AUGUST 2017

IDENTIFYING AND ADDRESSING THE PUBLIC HEALTH RISKS OF SPLASH PARKS

Photo by: Cpl. William Jackson (Public Domain) Playing with a watergun at the Combat Center's Splash Park, MCAGCC Twentynine Palms, Calif., May 8, 2013.

KEY MESSAGES

- *Recirculating splash parks have caused several large gastrointestinal outbreaks in recent years.*
- *Outbreaks are typically linked to failure of the chlorination/filtration systems and/or lack of secondary disinfection, such as ultraviolet light, but may also derive from user behaviour as well as design and operating conditions.*
- *This document reviews the literature to identify design, hygiene, and operational best practices that are thought to reduce the risk of critical disinfection failures.*

Introduction

Splash parks, also known as splash pads, spray parks, or wet decks, have gained in popularity over the last decade. These interactive parks are artificially created depressions or basins into which water is sprayed, splashed or poured onto visitors; water is not permitted to accumulate, but instead drains immediately out of the play area.[1,2] Splash parks may take one of two basic designs, which influences the associated public health risks. ***Non-recirculating or flow-through*** parks discharge the water directly to waste and present a relatively low risk to their users as the design is based on using fresh potable water (Figure 1a). In contrast, ***recirculating parks*** collect water in an underground tank, apply some form of water treatment, and re-use the water again (Figure 1b). This presents an increased risk of contamination and disease transmission that can be mitigated through proper design and operation.

The objective of this document is to identify risks to public health posed by splash parks, the factors that contribute to this risk, outline practices that can mitigate these risks, and summarize the existing regulatory environment for these facilities (see Appendix A for details on Methods). It focuses on epidemiological risks rather than physical hazards such as slip and fall injuries, heat stroke, and foot lacerations.

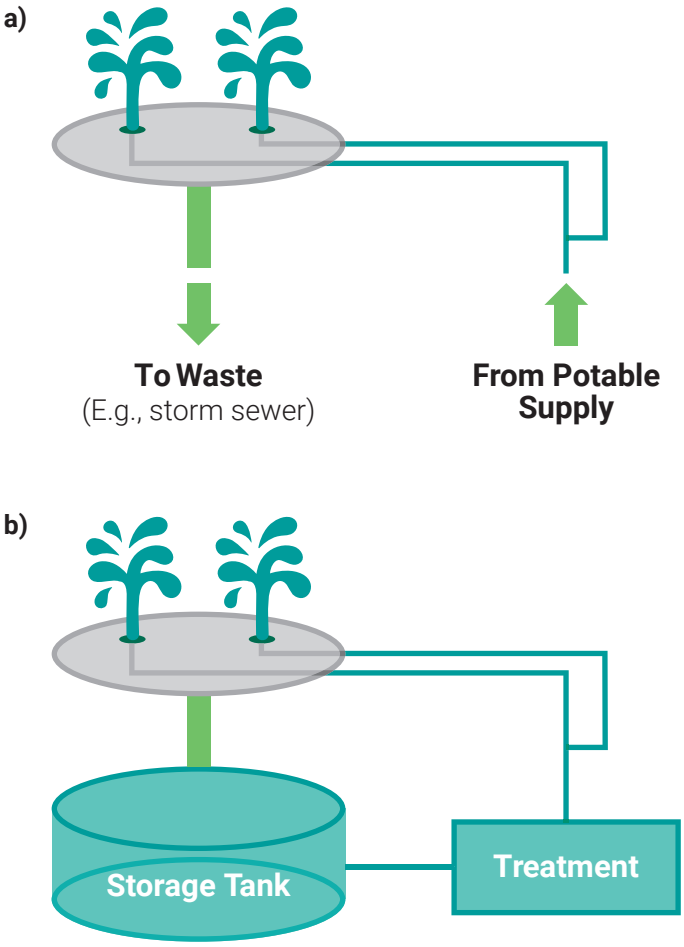

Figure 1. Depiction of a) a non-recirculating system in which potable water is used once and then discharged to waste, and b) a recirculating splash park in which water is collected, treated and re-used.

