# Appendix 2 - Risks of getting *P. aeruginosa* from the environment

We understand that many parents are very concerned about their child 'catching' or acquiring *Pseudomonas aeruginosa* (PsA) from the environment. We realise this is a personal issue and that different families view things differently, especially in terms of balancing risk *vs* benefit. Parent's views may also change with time *e.g*. as their child gets older or depending on how well their child has been.

In order to ensure a consistent message, we have written this guide, which is a consensus view from the Brompton paediatric team and follows a comprehensive literature search. In some cases there is strong research evidence and we can be firm in our views. However, for many situations, the evidence is lacking or itself inconsistent. In those instances, parents will need to decide for themselves what to let their child do and decisions are often best made using common sense.

The UK CF Trust state 'It's important to remember that life can be risky – we all have to weigh up risk against quality of life.' We agree with this and would like children to lead as normal a life as possible, and not miss out on fun activities at home or school.

It is impossible to avoid contact with PsA, it is everywhere, and water is its natural environment. The risk of PsA acquisition is greater if PsA is present in water that is aerosolised (converted into a fine spray or mist), so it can be inhaled directly into the lungs. There is a small risk, but it is still possible, for a child to have PsA on their hands and put their fingers in the nose or mouth and hence inhale it. There is a dose effect, so the longer the exposure or the higher the bacterial content, the more likely the bacteria will be acquired and stay in the lungs. It is difficult to know whether drinking PsA-contaminated water affects the lungs as PsA can be found in stool samples in many healthy people. Always remember that other people with PsA infection are a potential source, and close contact with them puts children with CF at risk of infection.

We have focussed this guide on PsA, but obviously there are other organisms acquired from the environment that can be a problem, these are mentioned within the main guidelines where appropriate. These guidelines still apply to children who have already isolated PsA; it is possible to acquire more than one strain.

## Things to definitely avoid

- **Hot tubs, Whirlpools, Spa pools, Jacuzzis, Hydrotherapy pools**
  There is strong evidence of the presence of PsA in warm water that is aerosolised and easily inhaled with the person's head just above the water; and reported cases of acquired infection in adults with CF. PsA has been isolated from culture plates held 15 cms (6 inches) above the water surface when the tub was turned on. A 2018 Northern Ireland study found PsA in 21% of 243 hot tubs and 7% of 5811 Jacuzzis There is guidance to reduce survival and growth of PsA in these environments (*e.g*. levels of free chlorine and bromine, pH of water) but we still recommend total avoidance.

- **Tropical greenhouses, butterfly houses**
  Misting systems to water plants in tropical greenhouses and butterfly houses have been shown to contain PsA so are a risk as the fine water droplets are easily inhaled.

- **Outdoor misting systems**
  Some restaurants or other public areas have an outdoor misting system that sends a spray of mist downwards to keep people cool. We can find no evidence but there is a theoretical risk that the mist may contain PsA from the local water supply.

- **Squirting bath toys**
  Bath toys that have a valve on the base (*e.g.* plastic ducks) or that can squirt out water can be a problem if the water sits inside the toy for a long time, as they cannot be fully emptied and dried. There is evidence of a PsA outbreak on a children's cancer ward that originated in the toy box containing water-retaining bath toys. The same would apply to any hollow bath toy that retains water.

- **Swimming in stagnant ponds & canals** (see below).

- **Fish tanks (especially warm tanks for tropical fish)**
  Organisms have been isolated from fish tanks and cases reported of infection in people with CF. We believe they should be avoided. However, the US guidelines [1] simply suggest that gloves should be worn when cleaning out a fish tank.

- **Compost** (heaps and bags)
  Compost is essentially decayed vegetation, and is like enriched soil, but it can contain *Aspergillus* spores, and also bacteria such as *Pseudomonas* species. It should definitely be avoided due to the particularly high risk of *Aspergillus*.

- **Mucking out stables**
  This is particularly bad for potential contamination with *Aspergillus*. A warm mucky stable is also likely to be a source of PsA as well.

**<u>Things to take precautions with but allow</u>**

- **Digging in the garden soil, playing in the park, playing outdoor sport**
  PsA is known to reside in soil, although interestingly despite this fact being frequently quoted, publications suggest PsA is infrequently cultured. A 1974 study in 58 agricultural sites in California found that a quarter of soil samples grew PsA (especially in soils where tomatoes were grown). However, many studies since have found it to be rarely detected (*e.g.* a 2014 study of 380 samples from France & Burkina Fasu). Soil that is contaminated by organic fertiliser or animal manure is best avoided. Any PsA present in someone's garden is only a potential source of infection if the child puts the soil on their face and specifically up their noses or in their mouths (from contaminated fingers). We therefore suggest playing in the garden or park should not be stopped, as long as the children's hands and face are cleaned properly afterwards. The same applies to older children playing outdoor team sport (football, rugby etc.) which we encourage as exercise is so beneficial. We believe running through piles of damp leaves (or collecting leaves) would also seem to be safe. The US guidelines suggest that people with CF should limit prolonged exposures to activity that generates dust from the soil or organic matter *e.g.* lawn mowing to decrease exposure to *Aspergillus* and *B cepacia.* If a child wants to 'garden' they could always wear gardening gloves.

