Exploring the Relationship Between Swimming Pools and COVID-19

Love, J. R.

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Abstract

Swimming Pools and their operations are often a misunderstood environment. Through lack of knowledge, incorrect assumptions, decisions are being made that severely and negatively impact a highly regulated industry. To guide and promote evidence-based decisions, this review investigated three main areas: 1) COVID-19 persistence/survival/removal in water; 2) Humidity as a factor in reducing COVID-19 transmission and 3) The structured/unstructured environmental landscape. This review suggests that swimming pools are one of the safest and should be the first to reopen post lockdown as: i) COVID-19 has low stability water, with little or no chance to cause infection in pool water as it is incredibly susceptible to Chlorine, Ozone and UVC,; ii)The maintenance of controlled humidity and temperature play a role in the inactivation of COVID-19; iii) The indoor structured programs provide a safe sporting environment. Recommendations are provided for the restart of these structured swim programs.

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Today's pools are sophisticated facilities with operating plants, filtration and water quality systems, and environmental air controls. However, from outdated information based on pools of the past, there is a misconception from the general public and at times, medical professionals, who mistakenly ascribe pools to be the contributor to the spread of illnesses.

Today, swimming pools are highly regulated and controlled environments, with strict mandated operational and water quality guidelines. As part of Health regulations, pool water must be tested regularly. The majority of today's pool facilities operate automatic systems, where water quality can be tested and adjusted every 2 minutes. These disinfection systems ensure a safe environment which inhibits the spread of bacterial germs and viruses.

In Victoria, it is important to note, that the spectrum of swimming pool operation ranges from Council Community Facilities to School pools, to independently owned and operated swim school pools. Conscious of the public expectations, swimming pool operators consistently choose to manage their facilities over and above the minimum requirements to ensure the health and safety of their clients as vitally important.

For indoor pools, air temperature and water temperature play a pivotal role in providing ideal healthy and comfortable operational conditions.

The aim of this review is to provide a clearer understanding of COVID-19 and the safety of swimming pools operating during this period. This review is divided into three parts: 1) COVID-19 persistence/survival/removal in water; 2) Humidity as a factor in reducing COVID-19 transmission and 3) The structured/unstructured environmental landscape.

Review of Literature

For brevity and simplicity, the information has been condensed to provide a concise overview. With the openness to share the regularly updated research about COVID-19, many papers are open source, and some of the present research studies utilised were preprint papers, still to be peer-reviewed.

1. COVID- 19 persistence/survival/removal in water

COVID-19 belongs to the Coronavirus family, known to be highly contagious and easily transmissible. COVID-19 is an enveloped virus, a more 'wimpy virus', and behaves differently from the more commonly known non-enveloped viruses such as Norovirus and Enterovirus. In uncontrolled (no disinfection) water environments, it is feasible for non-enveloped viruses to be transmitted in water (Bonadonna and La Rosa, 2019). However, enveloped viruses, such as COVID-19 have never demonstrated waterborne transmission in humans (La Rosa, Bonadonna, Lucentini, Kenmoe, & Suffredini, 2020).

Unfortunately, there is limited research investigating the transmission of viruses in swimming pools, and at this time, no research could be found on COVID-19 and swimming pools. To date, no transmission of COVID-19 in water environments has been proven.

In 2003, there was an outbreak of the first Coronavirus, SARS-CoV; given its highly deadly nature, early research was directed at providing solutions for its inactivation. In laboratory studies utilising the first SARS-CoV, it was found that the virus was inactivated with 0.5mg/l of Chlorine (Lai, Cheng, & Lim, 2005) and by ultraviolet light (UVC) at 254 nm (Darnell, Subbarao, Feinstone, & Taylor, 2004), it is important to note, these are two of the

current methods utilised in pools for disinfection. In regards to swimming pools, according to the results of Wang et al., (2005), SARS-CoV is resistant to Chlorine at much lower rates than most other bacteria's or viruses. Similarly, they also found that water temperature strongly influences virus survival, finding that SARS-CoV could not be detected in water above 26^0C, but was evident at 20^0C (Wang et al., 2005). It is standard practice for public pools to be operated at 26^0C or more, and learn to swim pools above 30^0C.

Ozone is another disinfection system used in pools, where Ozone is generated and infused it into the water. Studies show Ozone to be an effective deactivator of SARS-CoV in the airborne and water environment (Wang et al., 2020).

Many of the present studies focus on the prevention of COVID-19 transmission pathways in drinking water, and sanitation management commonly from hospital wastewater, but are useful in providing information for its survival (Nghiem, Morgan, Donner, & Short, 2020; Wang et al., 2020). The conclusion from these the studies is that the treatment of water with Chlorine, Ozone or UV will deactivate the COVID-19 virus in water and it is equally applicable to fresh water, wastewater, and swimming pool water.

The WHO, (2020) suggest there is no risk of transmission of COVID-19 in swimming pools that maintain appropriate disinfection routines, and a minimum Free Chlorine level of 1 mg/l throughout the pool. In addition, they suggest that a lower free chlorine concentration (0.5 mg/l or less) is adequate when Chlorine is used in combination with Ozone or UV disinfection.

