

REPORTING AND HANDLING MICROBIAL NON-DETECTS: A Research Overview

KEY MESSAGES

- Microbial non-detects are not censored data and should not be reported as such
- Misuse of statistical approaches tailored for censored data will bias data analysis
- It is critical to report all microbial data, including non-detects, with raw observations and sample volumes to support proper statistical analysis



FOR WHOM IS THIS RELEVANT?

This research overview is designed for people who generate and analyze quantitative microbial data such as laboratories, microbiologists, researchers, and engineers. It also provides information and tools for decision-makers and risk analysts to support robust decision-making based on accurate data, analysis, and reporting.

WHY WAS THIS DONE?

Quantitative microbial data are essential in water and food safety, sanitation, and many other applications. When looking for pathogens or indicators of contamination, non-detects can be very common. Non-detects have commonly been reported in a way that is interpreted as censored data (e.g. <1 CFU/mL). This has led to persistent debate about how to incorporate such values into data analysis, including the widely recognized debate about how common approaches for handling these data can significantly bias results and misinform decision-makers. Here, we explore the legitimacy of reporting microbial non-detects as censored data, particularly for enumeration and detection-based methods (e.g. counting under a microscope, plating, and most probable number methods), as well as appropriate methods for handling non-detects in data analysis.

WHAT WAS THE APPROACH?

The relationship between laboratory observations (e.g. counts, volumes, presence-absence patterns) and the concentration estimates derived from those data has been widely discussed. Nonetheless, reported concentration values are often regarded as exact measurements except in the special case of non-detects. With this in mind, we undertook a critical review of selected literature to understand how non-detects have been reported, interpreted, and analyzed for both chemical and microbial analyses.

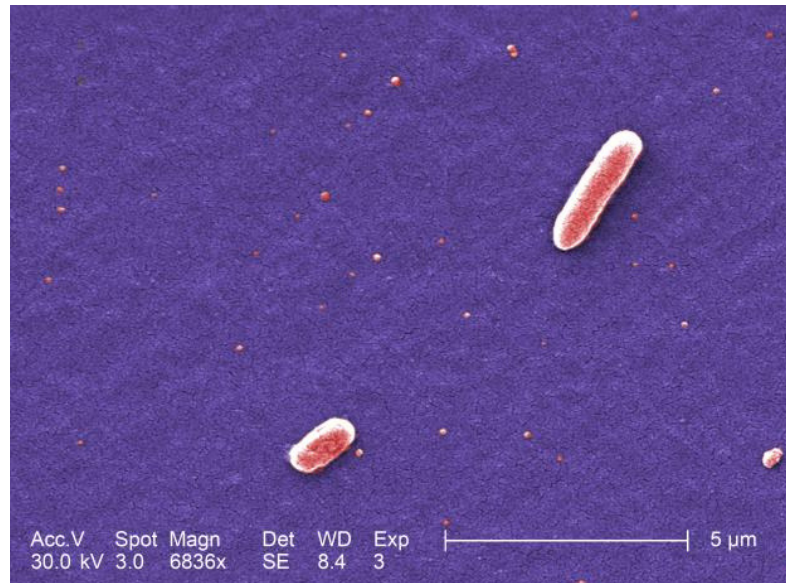
The over-estimation of pathogen concentrations caused by handling zeroes as $<MDL$ "...might seem protective of public health, but that bias, and hence the protection it might afford, disappears at high concentrations where having a safety factor seems most desirable."

Parkhurst and Stern, 1998

"Determining Average Concentrations of *Cryptosporidium* and other Pathogens in Water"

WHAT WAS SHOWN?

Through a series of illustrative examples, this work demonstrates why the reporting of microbial non-detects as censored data is inappropriate. **The current conventions for reporting these data as censored concentrations lead to biased data analysis that misrepresent the character of microbial data.** This is true even when approaches that are appropriate for truly censored data are used. Overall, we demonstrate that **standardized reporting of raw observations is necessary for enabling appropriate statistical analysis and subsequent interpretation.**



Scanning electron microscopic image of *E. coli* bacteria
CDC / National Escherichia, Shigella, Vibrio Reference Unit
Photo credit: Janice Haney Carr
Public Health Image Library (PHIL)

WHAT ARE THE IMPLICATIONS?

Under current reporting conventions, non-detects are frequently misrepresented as censored data which biases later interpretation. Moreover, approaches to handling these data are varied and unstandardized – this has been widely debated. We've discovered this introduces bias into the analysis which can lead to inappropriate or misguided risk management decisions, such as for public health. **Robust decision-making in the public health sector would be better supported through reporting raw observations and sample volumes so proper analytical methods can follow and accurate conclusions can be drawn.**

For further information and publications, please visit www.waterSTP.ca or contact waterSTP@uwaterloo.ca

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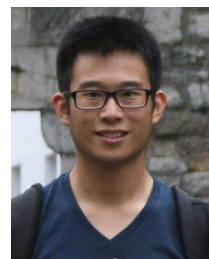
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This overview is adapted from: Chik AHS, Schmidt PJ, and Emelko MB (2018).

Learning Something From Nothing: The Critical Importance of Rethinking Microbial Non-Detects. *Frontiers in Microbiology* 9:2304.