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Table 1. Selected outbreaks associated with splash parks

LOCATION (Year)	PATHOGEN IDENTIFIED	NUMBER AFFECTED	CONTRIBUTING FACTORS AND SUPPORTING DOCUMENTS
FLORIDA (1999)	*Cryptosporidium; Shigella soni*	38	No filtration and inadequate chlorine residual.[4]
FLORIDA (2006)	*Cryptosporidium; Giardia*	49	Inadequate chlorination and other operational deficiencies.[5]
ILLINOIS (2001)	*Cryptosporidium*	358	Park was found to be in compliance with operational requirements. No secondary disinfection installed.[6]
BRITISH COLUMBIA (2004)	*Escherichia coli*	10	Improper construction of waste water discharge.[7]
NEW YORK (2005)	*Cryptosporidium*	~4000	No secondary disinfection installed.[8]
IDAHO (2007)	*Cryptosporidium*	12	No secondary disinfection installed.[9]
ONTARIO (2013)	*Cryptosporidium*	12	UV light was out of service at time of suspected exposure.[10]

Evidence of public health risk

Splash parks have been the source of numerous outbreaks of gastrointestinal illness over the last 20 years in the US and Canada, and the US *Model Aquatic Health Code* categorizes splash parks as an "Increased Risk Aquatic Venue."[3] Selected outbreaks are summarized in **Table 1**.

Cryptosporidiosis was the most common cause of splash-park-associated outbreaks identified in the literature, which is consistent with past studies of recreational water outbreaks in which *Cryptosporidium* and *Giardia* were found to be the primary cause of outbreaks in treated recreational water.[11]

Cryptosporidium is a protozoan parasite that forms an oocyst and is resistant to the levels of chlorine typically used in recreational water for up to several days.[12,13] In order to kill or deactivate *Cryptosporidium*, treatment methods in addition to chlorine are required, for example ultraviolet (UV) light. This was demonstrated during the 2001 Illinois outbreak, in which 358 people became ill, despite satisfactory operation of the park's chlorination system.[6]

In addition to *Cryptosporidium,* water quality analyses carried out at 29 splash parks in Tennessee found that 21% of water samples taken were positive for other indicators of fecal or environmental contamination.[14] This study was carried out in response to a salmonellosis outbreak associated with a Tennessee spray park in 2014. The majority of parks (n = 24) analyzed were recirculating systems, and 33% (8) of these tested positive for *Giardia, E. coli, Salmonella,* or norovirus (among other indicators). None of the samples from the non-recirculating parks (n = 5) analyzed tested positive for pathogenic indicators.[14]

In addition to gastrointestinal illness, there is also the potential of contracting a respiratory illness such as Legionellosis, due to the fact that users may be exposed to aerosolized droplets produced by spray features.[1,15] While a literature review did not identify cases of Legionellosis linked specifically to splash parks, there have been several documented cases linked to decorative fountains, which also recirculate and spray water.[16,17] Although not the focus of this document, splash parks are also a source of abrasion and impact injuries[18] and have the potential to cause eye injuries if spray features are not designed correctly.[19]

Factors that contribute to public health risk

A number of factors increase the risk of an illness or outbreak associated with splash parks, related to both user behavior and the design and operation of the park. Users of splash parks tend to be young and/or diapered children, which increases the risk of a fecal accident occurring.[8,18] Younger users may also engage in other non-hygienic behaviours, such as exposing buttocks to spray features or drinking water directly from spray nozzles, which can increase the risk of disease transmission.[2,8,14,20] In addition to human users, unsecured splash parks may also be accessed by animals such as dogs, cats, and birds.[1] Because splash parks are often unsupervised by park staff, fecal contamination, whether from human users or animal activity, may go undetected.[5]

Splash parks by nature have many areas that remain damp for prolonged periods, which have been found to contain higher numbers of microorganisms compared to areas that are constantly submerged in chlorinated water.[18] Large

bather loads relative to volume of water provide increased opportunity for infected people to transmit infection and can contribute to increased turbidity, which can affect disinfection processes.[1,8] Splash parks also have reduced turnover rates compared to swimming pools that recirculate continuously, even when not in use.[21] Finally, the use of foggers, misters or other spray features that generate a fine atomized mist increase the risk of exposure to a respiratory illness, particularly if water quality is not adequately maintained.[1]

Best practices in design and operation

A previous water quality survey of 29 recirculating and non-recirculating spray parks found indicators of fecal or environmental contamination in 21% of all samples, and all of those testing positive were recirculating parks.[14] Importantly, no significant association was found between the presence of fecal indicators and factors such as inadequate chlorination, the availability of hygienic facilities, *or* the presence of signage, indicating that no single factor is responsible for disinfection failures. These results highlight the importance of assessing spray parks in a comprehensive manner and addressing risks through safer design and best practices for operating and use.