Current Victorian Dept. of Health Aquatic Facility guidelines (2019) state that for public aquatic facilities, the quantity of Chlorine required to be provided in a pool is –

Free Chlorine –

Without cyanuric acid min 1mg/ litre

With cyanuric acid - outdoor pool only – min 2mg/ litre

Combined Chlorine

Any pool – 1mg/ litre

While these are the minimum requirements for infection control, most pools operate above these minimum requirements. Spica et al. (2020) supports this notion and further suggests that pools increase Chlorine levels to the highest thresholds allowed by current regulations.

Based on the evidence provided in recent studies, the current water quality operations of swimming pools meet the requirements to eliminate transmission (if it occurs) in swimming pool water.

2. **Humidity as a factor in reducing COVID-19 transmission**

From past research, we know that humidity plays a role in the respiratory transmission of airborne viruses such as influenza. In low humidity conditions, the air is drier, with little or no water vapour, meaning that when someone coughs, the aerosolised particles remain smaller, can travel further and are suspended in the air for longer. In humid conditions, and when there is water in the air, any expulsion of particles attaches to water molecules, becoming heavier, and dropping faster to the ground. Potentially, a humid environment could work to reduce and prevent the spread of the COVID virus.

It has been documented that airborne viruses have reduced survival or infectivity when exposed to relative humidity between 40 and 70% (Arundel, Sterling. E, Biggin, & Sterling, T. 1986). This is supported by evidence from the Northern Territory, where humidity averages 44% to 72%, and where only 29 positive COVID-19 cases have been recorded and zero deaths. In addition, support for this finding comes from a more extensive Chinese study (during winter),

which found when humidity was in the range of 67% to 85.5%, every 1% increase in humidity led to a decrease in the daily confirmed cases by 11% to 22% (Qi et al., 2020). A similar Australian time-series study was conducted using local data from New South Wales, for the period January to March (during summer), 2020 and calculated that a 1 % reduction in relative humidity was predicted to increase COVID-19 cases by 6.11% (Ward, Xiao, & Zhang, 2020).

In 2010 a genetically cloned SARS-CoV virus was tested in differing levels of relative humidity, it was shown that the highest level of virus inactivation took place at 50% relative humidity (Casanova, Jeon, Rutala, Weber, & Sobsey, 2010). Yang and Marr (2012), found similar when experimenting on enveloped viruses (like COVID-19), determining a humidity range of 40 – 60% compromised the virus's infectivity.

Most indoor pools naturally operate at a humidity level of 50-60%. With pool systems set to maintain air temperature at 2 degrees higher than the water temperature, humidity can be adequately controlled within this range. Unfortunately, humidity in outdoor pools is dependent on weather conditions to provide a similar effect.

These results would suggest the present physical distancing requirements of 4m^2 is adequate for both in-water and on pool deck situations. At this time, indoor pools would be the safest and most logical preference to reopen first.

3. **The structured/unstructured environmental landscape.**

The unstructured is defined as the unsupervised swimmer, fun water play, or general public swimming. It has been suggested that unstructured leisure swimming tends to involve reduced physical distancing, potentially increasing the risk of virus spread (Allende, et al., 2020).

This unstructured public situation makes it challenging to enforce physical distancing, “especially with kids, who are all over the place in the pool, and they’re shrieking with delight” (Allende, 2020). We only need to be reminded of Bondi Beach in March this year, when authorities were unable to control physical distancing measures, and promptly closed the beach. A recent Stanford study which analysed non-compliance of physical distancing measures in the US found nearly 40% of over 20,000 participants were non-compliant (Moore, Lee, Hancock, Halley, & Linos, 2020). A similar theme was found in a smaller UK study, which also acknowledged that some individuals will seek close physical engagement to others when the opportunity allowed (Williams et al., 2020).

An Italian study recommends that upon reopening, that pool users need to be managed better. They recommend preventative measures would be upheld if staff took responsibility for the planning and management of programs (Spica et al., 2020).

This is in line with structured programs such as learn to swim, squad swimming and supervised rehabilitation programs, which can maintain close supervision of physical distancing, up to date contact details and the continued preservation of the hygienic environment.

Recommendation

While there is limited research available at present on Covid-19 and swimming pools, the research currently available notes the swimming pool environment is perhaps the safest sporting environment and should be one of the first to reopen post Stage 4 lockdown.

It is recommended that indoor pools be reopened before outdoor pools, due to the superior control of water quality, air temperature, humidity and supervision of clients.

Pool water quality requirements are already adequately controlled by current Victorian Health Department regulations, however, if not already done, consideration should be given to maintaining total chlorine levels above those recommended.

Indoor pools must incorporate a system for checking and maintaining pool air humidity to between 40% - 60%, either via mechanical or manual means.

In stage 3, to aid with physical distancing and further reduce risk, it is recommended pool deck numbers are contained to essential participants only. Research supports that the pool itself is not the issue, but rather the behaviour of the people outside the pool water. Swimming pools providing structured swim programs are well suited to controlling clients in their facilities. This physical distancing should be maintained as per government recommendations, outside the pool and presently set at $4m^2$; in the water to be controlled with best practices through structured programs. In Stage 3, maximum pool deck attendance calculations should be derived based on pool deck space, and by excluding water area and change room areas, which we would recommend being closed until Stage 2 occurs.

Lastly, as Spica et al., (2020, p441) championed “The long-established expertise of swimming pool operators in managing safety issues through conventional procedures, dedicated paths, regulations, technologies for disinfection and treatment of water, environmental sanitisation and acquired good practices, leads to consider the swimming pools among the most prepared and safe facilities to reopen and recover sport and physical activities, assuring continuity to safety management”.

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