



DRUM

Drivers of Resistance in Uganda & Malawi

POLICY BRIEF

Water, sanitation and hygiene (WASH): a critical barrier against antimicrobial resistance (AMR) in Malawi

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KEY MESSAGES

- The 2030 WASH agenda targets achieving access to adequate and equitable sanitation and hygiene for all but progress is slow in many low and medium-income countries (LMICs).
- The presence of bacteria, especially *E. coli*, in both rural and urban domestic water sources such as streams, shallow wells and some boreholes points to a risk to human health including AMR.
- Populations in LMICs are exposed to faecal material containing AMR elements through multiple pathways due to poor WASH measures.
- Microbes in the environment as a result of poor WASH are exposed to elements and chemicals in the environment which can drive AMR.
- Lack of surveillance data to quantify the problem and insufficient human and financial resources as well as microbiology expertise to manage the problem are major barriers to addressing WASH related AMR in LMICs.
- In order to effectively address AMR, a One Health approach is essential including incorporating WASH.
- Interrupting bacterial and AMR transmission through promoting appropriate WASH practices and developing adequate infrastructure will reduce the incidence of AMR infection and spread.

Context

Antimicrobial resistance (AMR) has reached a critical point and is already estimated to be responsible for over 700,000 deaths per year.¹ It is expected that by the year 2050, AMR will claim over 10 million lives annually and will cost over US\$ 100 trillion per year to manage.¹ While this is a global threat, Africa and Asia are likely to be disproportionately affected as they do not have established AMR surveillance systems.² Many key AMR bacteria are present throughout humans, animals and the environment, and are in a constant state of flux between all three “compartments”. In the environment, bacteria increasingly encounter antibiotic residues (AR), which drive transfer of antibiotic resistance genes (ARG).³ This cycle of transmission between humans, animals and the environment is exacerbated if there is inadequate access to effective WASH infrastructure, as is frequently the case in LMICs. For example, a lack of faeces containment, management and treatment can lead to widespread distribution of AMR bacteria in the environment, and increased faecal-oral transmission of bacteria. As such, improved WASH facilities and the associated practices have the potential to minimise the spread of key human pathogens and AMR in the ecosystem. The World Health Organisation (WHO) is committed to addressing AMR through the Global Action Plan on Antimicrobial Resistance (GAP on AMR), and have highlighted WASH as a key area to be addressed.⁴

Water

Over the years, Malawi has made remarkable improvements in access to safe water with current coverage at 80%.⁵ However, only 40% of the piped, 5% boreholes, 27% dug wells and springs are located within the premises⁶ and therefore there still exist some serious safe water access challenges in both urban and rural areas especially where they depend mainly on ground water supply.⁷ As a result, a good fraction of the population (approximately 20%) still access water from unsafe communal ground water sources (such as shallow wells, some boreholes and streams) some

¹ O'Neill, J., (2016). Tackling Drug-Resistant Infections Globally: final report and recommendations, The Review on Antimicrobial Resistance. London, UK.

² WHO. 2014. Antimicrobial resistance: global report on surveillance 2014. http://apps.who.int/iris/bitstream/10665/112642/1/9789241564748_eng.pdf?ua=1

³ Susanne Wuijts, Harold H. J. L. van den Berg, Jennifer Miller, Lydia Abebe, Mark Sobsey, Antoine Andremont, Kate O. Medlicott, Mark W. J. van Passel, Ana Maria de Rada Husman (2017). Towards a research agenda for water, sanitation and antimicrobial resistance. *J Water Health* 1 April 2017; 15 (2): 175–184. doi: <https://doi.org/10.2166/wh.2017.124>

⁴ WHO (World Health Organization). Global action plan on antimicrobial resistance (2015), p. 28; www.who.int/iris/handle/10665/193736.

⁵ USAID. <https://www.usaid.gov/malawi/global-health/wash>

⁶ JMP. (2017). Safely managed drinking water. <http://apps.who.int/bookorders>.