When designing a new splash park, a number of features can be implemented to limit contamination of the splash park area and its equipment from the outset:

- Siting the park in a location that minimizes potential sources of dust, debris, and other contamination, as much as possible. Fencing may also serve to reduce animal activity as well as debris carried in by foot traffic.
- Installing an appropriately sized reservoir to assist with dilution and allow for more effective disinfection. The reservoir should be a minimum of three times the flow rate of all pumps (e.g., if the flow rate for all pumps is 2,000 gallons per minute, the reservoir should be 6,000 gallons.[1] This helps minimize the accumulation of disinfection by-products, assists with maintaining balanced water chemistry, and reduces the frequency with which the tank must be drained. The reservoir should be designed to allow for complete drainage during routine cleaning and maintenance.
- Including provisions to allow for the constant recirculation and treatment of water, even when the park is not in use. This requires the spray features to be supplied from separate pumps than the filtration and treatment system. Where this is done, the system should be designed so that the feature pumps cannot operate when the treatment pump is not running.[1]
- Giving consideration to discharging some water from the reservoir (e.g., to waste, to irrigation) while the park is not in operation in order to draw in more fresh water.
- Providing adequate filtration, which is necessary to control turbidity and ensure that disinfection systems function as intended, typically by maintaining turbidity at less than 3.0 NTU.[22]

Installing an adequate disinfection system. This may entail increased levels of chlorine compared to a traditional swimming pool – many jurisdictions require at least 2.0 ppm.[23,24] In addition to traditional pool filtration and chlorination, a secondary disinfection system (e.g., ultraviolet light, ozonization or microfiltration) should be incorporated, as chlorination alone is inadequate to address risks due to *Cryptosporidium* and *Giardia*.[20]

- Supplying foggers, misters or other atomizing spray features from a potable water source rather than from recirculated water.[1]

Photo by: Kids playing in fountain (stock photo).(pic-a-boo/Getty Images)

There are generally two different ways to supply the reservoir water to the spray features:

- ***Full flow filtration:*** the features and filtration are in series, so 100% of the water fed to the features comes directly from the filters/filtration pump.
- ***Partial filtration:*** the reservoir is filtered, but a separate pump draws water from the reservoir and supplies the features, typically at a much higher flow rate.

It can be costly to install treatment systems that must filter all of the water intended for the features because this flow rate is typically much higher than the minimum required to achieve turnover alone. As a result, parks may be designed to provide partial filtration. However, in this scenario, the higher feature flow rate can introduce turbidity at a rate greater than that which the filters can remove. For this reason, the

ratio of the feature flow rate to treatment flow rate should not exceed 3:1 in order to ensure that turbidity does not exceed 3.0 NTU.[22]

Once in operation, there are a number of best practices that may serve to decrease the risk of a disinfection failure:

- Daily flushing of the park surface to waste prior to operation to remove any debris that may have accumulated on the surface. This will require the installation of direct-to-waste plumbing and valves to ensure that the water is not returned to the reservoir.
- Daily inspection for materials such as animal feces and broken glass can minimize the amount of contamination that must be removed by the disinfection system and reduce injuries.
- Regular cleaning to remove debris and disinfect surfaces using a sanitizer suitable for the material, particularly in areas that are not adequately sloped to drain.[18] Quaternary ammonia-based sanitizers should not be used as they will interact with the chlorine used to disinfect the spray water, resulting in the formation of disinfection byproducts.[25]
- Where permanent rubber surfaces are used, special care should be taken to ensure that they are adequately cleaned and sanitized.[18]

Finally, a number of educational strategies can be used to encourage good hygienic practice among splash park patrons:

