HUMAN NOROVIRUSES AND FAECAL INDICATOR BACTERIA IN A SHELLFISH WATER IMPACTED BY SEWAGE DISCHARGES AND FRESHWATER INPUTS FROM AN EPHEMERAL RIVER

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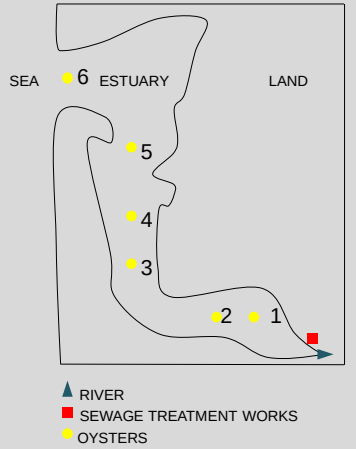
AIMS AND SCOPE

Norovirus (NoV) is the most common cause of human illness following consumption of faecally contaminated filter-feeding shellfish. A better understanding of the environmental pathways of NoV in shellfish water catchments is key to the development of effective risk management measures to reduce the burden of disease. The aims of this study were:

- To quantify NoV inputs from sewage discharges (storm tank overflows and UV-disinfected effluent) and rivers to an oyster fishery;
- To evaluate the environmental dispersion of NoV in the shellfish water; and
- To characterise the environmental factors driving NoV contamination of shellfish.

METHODS

The shellfish water catchment is situated on the south coast of England. It is sparsely populated with some urban development in the lower reaches. It is drained by an ephemeral stream with a baseflow-dominated regime; however, spring outflows can increase dramatically following exceptional rainfall.
Oysters were placed at various distances from the main sewage treatment works (STW) impacting the estuary. Sampling was undertaken during dry-, wet-weather and sewage spill conditions.
Levels of NoV (genogroups I and II) and *E. coli* were quantified in freshwater, sewage and native oysters (*O. edulis*) using MPN and PCR-based methods from May 2009 and April 2011 and from November 2012 to February 2013.



RESULTS

- Storm tank discharges contributed 97.6%–99.9% of the total NoV load to the estuary.
- Of the five samples of freshwater tested, one was positive for GI and three were positive for GII. Median levels of NoV during river flow conditions were >1log$_{10}$ higher than those during no flows (Fig. 1).
- During periods when freshwater flows reached the tidal limit of the estuary, concentrations of *E. coli* and NoV increased as flows in the river increased (Fig. 2).

Figure 2. Levels of *E. coli* (A) and norovirus (B) as a function of river flows. Vertical reference line indicates mean flow. Horizontal reference lines indicate thresholds for classification of shellfish production areas. ▼

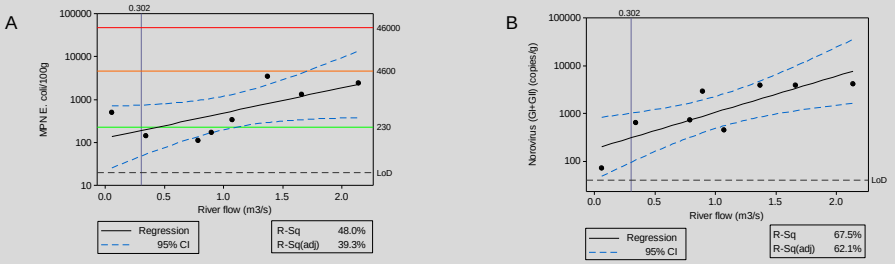


Figure 3. Levels of *E. coli* (A) and norovirus (B) as a function of distance from the sewage outfall Red dots represent samples collected under dry weather ▼

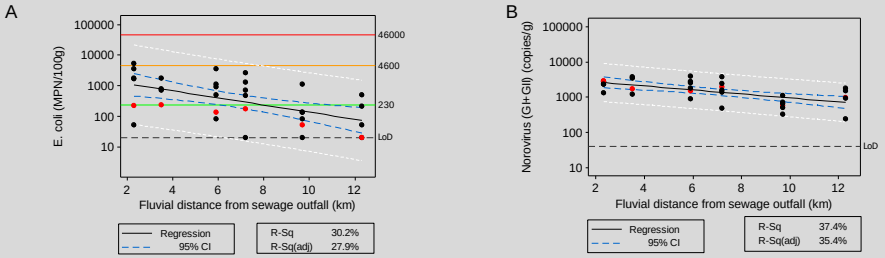
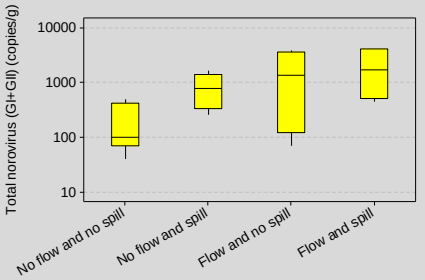


Fig. 1. Variation of norovirus levels during four scenarios of environmental contamination. ▼



- Concentrations of total NoV and *E. coli* in oysters decreased as the distance from the STW outfall increased (Fig. 3).
- Mean NoV levels were of the same magnitude over a fluvial distance of 7km from the pollution source.
- The high persistence of NoV was associated with the high number of stormwater spills recorded during the study period.
- NoV levels in oysters exceeded 1,000 copies/g over distances of more than 7km from the pollution source.
- A proportion of oyster samples compliant with the class A *E. coli* standard (230 MPN/100g) had total NoV content >1,000 copies/g.

CONCLUSIONS

The results indicate that storm tank discharges are major sources of NoV to the shellfish waters in this estuary.
Future investment in sewerage infrastructure should therefore prioritise these pollution sources.

The linear models indicate that river flows and, to a lesser extent, distance from sewage outfalls are risk factors for NoV contamination of shellfish waters.

In this study site, river flows can be used as surrogates for *E. coli* and NoV contamination from catchment diffuse sources when sewage discharges are not operating.

This study was carried out during the period of peak prevalence of NoV in the community. The PCR genome copies detected in oyster samples from this study site are consistent with those found in samples associated with outbreaks in England and Wales.

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