⁷ Government of Malawi (2013). Household Water Treatment and Safe Storage in Malawi: Report on the 18 April, 2013 Stakeholders' Consultative Workshop on the Development of a National Action Plan. Malawi, Ministry of Health, Government of Malawi, Lilongwe.

of which are grossly polluted with disease causing bacteria and other contaminants. For example, high concentrations of faecal coliform and faecal Streptococci have been detected in the shallow wells and some boreholes in Lilongwe⁸, Balaka⁹, Blantyre, Chiradzulu and Mulanje⁹; and the Likangala river in Zomba.¹⁰ Such contaminants originate from a variety of practices which include: open defaecation, pit latrines constructed close to water sources, improper waste and waste water disposal in the overcrowded areas, discharge of livestock faecal waste into the water sources and soil re-suspension within the well during water withdrawal.^{8,9} Further, water drawn from such sources is subject to post collection contamination as a result of poor transportation (uncovered buckets), improper storage and lack of treatment before domestic use.⁷ Also, it is often the case that people use unsafe water for cooking and cleaning, a practice that has been associated with drug resistant typhoid fever.¹¹ These environmental bacteria often contain AMR elements some of which, like *E. Coli*, have great capacity to accumulate resistance genes¹² and the potential of spreading them to humans and animals that consume or get in contact with such water (e.g., bathing) before treatment. Constructing fences around water points to secure them from domesticated animals, avoiding contaminated water sources, treating and proper storage of domestic water will therefore reduce the risk of AMR spread to humans and animals.

Sanitation

Inadequate sanitation is a major cause of disease transmission worldwide¹³ as it exposes humans and animals to contaminated water, solid wastes, wastewater and particularly faecal matter. Wastes, including faecal matter, may harbour antimicrobial residues making onsite sanitation, waste collection and treatment sites hotspots for the spread and selection of AMR bacteria, which are later transferred into the environment if the wastes are improperly discharged.^{14,15} In Malawi, solid and liquid waste management is limited and inadequate¹⁶ as follows;

- **Human waste**

In Blantyre City, for example, human waste accounts for 90% of faecal sludge (FS) generated while the remaining 10% is waste water (WW). Due to poor containment structures such as; unlined pit latrines, inefficient emptying mechanisms; ineffective waste treatment since most treatment sites are dysfunctional; and open defaecation: only 34% is properly managed (1% WW treated, 24% FS contained on site and 8% FS treated). Therefore, 66% of the wastes (2% open defaecation, 9% untreated WW, 55% untreated FS) enter the environment unsafely¹⁷ thereby contaminating the surroundings including rivers and soils with faecal contaminants which are rich in bacteria including that which is AMR.

- **Animal waste**

Open animal farming is a common practice in the rural areas

of Malawi and therefore spreads animal waste around households and the wider environment. Poor antibiotic adsorption in animal guts produces animal wastes which are largely faecal matter and are particularly cited as hotspots for antibiotic residues.¹⁸ Indiscriminate spread of animal wastes therefore spreads the faecal matter around households as they get in direct contact with humans (especially young children) and in the wider environment as are washed down the soil profile, rivers and open wells which humans share with animals thereby driving AMR.

- **Solid waste**

In Malawi, most solid waste is never collected (70%) ending up on the streets, in streams and open dumpsites; while some of the 30% collected solid waste is ineffectively disposed.¹⁶ This creates a breeding ground for bacteria which later spread into the environment. The bacteria then find their way to humans and animals through water and the food chain.

All these compromise the state of sanitation in the country as untreated and insufficiently treated wastes contaminate the soil, surface as well as ground water, spread diseases and are a driver of AMR. With over 70% of the population in Malawi without access to internationally approved sanitation facilities,¹⁹ there is a high risk of them coming into contact with faecal contaminants including faecal matter which exposes them to AMR bacteria. Therefore, proper sanitation practices like; proper management of livestock and stopping open defecation; and appropriate sanitation infrastructure such as well managed latrines, sewerage systems and effective waste collection and treatment sites will limit human and animal contact with faecal matter breaking the AMR transmission pathway.

