



UNIVERSITY OF BIRMINGHAM

EMBRACE-WATERS statement: Recommendations for reporting of studies on antimicrobial resistance in wastewater and related aquatic environments



DARWIN

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Rationale and Objectives

We attempted a meta-analysis of studies comparing AMR in hospital versus community wastewater (1). To our frustration, this was not possible because different studies reported AMR prevalence on a distinct basis (see Example). We also found a high risk of bias in several elements of sampling, comparability and analysis categories in most studies (1). And there are other shortcomings.

Therefore, we decided to include many experts to produce reporting standards to enable meta-analyses and other value-adding integration of studies in the future (2).

Why Do We Need Standards of Reporting?



Current observations are piecemeal and need to be brought together in order to

- Generate reliable and accurate large-scale trends
- Enable meta-analysis and direct comparisons
- Improve the quality of scientific papers
- Enhance the communication among different experts

Example: Studies report AMR on a distinct basis

Vancomycin resistant Enterococci (VRE) in hospital (H) and community (C) - untreated (u) or treated (t) wastewater (1).

Study	Samples H	Samples C	ARB units	Hospital (H)	Community (C)
Blanch, 2003	59	207	Log CFU/100 ml VRE	334.59 (u)	2146.15 (u)
Caplin, 2008	26	48	Log CFU/100 ml VRE	1.3 x 10 ⁵ (u)	5.7 x 10 ⁵ (u)
Hamiwe, 2019	4	44			
Iversen, 2002	14	67	VRE + samples/all samples (%)	5/14 (36) (u)	21/35 (60) (u)
Kotzamanidis, 2009	16	42	VRE + samples/all samples (%)	14/16 (87) (u)	20/30 (67) (u)
Meir-Gruber, 2017	Not Reported		VRE + sampling location (%)	18/54 (33) (u)	6/55 (11) (u)
Narciso-da-Rocha, 2014	7	42		H >> C (u)	
Novais, 2005	14	12	VRE + samples/all samples (%)	11/14 (78.6) (u)	0/12 (0) (u)
Schwartz, 2003	6	10	% VRE	25% (u)	12.5 (t)
Silva, 2005	2	4	% Intermediate VRE/all isolates (%)	3/26 (11.54) (u)	9/37 (24.32) (u)

Method: Consensus building through a Delphi process

First step

Identify quality indicators for reporting through a systematic review of the literature

Second step

In-person meeting of multidisciplinary panel of experts
Generation of 20 recommendations in 5 categories

Third step

The expert panel was expanded and questionnaire rounds were used to solicit feedback

Result: Reporting recommendations

EMBRACE-WATERS checklist – recommendations for reporting on AMR in wastewater and related aquatic environments (2).

Topic	Checklist item
Title	1 Describe the environmental compartment and antimicrobial resistance studied
Abstract	2 Provide a structured summary including implications of key findings
Background	3 Describe the scientific background and the rationale of the study
Methods	
Planned location	4 Report on predefined sampling locations
Sample types	5 Describe sample types in each location
Technique	6 Describe the sampling techniques
Equipment	7 Describe the type of equipment used for sampling
Sample volume	8 Report the volume of the samples from all locations for each analysis
Sample processing	9 Report sample processing by sample type and on-site preservation methods
Source characterization	10 If sampling water from a point source (agricultural water, raw sewage inlet, WWTP effluent, etc.) or downstream the point source, report the exact source and its characteristics; In the absence of a point source, report characteristics of the watershed
Microbiological methods	11a Describe the microbiological methods used to detect bacteria
	11b Report how antibiotic resistance was assessed
Analysis plan	12 Describe the data analysis or analytical pipeline planned for comparison. Report on use of statistical tests
Sample size	13 Calculate the number of samples required to address the research question (statistical power calculation)
Results	
Locations	14 Report and describe actual sampling locations
Dates and weather	15a Report the season, dates and frequency of sampling
	15b Provide description of weather conditions in the period leading up to the sampling, precipitation and any other external factors
Water quality indicators and metadata	16 Report general water quality conditions and any other meta-data
Results	17 Report results per location, including negative results
Units of analysis	18 If possible, report outcomes as concentration units (and normalized concentration) and provide confidence intervals for all results
Post hoc analysis	19 Describe statistical analysis performed if different than planned, report on additional post-hoc analyses if done
Discussion	
Interpretation	20 Discuss the study findings in context of existing evidence
Limitations	21 Address the study limitations

Conclusions and Future Outlook

- EMBRACE-WATERS reporting standards facilitate comparability and integration of studies that would otherwise remain disjoint
- Huge potential for added value if widely adopted
- Standards can and should evolve

References

- 1 Hassoun-Kheir N, Stabholz Y, Kreft J-U, de la Cruz R, Romalde JL, Nesme J, Sørensen SJ, Smets BF, Graham D, Paul M (2020). Comparison of antibiotic-resistant bacteria and antibiotic resistance genes abundance in hospital and community wastewater: A systematic review. *Science of The Total Environment* 743: 140804
- 2 Hassoun-Kheir N, Stabholz Y, Kreft J-U, de la Cruz R, Dechesne A, Smets BF, Romalde JL, Lema A, Balboa S, García-Riestra C, Torres-Sangiao E, Neuberger A, Graham D, Quintela-Baluja M, Stekel DJ, Graham J, Pruden A, Nesme J, Sørensen SJ, Hough R, Paul M (2021). EMBRACE-WATERS statement: Recommendations for reporting of studies on antimicrobial resistance in wastewater and related aquatic environments. *One Health* 13: 100339

