its disinfection.

Epidemic of diarrhoea among swimmers is not a rare occurrence, where the swimmers themselves are the source of the epidemic. According to epidemiologists' estimation, only one diseased swimming pool user can contaminate the whole swimming pool and that for a longer period. For those reasons some people should not use swimming pools at least two weeks after they have been cured from diarrhoea [5].

One of the primary risk mitigation interventions is the reduction of accidental faecal pollution, where the education of swimming pool users stands in the first place. Anyway, whatever the way of occurrence of faecal pollution is, it is clear that these organisms cannot be eliminated instantaneously, and that time is needed for a safe disinfection effect. Protection of health in these conditions includes the ban of using swimming pools and education of their users [1].

The risk of disease in swimming pools, connected to pathogenic protozoa of faecal origin most commonly includes two parasites Giardia and Cryptosporidium. These two organisms are similar in many ways: they have low infective dose and are present in great density in individuals who are diseased with Giardiasis and Cryptosporidiosis. They possess cysts or oocysts which are highly resistant to natural stresses and disinfectors; therefore, much stronger disinfector has to be used, such as ozone. However, since ozone does not have residual action on the swimming pool water, some disinfector with stronger residual action has to be provided.

The safest way of fighting against the protozoa is preventive action, so the sudden faecal pollution would never occur, in a way that users would be notified with consequences of the failure to comply with good hygiene habits.

- Pathogenic protozoa such as Giardia are found in people's and some animals' intestinal tract in trophozoite stadium. When these organisms are released into the environment, such as water, they cross to the stadium of cyst (4-12μDisinfection with a purpose of removing or destroying infective microorganisms, so there would not be any disease carriers in a swimming pool
- Appropriate hydraulics of a swimming pool which would primarily achieve optimal distribution of disinfectors in all swimming pool
- Appropriate cleaning of water in order to remove pollutants
- Frequent adding of fresh water in order to dis-

Zaključak:
Korištenje bazena, otvorenog ili zatvorenog tipa, nosi sa sobom i određeni zdravstveni rizik povezan sa mikrobiološkim kvalitetom vode. Prećišćavanje vode smanjuje dijelom taj rizik, ali se najveća mjera sigurnosti korisnika može ostvariti tek dezinfekcijom vode u bazenu i stalnim održavanjem rezidualne koncentracije dezinfikcionog sredstva. Kulatura i samodisciplina kupača su doprinosni činioci njenoj bezbijednosti.

solute matters that cannot be removed by usual treatment of the water.

In closed (roofed) swimming pools, maintaining air quality is also important, so that certain microorganisms (like Legionella) and evaporable by-products of disinfection would not accumulate in the air above the swimming pool itself[4].

Conclusion:

Using a swimming pool, indoor or open type carries a certain health risk connected to microbiological quality of the water. Cleaning the water partially decreases that risk, but the greatest safety measure can be achieved only by disinfection of swimming pool water and by constantly maintaining residual concentration of disinfector. The culture and self-discipline of swimmers are contributing factors to the water's safety.

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