Hygiene

Water is an important agent in the improvement of hygiene as it helps to prevent and separate faecal matter from human and animal contact. This reduces faecal-oral transmission and consequently diseases, making Sustainable Development Goal (SDG) 6 (Clean Water and Sanitation) an important factor in the realisation of SDG 3 (Good Health and Wellbeing).²⁰ However, harmful bacteria, including those with AMR, emerge and spread in the communities due to poor hand and food hygiene practices as well as poor community hygiene facilities as explained below;

- **Hand hygiene**

Bacteria, including that which is AMR easily find its way to the human mouth due to poor hand hygiene practices. These include not washing hands; before and after eating, before preparing foods, after defaecating and after touching the soil, dirty objects and surfaces. Unwashed hands are critical in the transmission of faecal matter (which contain harmful bacteria including that with AMR) into the mouth.

- **Food hygiene**

Improper handling of foods at commercial and household

⁸ Chidya, R.C.G., Mulwafu, W.O., Banda, C.T.S. (2016). Water supply dynamics and quality of alternative water sources in low-income areas of Lilongwe City, Malawi. *Phys. Chem. Earth*. <http://dx.doi.org/10.1016/j.pce.2016.03.003>.

⁹ Mkwate, Raphael & Chidya, Russel & Wanda, Elijah (2016). Assessment of Drinking Water Quality and Rural Household Water Treatment in Balaka District, Malawi. *Physics and Chemistry of the Earth, Parts A/B/C*. 10.1016/j.pce.2016.10.006.

¹⁰ D Pullanikattil, IG Palamuleni & TM Ruhiga (2015). Impact of land use on water quality in the Likangala catchment, southern Malawi. *African Journal of Aquatic Science*, 40:3, 277-286, DOI: 10.2989/16085914.2015.1077777.

¹¹ Gauld, J.S., Olgemoeller, F., Nkhata, R., Li, C., Chirambo, A., Morse, T., Gordon, M.A., Read, J.M., Heyderman, R.S., Kennedy, N., Diggle, P.J., & Feasey, N.A. (2020). Domestic River Water Use and Risk of Typhoid Fever: Results From a Case-control Study in Blantyre, Malawi. *Clinical Infectious Diseases: an official publication of the Infectious Diseases Society of America*, 70(7), 1278-1284. <https://doi.org/10.1093/cid/ciz405>

¹² Poirel L, Cattoir V, Nordmann P (2008). Is plasmid-mediated quinolone resistance a clinically significant problem? *Clinical microbiology and infection: the official publication of the European Society of Clinical Microbiology and Infectious Diseases* 14: 295-297.

¹³ WHO/UNICEF JMP (2015). Available at: <https://www.unwater.org/publications/whounicef-joint-monitoring-program-water-supply-sanitation-jmp-2015-update/>

¹⁴ Rizzo, Luigi, Fiorentino, A., & Anselmo, A. (2013). Advanced treatment of urban wastewater by UV radiation: Effect on antibiotics and antibiotic-resistant *E. coli* strains. *Chemosphere*, 92(2), 171-176. <https://doi.org/10.1016/j.chemosphere.2013.03.021>

¹⁵ L. Rizzo, C. Manaia, C. Merlin, T. Schwartz, C. Dagot, M. C. Ploy, I. Michael, D. Fatta-Kassinos (2013). Urban wastewater treatment plants as hotspots for antibiotic resistant bacteria and genes spread into the environment: A review. *Sci. Total Environ.* 447, 345-360.

¹⁶ Malawi: Country Environmental Analysis (2019). World Bank, Washington DC.

¹⁷ SFD Blantyre (2019). Available at: https://www.susana.org/_resources/documents/default/3-3545-7-1550665329.pdf

¹⁸ Samah, A.K., Meyer, M.T., and Boxall, A.B. (2006). A global perspective on the use, sales, exposure pathways, occurrence, fate and effects of veterinary antibiotics (VAs) in the environment. *Chemosphere*, 65(5), 725-759.