- Using signage and providing facilities to encourage users to take a cleansing shower prior to entering the park. Similarly, providing washrooms with diaper-change stations may help to discourage parents from changing infants and toddlers directly on the spray deck.
- Installing a foot shower that drains to waste (rather than to the recirculation system) to allow bathers to clean debris from their feet prior to entering the park.
- Providing signage to discourage users from drinking from the spray features. Drinking fountains could be provided as an alternative.
- Having supervision of the park may promote good hygienic practices, such as showering and diapering away from the deck, and result in quicker detection and response to fecal accidents. However, there is some evidence of limited benefit from an on-site supervisor.[2]

In addition to the above, communities should carefully evaluate the costs and benefits of recirculating splash-park water. Non-recirculating parks present a relatively low risk to their users. Where water conservation is not a significant factor and sprayed water can be drained to waste, or where water that has been used once can be saved and put to another use (such as irrigation), these options could be considered as alternatives to recirculation.

Current Regulatory Context

The degree of regulation of splash parks varies from jurisdiction to jurisdiction. For example, in some provinces, such as BC and Alberta, splash parks are captured under the same regulations that govern swimming pools and other aquatic facilities.[26,27] In Ontario, splash parks are considered non-regulated recreational water facilities, but are still subject to some oversight by way of a guidance document that establishes operating procedures for such facilities.[28] In others, these parks fall outside the scope of existing legislation. A similar regulatory context exists in the United States, where some jurisdictions regulate splash parks, and others do not.[2]

While regulatory frameworks that support safe drinking water have evolved to acknowledge risks from protozoan parasites such as *Cryptosporidium*, this is not necessarily the case for recreational water. For example, in the United States, the US Environmental Protection Agency requires water supplies to achieve a 2-log reduction in *Cryptosporidium*; however, there is no corresponding requirement for recreational water.[8] Likewise, in British Columbia, public water suppliers are required to achieve a 3-log reduction in *Cryptosporidium* and *Giardia*,[29] but there is no such requirement for recreational water facilities, including splash parks.[30]

Conclusion

Splash parks offer users a fun and economical recreational opportunity. Environmental health practitioners can play a role in ensuring that these facilities are designed and operated in a way that reduces the risk to park users. There is an opportunity for public health professionals to work with municipalities and park owners to implement best practices at the design stage, to operate and maintain these facilities in an effective manner, and to encourage hygienic practices by park users. At the policy level, there is room to strengthen the existing regulatory context around these parks to better support practitioners in this role.

Acknowledgements

The authors would like to acknowledge the contributions of Michele Wiens (NCCEH), Ralph Stanley (Peel Public Health), Douglas Sackett (Council of the Model Aquatic Health Code), Heather Florence (Vancouver Island Health), and Rupert Benzon (BC Ministry of Health).

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Appendix A – Methods

This review was conducted in response to queries from public health practitioners seeking scientific evidence regarding splash pads and public health risks, including but not limited to *Giardia*, Legionnaire's disease, norovirus, and rashes/irritations. This review also sought information on guidance, regulation, or inspection of splash parks or similar facilities with fountains or other features not in continuous contact with water.

The information reviewed here includes peer-reviewed academic studies, as well as gray literature from public health agencies. Dissertations and conference proceedings were excluded. English-language articles were identified by Medline and CINAHL (EBSCO) and Google Scholar using the following search terms (variants and Boolean operator combinations thereof):

> ("interactive fountain" OR "interactive water fountain" OR "wet deck" OR "water park" OR "waterpark" OR "splash pad" OR "splash park" OR "wave pool" OR "water features" OR "spray pad" OR "spray park" OR "kiddie pool" OR "water play" OR "water toy and park" OR "spraypark" OR "splashpark" OR "spray fountain" OR "water sprinkler fountain" OR "aquatic playground" OR "aquatic facility*")
>
> AND
>
> (health OR illness OR injuries OR injury OR sanitary OR disease OR Hepatitis OR giardia OR fungal OR fungus OR e-coli OR legionnaire OR crypto OR shigell* OR fowleri OR amoeba OR norovirus OR bacterium OR irritation OR rash OR endotoxin)
>
> AND
>
> (rule OR guidance OR guideline OR regulation OR operation OR legislation)

The search results were subjected to title and abstract review to identify relevant documents, which were then subjected to full-text review. In addition to database searches, documents relevant to the topic were solicited from public health and industry experts, and drawn from the reference lists of the documents reviewed.

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ISBN: 978-1-988234-14-4