Chlorine Resistance in Coliforms in Water Treatment

Cara Wray[1]

David Graham[1], David Werner[1], Karen Heaton[2]

[1] Civil Engineering and Geosciences, Newcastle University

[2] Severn Trent Water

Stream

The Industrial Doctorate Centre for the Water Sector

Background

Coliforms are a group of bacteria found predominantly in the gut of humans and animals.

In water treatment, coliforms are monitored as **indicators of faecal contamination**.

Detection of even a single coliform has serious consequences for the water company:

- Potential health hazard to customers
- Large fines
- Damage to their reputation

Chlorination is the most commonly used method of water disinfection.

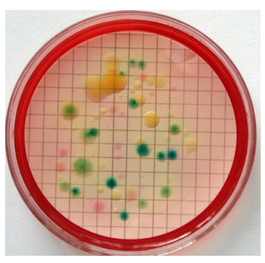
In many cases of coliform contamination, the treatment process appears to be working to approved standards - the root cause of contamination is unknown.

The key question:

How could coliforms survive disinfection in the water treatment process?

Genetic resistance

Have coliforms developed genetic resistance to chlorine?



Stage 1

- Water samples taken from 5 water treatment plants (WTPs).
- Samples exposed to a range of chlorine concentrations for a range of contact times.
- Surviving coliforms were isolated and enumerated on selective media.
- **No coliforms were found to show significant resistance to chlorine.**

Stage 2

- Five WTP E.coli isolates were grown up in pure culture and their chlorine tolerance determined in a survival assay.
- The chlorine tolerance of these 5 environmental isolates was compared to 5 lab strain E.coli and 5 E.coli isolated directly from human faecal samples.

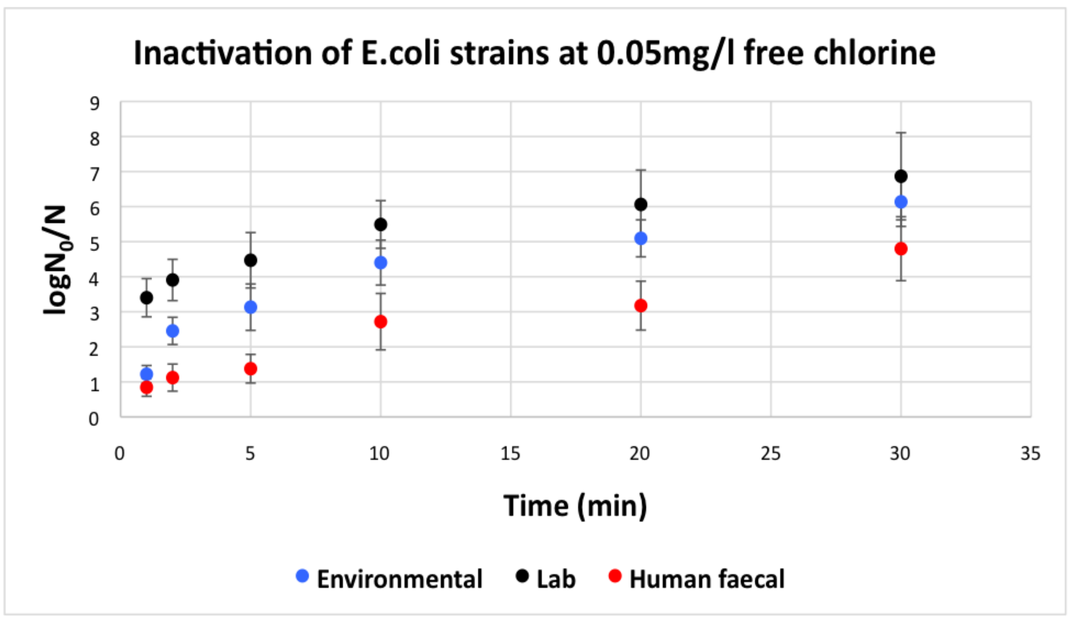


Figure 1 – Each data point represents the mean value of triplicate plate counts of five E.coli isolates. Environmental isolates were obtained from five Severn Trent WTPs located in the Midlands; lab isolates and human faecal isolates were donated by Dr John Perry, Freeman Hospital, Newcastle upon Tyne.

'Operational' resistance

Can genetically chlorine-sensitive coliforms take advantage of operational conditions to survive disinfection?

Developing strategies to avoid exposure to chlorine could allow coliforms to survive disinfection, even while being genetically sensitive to chlorine.

Strategies include:

- Attachment to particles
- Shielding within a biofilm
- Intracellular survival within zooplankton

Biofilm sampling survey

- Biofilm samples were collected from 5 stages of the treatment process at two water treatment plants at 30 days, 60 days, 90 days and 6months.
- Bulk water samples were collected at the same locations and time points.

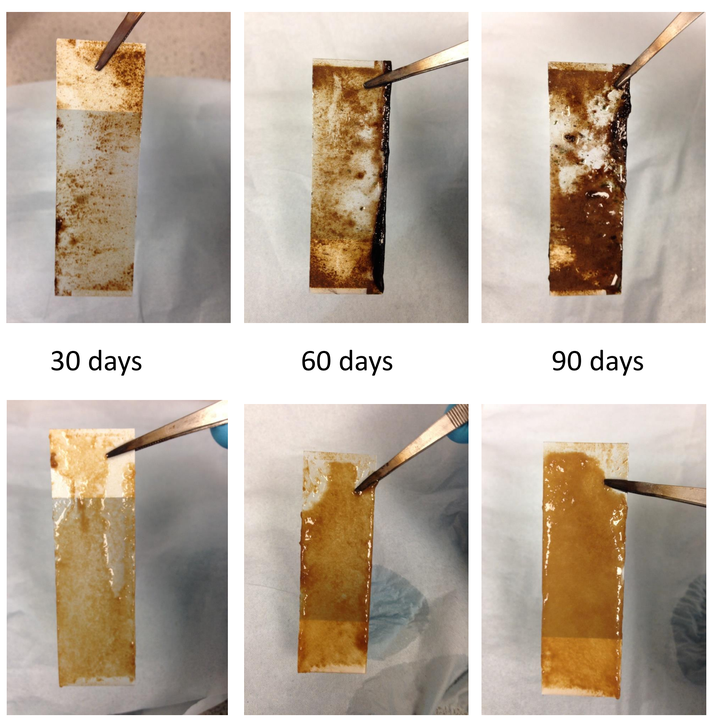


Figure 2 – Biofilm collectors containing frosted glass slides were placed at 5 locations in the treatment process: raw intake water, post-clarification, post-filtration, post-GAC and post-contact tank. The photos show biofilm growth over 3 months at the raw water (top row) and post-clarification (bottom row) stages.

Conclusions and future work

- **No evidence of genetic resistance** to chlorine in coliforms was observed.
- There is a **significant difference** (p-value = 0) **in chlorine tolerance** between lab, environmental and human E.coli.
- However, differences were only apparent at very low chlorine concentrations (0.05mg/l free chlorine) and at the high doses of a WTP, **genetic tolerance to chlorine likely has minimal contribution to coliform survival.**
- Biofilm and bulk water samples will be sequenced to determine what proportion of the community consists of coliform bacteria throughout the treatment process and whether biofilms are a likely source of coliform failures.

www.stream-idc.net

For further information: C.Wray1@newcastle.ac.uk

Postal Address: Cassie Building, School of Civil Engineering and Geosciences, Newcastle University NE1 7RU

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Newcastle University

School of Civil Engineering &Geosciences

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