¹⁹ UNICEF (2020). Available at: <https://www.unicef.org/malawi/water-sanitation-and-hygiene>

²⁰ WHO Water, Sanitation and Hygiene strategy 2018-2025. Geneva: World Health Organization; 2018 [WHO/CED/PHE/WSH/18.03]. Licence: CC BY-NC-SA 3.0 IGO.

levels can lead to disease and AMR transmission due to direct and cross contamination, or multiplication of pathogens. These poor practices include; improper storage, use of dirty utensils, not washing foodstuffs with clean water before preparation and improper cooking of animal products such as meats, milk and eggs.

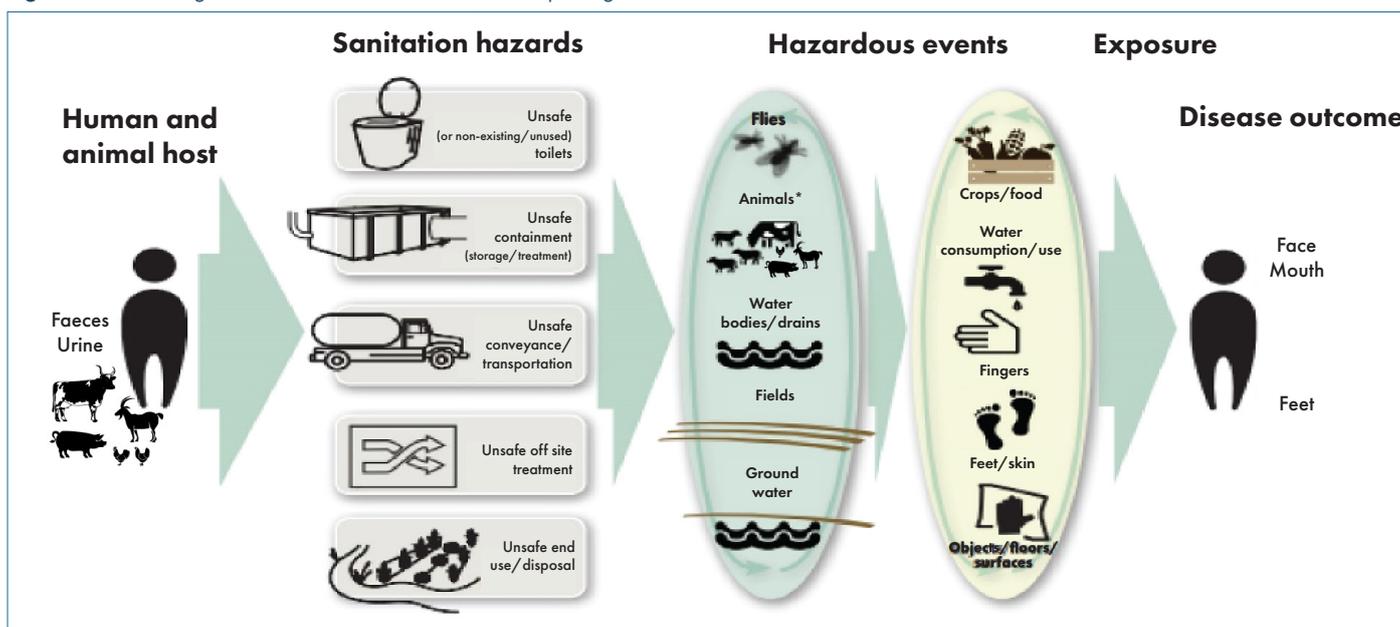
These poor hygiene practices (behaviour) and facilities (infrastructure) create hazards which encourage the development and spread (exposure) of AMR bacteria in the environment. Better hygiene practices like washing hands with soap at critical times, treating domestic water to make it potable, proper water and food storage, cooking animal products appropriately; and constructing improved hygiene facilities such as proper latrines and

the cycle of harmful bacteria including that which cause AMR in the environment.