Proper hand washing is imperative. That is not always possible when outside the home, so parents (and older children) may wish to carry small bottles/tubes of antibacterial gel (hand sanitisers) that can be bought in chemists and supermarkets.

- **Mud kitchens**
  These are toy kitchen units made of wood, plastic and metal, where mud is used as the ingredient for all the food being made so gets all over the children's hands and probably faces! The same applies as digging in the garden, any PsA in the mud will not be aerosolised, so as long as the children's hands and face are cleaned properly afterwards, we believe the risk is minimal. There is no published evidence to further guide us.

- **Muddy puddles**
  Mud is a mixture of compressed soil and water; a puddle that has dirty stagnant water in it may contain many bacteria. A 2018 study in Northern Ireland sampled 18 freshly formed puddles in two hospitals, and 8 puddles from two countryside locations. A large number of bacteria were isolated, more often from the hospital locations. The commonest type were gram-negative organisms, and particularly *E.coli*. PsA was isolated only from one hospital puddle (and was a type not found in any CF patient in N. Ireland; there were three other types of Pseudomonas found in the countryside and hospital. However, if a child steps in it or even splashes in it, the water is not aerosolised sufficiently to be inhaled so we believe this is not a significant risk and need not be avoided. Pavement puddles dry so fast that the water does not stagnate and is also not in contact with soil/mud, so is perfectly safe to splash through.

- **Sandpits**
  Sand can be contaminated with PsA and it has been occasionally isolated from some beaches (probably due to human contamination in the sea). In a sandpit with clean dry sand the risk is minimal, although the sand is often damp; nevertheless, we believe the risk is only significant in a sandpit with free standing stagnant water. So, we suggest sandpits are fine as long as there is no visible standing water; this will be easier to control in someone's own garden. It is worth keeping a lid on the sandpit to reduce the amount of rainwater that might collect. Also, when filling up the sandpit from large bags, the sand is usually wet in the bag and should be left to dry out before use. The CF Trust advises schools that the sand should be regularly changed although do not say how often. A sandpit in a park is less likely to be clean, but by far the most frequent contaminant is *Toxocara* from cat and dog faeces.

- **Swimming**
  It is important children learn to swim for safety reasons. PsA is an aquatic organism preferentially living in water habitats and colonising moist environments. The water will not be aerosolised (apart from waterfalls), so it is unlikely to be an issue as long as it is not inhaled. Washing afterwards is obviously a good idea. **Inflatable toys** should be dried out after use, and not be left to hold stagnating water.
  - **Sea** – PsA has been grown out in the open ocean. However, sea water by a beach is most likely contaminated from human faeces. It is worth checking the cleanliness of beaches which can be done online for UK beaches (https://www.gov.uk/quality-of-local-bathing-water). We suggest swimming in the sea is fine.
  - **Lakes** can also be contaminated in a similar way to the sea but again we do not believe this is a problem.

- **Rivers** – even rivers have isolated PsA but again we would not discourage swimming in a river (as long as it is deemed safe for bathers).
- **Ponds** – this is more likely to be a problem in a small stagnant pond due to rotting vegetation *e.g.,* leaves. In that case it should be avoided, although is likely to be safe in a large pond that looks clean.
- **Canals** – similarly to the ponds, the water is often stagnant and usually looks dirty. We would suggest avoiding this.
- **Swimming pools** – as long as the pool is disinfected (usually with chlorine) to recommended levels then this should not be a problem, although PsA has been isolated occasionally from both indoor and outdoor public pools. Caution though with hotels and renting holiday villas with private pools in case the pool is not treated properly. It is safest for people with CF to only use pools that are well maintained and have an associated quality assurance monitoring programme to eliminate PsA.

- **Paddling pools**
  These will be fine as long as they are emptied after each use & dried out, then filled up again with fresh water when they are to be reused.

- **Clay**
  Modelling clay usually comes in a bag and is wet, often with loose water at the bottom of the bag. The clay should be allowed to dry out first although needs to be moist for it to be usable.

- **Water amusement parks**
  The water will be aerosolised and on some rides, spray can be inhaled. However as long as the facility uses treated disinfected (usually chlorinated) water to industry standards this should be safe and can be checked in advance.

- **Play fountains** (water that spouts up from pavement jets)
  Some of the water is likely to be aerosolised so does present a risk. However, if the fountains are chlorinated (like in a swimming pool), they should be safe.

