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Short report

Preventing SARS-CoV-2 transmission in rehabilitation pools and therapeutic water environments

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SUMMARY

SARS-CoV-2 is mainly transmitted by respiratory droplets and contact with contaminated surfaces. It can be retrieved in faeces but there is no evidence of faecal–oral transmission, which is the main route of contamination in recreational waters. Standard cleaning and disinfecting procedures, microbiological control and health rules aim to prevent infectious risk regardless of the micro-organisms. In the context of progressive lockdown exit and hospital activities recovery, we assessed the risk of SARS-CoV-2 transmission in rehabilitation pools and therapeutic water environments in order to provide specific recommendations to control the spread of SARS-CoV-2 while ensuring essential rehabilitation care for patients.

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SARS-CoV-2 is mostly transmitted by droplets and contact with contaminated surfaces but can also be retrieved in high loads in faeces [1]. It is mainly responsible for both respiratory

and gastrointestinal symptoms but there is no evidence of SARS-CoV-2 faecal–oral transmission to date [2]. A recent research letter suggested a possible cross-transmission of SARS-CoV-2 between nine patients via bathing in a public bath centre [3], underlining the need to implement specific measures to prevent this risk. In the context of progressive hospital activities recovery, we assessed the risk of SARS-CoV-2 transmission in rehabilitation pools and therapeutic water environments in order to protect patients and healthcare workers from COVID-19. To do so, we reviewed the current literature

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on SARS-CoV-2 sustainability in water environments. We also made an overview on risk and likely causes of viral cross-transmission in swimming pools. The different methods for swimming pool water disinfection in order to maintain its microbiological quality were described. According to this risk assessment strategy, we proposed pragmatic recommendations to control the risk of SARS-CoV-2 cross-transmission while preserving essential rehabilitation care for patients.

SARS-CoV-2 sustainability in water environments

SARS-CoV-2 environmental sustainability is conditioned by the initial viral load, the type of support, the residual humidity, the temperature and the presence of biological fluids. SARS-CoV-2 survival conditions in biological fluids are not transposable to recreational water and there are no current data on SARS-CoV-2 stability in water environments such as swimming pools. However, coronaviruses seem instable in water environments and are very sensitive to chlorine [4]. Enveloped viruses including influenza viruses and coronaviruses, are too sensitive to environment and too rapidly inactivated in water to be transmitted within swimming pools; this is converse to naked viruses such as adenoviruses, noroviruses, enteroviruses or hepatitis A virus, which are usually more resistant and able to survive several days in water, even when treated with biocides such as chlorine, ozone or bromide [4,5]. Accordingly, water from swimming pools does not appear favourable for the survival of SARS-CoV-2.

Swimming pools and risk assessment of viral cross-transmission

Most outbreaks related to contaminated recreational waters are caused by oral–faecal transmission of enteric viruses [6,7]. Investigating waterborne viral outbreaks is hampered by the requirement to sample very large volumes of water (1000–2000 L), which helps explain why the causative virus is identified in water in less than 28% of cases.

Viruses can contaminate swimming pools for various reasons including inadequate compliance with disinfection procedures due to technical failures or human factors (lack of, or incompetent, maintenance); lack of a warning system; or faecal soiling by infected users. Although few specific data are available, the same risks apply to rehabilitation pools and therapeutic water environments.

Viruses are not able to replicate on inanimate supports out of host tissues and cells. Consequently, the presence of viruses in the water of swimming pools is directly linked with contamination by bathers that excrete biological fluids such as saliva, mucus, vomit or faeces (<http://www.who.int/iris/handle/10665/43336>). Ingestion by the oral route remains the most frequent route of viral transmission in water, but the ocular mucosa may also be an important portal of entry for SARS-CoV-2 [8,9], possibly contributed to by irritation caused by chemical products used for disinfecting water. Skin lesions (injury, barrier disruption) may also allow viral entry, possibly contributed to by the skin softening that occurs with prolonged

immersion in water; however, this mode of transmission has not been demonstrated for SARS-CoV-2.

Standards of cleaning and disinfection procedure in swimming pools

Strict standards apply for treating water and maintaining its quality in swimming pools. In both public and hospital swimming pools, the water must be filtered and disinfected, and must meet physical, chemical and microbiological qualities defined by the French Public Health Code [10]. The Code also defines the required frequencies of monitoring of physicochemical and microbiological indicators, and the processes for pool closure and maintenance operations in case of non-conformity.

