

Bathing water and beach safety from human pathogens

1: Introduction

The Environment Agency (EA) conducted a preliminary literature search in 2009 on human health risks from faecal bacteria associated with seaweed both when in bathing waters and after it is cast onto beaches. It concluded that faecal bacteria have been reported to be associated with seaweed and suggests more research is required particularly where high levels of faecal contamination occur for instance near storm water overflows. The EA also reported that sand under seaweed on beaches may also have high populations of faecal bacteria. It concludes the extent of risk of microbes associate with seaweed to human health cannot be determined because of a lack of scientific evidence. This document examines more recent literature to determine the progress in assessing health risks to both bathers and beach goers since the EA literature review.

2: Inadequacy of assessing seawater and not the beach

- 2.1 The Blue Flag scheme may not assure adequate health protection on CROWD beaches.
- 2.2 WHO 2021 review recommends that beaches as well as the adjoining seawater be assessed for health hazards.
- 2.3 The EU is consulting on improving its rules on bathing waters to consider the safety of beach sand. Studies on the beaches of Portugal have revealed health risks (Brandão *et al.*, 2023).
- 2.4 The microorganisms of concern can be subdivided into those that can be brought to the environment by anthropogenic activities including agriculture and sewage disposal (allochthonous; Table 1) and those occurring naturally in the sand environment (autochthonous, see Section 3).

Table 1: Allochthonous microbial pathogens associated with recreational water or/and shellfish-related human illness. (Data from Malham *et al.*, 2014).

Bacteria	Source
<i>Campylobacter</i> spp.	Animal/bird faeces/slurry
<i>E. coli</i> O157	Animal/slurry
<i>Salmonella typhi</i> and <i>Paratyphi</i>	Human faeces/sewage
<i>Salmonella enterica</i> (various dirserogroups)	Human faeces/sewage or animal bird faeces/slurry
<i>Vibrio cholerae</i> O1 and O139 serotypes	Human faeces/sewage
Shigella spp.	Human faeces/sewage
Protozoa	
<i>Cryptosporidium parvum</i>	Human faeces/sewage or animal faeces/slurry
<i>Giardia duodenalis</i>	Human faeces/sewage
Virus	
Adenoviruses _	Human sewage
Norovirus	Human sewage
Hepatitis A	Human sewage
Echoviruses	Human sewage
Coxsackieviruses	Human sewage

- 2.5 Allochthonous pathogens become bound in biofilms that occur on sand granules, nurdles and also flocculation based on both organic and inorganic particles (Malham *et al.*, 2014; Rodrigues *et al.*, 2019). The latter are a main means of transport of pathogens to the sediment. The binding of pathogens to sediment enhances their persistence by reducing the effect of predators (e.g. protozoa) and the impact of UV.
- 2.6 The impact of flocculation is particularly important in ensuing persistence and even multiplication of pathogens in estuaries suggesting the mouth of streams and rivers entering CROWD beaches maybe a particular concern.
- 2.7 Work based on a Scottish beach has demonstrated that some senescing brown seaweeds particularly the very common *Laminaria saccharina* facilitate both the enhancement and the persistence of *E. coli* in the mid-shore and at the strand line. The populations in the sand beneath the seaweed are enhanced probably by providing

- shelter from harmful UV radiation during low tide and by creating a favourable microclimate and a potential nutrient source. Unfortunately, the distribution of high populations of *E. coli* associated with this seaweed are very patchy and so require more complex sampling than of seawater to establish the level of hazard (Quilliam *et al.*, 2014).
- 2.8 The contribution of seaweed relative to other sources of *E.coli* may be increased in relatively calm non-storm days but the importance of this possibility may be difficult to determine (Quilliam *et al.*, 2014).
 - 2.9 The use of indicator organisms for bathing water pollution has been questioned due to the range of human pathogens and their differential responses to environmental conditions (references in Federigi *et al.*, 2019). For instance, counting Enterococci alone was not sufficient for predicting the numbers of pathogens such as *Vibrio* spp. in bathing water (Tiwari, *et al.*, 2019). Consequently, it is uncertain that the simple approach of measuring *E.coli* levels and Enterococci in seawater by the Blue Flag system are reliable indicators of the level of exposure of bathers and beach users to all human pathogens.
 - 2.10 Beach sand safety can be subdivided into hazards associated with the intertidal zone and with the supratidal zone (above high tide). The latter included organisms not associated with the sea or water flows from rivers. The bacteria of concern are *Staphylococcus aureus*, *Candida* spp., Enterococci and *E. coli* which may be present in beach sand at 1,000 to c5,000 the density in the adjacent water. *E.coli* populations may increase nearly 100 fold within 30 minutes of rainfall onto a beach. Hepatitis A and Human Adenovirus may also be viable when detected in sand and helminths have been raised as a concern in Lithuania. Two types of fungi of concern are those that cause superficial infection of hair nails, skull and scalp. They can be transmitted human to human, soil to human, and animal to human. Endemic forms are a second group of fungi found on beaches but their impact on human health is less well studied (Beverdsdorf, *et al.*, 2007; Brandão, *et al.*, 2023).
 - 2.11 One complexity is the likelihood of patchy distribution of pathogens in soil requiring several samples at a site for reliable detection in contrast to the adequacy of a single water sample.
 - 2.12 The risk of exposure to human pathogens in the supratidal zone requires investigation. It is unlikely to be attributable to sewage outflows from water companies. The risks can be managed by approaches such as ensuring beach users do not concentrate excessively in particular localities.