- **Pond-dipping**
  This is collecting pond life in a jar attached to a net that is dragged through the water. It is likely that the pond water (that may be stagnant) will get on the children's hands and of course may end up being flicked around when an adult is not looking, especially when there are a lot of children taking part. It is likely to be safe as long as it is supervised properly, and the child cleans their hands properly afterwards. There is no evidence to guide us, and it is difficult to know what is best, so parents will have to decide whether they believe it to be a sufficient risk to stop the child joining in.

- **Touch pools in a public aquarium**
  It is most likely that there will be bacteria in the water, including non-tuberculous mycobacteria. However, the water will not be aerosolised, and there are good hand-washing facilities on the spot, so we believe the children can take part as long as they definitely clean their hands well and are supervised carefully.

- **Petting zoos and farm visits**
  Clearly stagnant water or small ponds should be avoided. Caution also in chicken coops, stables and contact with mouldy hay for *Aspergillus*. Hand hygiene is important after stroking the animals and most places will have hand washing facilities for all the children anyway. There have been no reports of transmission of pathogens from farm animals or pet therapy animals to people with CF, although animals are a potential source of several types of infection (*e.g.* PsA from horses, MRSA from pigs).

- **Caves**
  These are often damp environments with water dripping down the sides of the walls. The water is not aerosolised, and the child will not be in direct contact with the water. There is no evidence to guide us, but we believe a visit to a cave need not be avoided.

- **Snow**
  A 2018 study analysed fallen snow from 37 sites in parks, gardens, public open spaces and footpaths. Although bacteria were detected in the majority of samples, PsA was not detected in any. Caution should be taken in dirty slushy melted snow especially lying over mud, but there should be no harm in playing in fresh white snow.

- **Showers**
  The shower heads can be a source of PsA with colonised biofilms, and the shower spray contains aerosolised droplets that can be inhaled. It is best to run the shower for 1-2 minutes before the child gets in.

- **Sink and bath taps**
  These can also contain PsA (in the form of biofilms) but the risk is reduced compared to showers as the water spray is not being inhaled. If the tap is in frequent usage the risk is also lessened but taps that are rarely used should have the water run through them for 1 minute every day. This is unlikely to be an issue in someone's home. PsA is most often detected from kitchen and bathroom drains in homes of people without CF; and from shower and bathroom drains in homes of people with CF.

- **Water pistols and 'super-soakers'**
  Similarly, to squirting bath toys, this could be a problem if the water is kept inside the toys for a long time. A forceful super-soaker could aerosolise the water and can be squirted in the face. However, we suggest as long as they are emptied fully after use and dried out they can still be played with. **Water play** should be safe as long as the water is fresh and has not sat stagnating in containers; toys should be dried out at the end.

- **Flower vases**
  Water should be changed before it smells and trim the leaves off stems so that they do not sit in the water.

- **Humidifiers & vaporisers**
  Water sits in a reservoir which is evaporated and blown into the air. As long as the reservoir is kept clean, and fresh water put into it before use, it should be safe, but do not use it if the water has been stagnating in the reservoir for a while. Also, never add disinfectant to the water – some have caused harmful interstitial lung disease.

- **Air conditioning**
  No evidence on this but these should best be avoided if the units are dripping water.

- **Flushing toilets**
  Aerosols containing bacteria, including PsA, can be created when flushing toilets, so the lids should be lowered before flushing.

**<u>Things that must not be avoided</u>**

- **Dentist**
  There has been concern expressed in the past about aerosolisation of PsA-contaminated water from dental chair units. PsA may get there from municipal water or the suck back of a patient's saliva into the line due to lack of anti-retraction valves. It is critical that children with CF attend the dentist regularly, especially given the effect of some of the antibiotics and the potential high sugar diet. Furthermore, rotten teeth can promote PsA in the mouth which can infect the airways.

- **Drinking water**
  PsA has been isolated in tap water, well water, drinking water dispensers (coolers), water from vending machines, bottled water, and even distilled water. There is no evidence that drinking water with the low levels of PsA found will cause lung infections, and high levels are required to colonise the gut. Drinking water need not be avoided, nor need the water be boiled first. The US guidelines suggest that tap water or well water that meets local public health standards may be used for drinking.

  Many people use refillable water bottles. Mostly the filters are not antibacterial but are carbon filters to remove chlorine and improve the taste. Certain designs mean that the filters remain wet, possibly even holding water, so these should be avoided. Similar advice is given for water jugs with filters. Bottles with antibacterial filters do exist (for camping etc.) but again it is important to know if the filter remains wet and possibly holds on to the bacteria, in which case they should be avoided.

[1] *Saiman et al. Infection prevention & control guidelines for cystic fibrosis: 2013 update. Infect Control & Hosp Epidemiol 2014;35:S1-S67.*