Disinfectant added to water must kill or inactivate microorganisms while preserving skin, eyes and mucosa integrity. Chlorine is usually used because of its cost-effectiveness, easy use and safety (<https://www.cdc.gov/coronavirus/2019-ncov/php/water.html>). Measures of cleaning and disinfecting must be accompanied by strict hygiene and behavioural rules for bathers, along with the respect of capacity limit of bathers, which can not be higher than three per 2 m³ of water in open-air recreational waters, and 3 per m³ in covered swimming pools [10].

Specific preventive measures regarding SARS-CoV-2 transmission

The first line of prevention of SARS-CoV-2 transmission is based on barrier measures including hand hygiene, physical distancing, and respiratory hygiene (wearing of a mask, covering the mouth and nose appropriately when coughing or sneezing). However, these precautions are difficult or impossible to apply in patients when bathing. We propose here a range of specific measures for pools used for rehabilitation care to protect bathers and healthcare workers from SARS-CoV-2 (Table 1). Ensuring safety begins with reviewing clinical records to ensure that patients have no symptoms of COVID-19, followed by use of barrier precautions and social distancing, especially in dressing rooms. Indeed, the main risk of SARS-CoV-2 cross-transmission is through respiratory droplets and contact with contaminated surfaces, and strict application of barrier measures is the best way to prevent transmission. Hand hygiene measures include appropriate provision of hydro-alcoholic solution for use on dry hands, but also soap and water for washing wet hands.

All these recommendations are based on the guidelines issued by the French Society for Hospital Hygiene (<https://www.sf2h.net/wp-content/uploads/2020/03/Avis-SARS-CoV-2-et-eau-de-piscine-SF2H-09.03.2020.pdf>) and are applicable to therapeutic pools and other therapeutic water environments. Meeting usual pool disinfection standards, together with appropriate individual behaviours in the pool should be sufficient to prevent a risk of waterborne transmission of SARS-CoV-2 (<https://www.wef.org/news-hub/wef-news/the-water-professionals-guide-to-the-2019-novel-coronavirus/>). These precautions must be accompanied by strict respect of barrier measures by both patients and healthcare workers outside of the pool. All these measures may also be applicable to public

Table I
Prevention measures of SARS-CoV-2 transmission in rehabilitation pools and therapeutic water environments

Specific recommendations	
For technical staff	<p>Ensure the proper application of standard guidance from the French Public Health Code in order to prevent microbiological risks in pools</p> <ul style="list-style-type: none"> • Appropriate procedure of water disinfection using chlorine or other disinfecting product • Monitoring physicochemical indicators • Monthly microbiological control of water • Pool closing and maintenance operation in case of non-conformity • Frequent surfaces disinfection with appropriate product ^a
For patients	<p>Ensure the respect of hygiene and behavioural rules before entrance into pools</p> <ul style="list-style-type: none"> • Use individual dressing rooms • Clothes storage on hangers in individual dedicated compartments • Shower using soap and water (before and after bathing) • Booth bath • Wearing of swim cap • Wearing of swimming goggles <p>Avoid access to bathers suspected of/affected with COVID-19 ^b</p> <p>Avoid or restrict access to bathers presenting respiratory and/or digestive symptoms ^b</p> <p>Ensure that bathers respect strict barrier measures in order to prevent cross-transmission outside of pools</p> <ul style="list-style-type: none"> • Strict hand hygiene at the entrance to the building and in case of bathroom use • Surgical mask wearing until reaching the dressing room and once dressed after bathing • Physical distancing of at least 1 m • Sneeze and cough into hands then directly wash their hands with soap and water ^c • Avoid touching face, nose, mouth and eyes
For healthcare workers	<p>Ensure the strict respect of barrier measures in order to prevent cross-transmission outside of pools</p> <ul style="list-style-type: none"> • Surgical mask wearing • Physical distancing of at least 1 m • Regular hand hygiene • Avoid touching face and eyes • Wearing of goggles or face shield in case of close contact with patient

^a Disinfection of common surfaces at both opening and closure of pools, and disinfection of dressing rooms and high-touch surfaces between patients. Recommended disinfectants are 0.5% bleach, 70° alcohol or usual disinfectant with virucidal activity according to the norm EN14464+A2 (July 2019).

^b By reviewing clinical record of patients.

^c Because it appears impossible to cough and sneeze in the elbow when bathing, we recommend using hands then immediately performing hand hygiene by washing hands with soap and water for at least 30 s as the use of hydro-alcoholic solution is not recommended on wet hands.

and private swimming pools in order to control the transmission of SARS-CoV-2 in the community.

Conflict of interest statement

None to declare.

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