3: The risk of added nutrients from organisms naturally present in the sea

- 3.1 Addition of only 1% sewage to estuarine water increase populations of the human bacterial pathogen *Vibrio vulnificus* by 100 to over 1000 (Conrad and Harwood, 2022). *V. cholerae* (the cause of cholera) can also increase in such conditions as can *V. parahaemolyticus* which causes abdominal pain, diarrhoea, nausea, vomiting, chills and headache (Conrad and Harwood 2022; Brandão *et al.*, 2023).
- 3.2 The methods of exposure of humans to *V. vulnificus* are consuming contaminated shellfish and bathing in estuaries with an open wound. Infection causes septicaemia, malaise chills, fever, prostration, cutaneous lesions. Fatalities occur (Brandão, *et al.*, 2023).

4: Responsible authorities and monitoring

- 4.1 Water companies are responsible for ensuring they do not discharge untreated sewage into rivers or the sea and to limit the use of storm overflows.
- 4.2 Farmers are responsible for not discharging sewage or agricultural runoff into rivers or the sea. Owners of private sewage facilities have similar responsibilities.
- 4.3 A key problem is that storm outflows and other river polluting events such as releases by watercress and trout farms are spiking ensuring periodic sampling is unlikely to detect such events (report of the Environmental Audit Committee Parliament UK, 2022).
- 4.4 The Environment Agency monitors bathing waters at weekly intervals for *E.coli* and Enterococci into Blue Flag beaches during the bathing season (15/05 to 30/09). If the

- number or these microbes renders the location to be classed as only sufficient and not good or excellent, then the EA investigates the cause. Local councils must display information at the bathing water to show water quality during the bathing season. If a site is classified as poor, then a notice advising against bathing must be shown.
- 4.5 The EA does not monitor for other pathogens in bathing water and the weekly sampling may fail to detect “spikey” events.
 - 4.6 The EA does not monitor for *E.coli* and Enterococci in rivers that are not bathing waters. It does monitor several aspects of the river water environment including invertebrates. The national ARMI Riverfly scheme sets thresholds for rivers and streams. If its values fall to or are below that threshold then EA investigates the pollution source. A spokesperson for EA at a meeting of CROWD stated that it was not responsible for monitoring human pathogens in rivers (as opposed to their environmental quality).
 - 4.7 Landowners are responsible for health and safety issues above the mean high tide level. The relevance to CROWD is its dry sand beaches and estuaries such as the lagoon at Charmouth. There seems to be no authority at present that routinely checks widely used beaches for these hazards.
 - 4.8 Local authorities are responsible for health and safety issues in the intertidal region. They can introduce byelaws placing responsibilities on others. Most, if not all, byelaws relate to non-biological risks.
 - 4.9 The Health and Safety Executive lays down guidance on beach safety. However, it has not included human pathogens on beaches as a health issue. Its remit overlaps with that of The Maritime & Coastguard Agency which also does not consider biological hazards in its document on beach safety (The Marine and Coastguard Agency, 2019).
 - 4.10 The seabed within UK territorial boundaries normally belongs to the Crown.

5: Comments

- 5.1 The monitoring of *E.coli* and Enterococci may be inadequate to ensure bathers and beach users are not exposed to the hazard of a range of human pathogens. There is insufficient data to determine if the level of exposure to this hazard represents a risk of substantial concern to users of beaches in the CROWD area.
- 5.2 It is unclear if any authority or agency currently monitors for the health and safety issue of human pathogens other than *E.coli* that are associated with bathing water. However, the EA did review risks from faecal organisms associated with seawater in 2007. This suggests they would be the responsible agency for assessing any risk to human health.
- 5.3 A difficult issue is how to progress the extent of any legitimate concerns about human pathogens and beaches given the lack of consideration of the issue. One way forward would be for the UK to extend the Blue Flag system to include beach sand as recommended by WHO (2021). This would presumably require monitoring by EA who would presumably requires extra funding to complete this extra activity.

References

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