Recommendations to addressing WASH related AMR

AMR is a growing problem that needs urgent attention. With its transmission occurring across the human, animal and environment divide, to address it calls for a concerted 'one health' approach with a consideration on the significant role played by WASH practices and infrastructure in driving AMR development and spread of AMR organisms. We therefore recommend the following actions:

Figure 1: The F-Diagram: Transmission of excreta-related pathogens



Adapted from WHO (2018) Guidelines on sanitation and health

hand washing facilities will break the spread of harmful bacteria including those with AMR elements. Hand hygiene facilities need to be considered not only in household environments, but also in institutional settings, work settings and in public spaces.

Chemical use in WASH practices

Some improved practices aimed at eradicating microbes in water treatment, sanitation and hygiene have promoted the use of chemicals as disinfectants. Where the chemicals have been ineffectively used, some harmful microbes survive and their exposure to the chemicals accelerate the emergence of AMR. For example, improper treatment of drinking water has been observed to expose bacteria to chemicals which have increased the antibiotic resistance of the bacteria that survive from the process.²¹ Further, wastewater treatment plants bring together various bacteria and chemicals from homes, institutions and industries. Ineffective treatment leads to further transfer and selection of harmful bacteria where new resistant elements that prevail over a variety of chemicals emerge.¹⁵ Releasing such poorly treated waste water into environment simply contaminates it with AMR bacteria. Effective use of chemical disinfectants, proper water and waste treatment will therefore break

Improve understanding of the current situation through effective surveillance

Because of lack of AMR surveillance in Malawi, there are few data on the scale of the problem and how issues such as WASH are contributing to the challenge. Therefore, surveillance and research is needed to generate more evidence that will determine the scale of the problem, improve the current understanding of AMR associated with the inadequacies of WASH infrastructure and behaviours and inform strategies to contain the problem.

Strengthen the capacity of personnel and infrastructure to improve surveillance

LMICs including Malawi usually face capacity challenges when it comes to addressing emerging issues.²² This is usually because of financial deficiencies. As highlighted by WHO, GAP (2015), addressing surveillance capacity gaps which include microbiology knowledge, skills and infrastructure should be prioritised in order to effectively investigate WASH related AMR.

Increase awareness and understanding in the wider population

AMR being a relatively new problem, and not a disease in itself but a complication of infection may not be well understood by the larger population. Therefore, public engagement activities must be undertaken to raise AMR awareness.

²¹ Xi, C., Zhang, Y., Marrs, C. F., Ye, W., Simon, C., Foxman, B., & Nriagu, J. (2009). Prevalence of antibiotic resistance in drinking water treatment and distribution systems. *Applied and environmental microbiology*, 75(17), 5714–5718. <https://doi.org/10.1128/AEM.00382-09>
²² Leopold SJ, van Leth F, Tarekegn H, Schultsz C. (2014). Antimicrobial drug resistance among clinically relevant bacterial isolates in sub-Saharan Africa: a systematic review. *The Journal of Antimicrobial Chemotherapy*. Sep;69(9):2337-2353. DOI: <https://doi.org/10.1093/jac/dku176>.

Support a combined infrastructure and behaviour change approach to improving WASH practices

The majority of the WASH related challenges faced in LMICs are a combination of both inadequate WASH infrastructure, and a lack of behaviour centred approaches to improving practices. We need innovation, political will, and a greater understanding of the context to develop solutions in this area which are fit for purpose. Making gains in this area will help reduce the environmental spread of human and animal faeces thereby supporting the control of AMR emergence and spread.

Embed WASH and a One Health approach in all AMR related policies

AMR cuts across the human health, animal health as well as the environment (One Health) and the relationship between deficiencies in WASH infrastructure and practice and AMR transmission is a critical example of this. Emergence of AMR therefore reflects deficiencies in public health infrastructure and systems and can only be effectively addressed by taking a One Health approach.

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