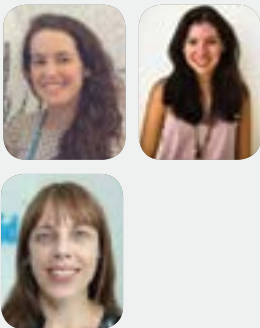


# PREVENTION FIRST: TACKLING ANTIMICROBIAL RESISTANCE THROUGH WATER, SANITATION AND HYGIENE

**ALISON MACINTYRE** (TOP LEFT), HEALTH ADVISOR, WATERAID AUSTRALIA; **MEGAN WILSON-JONES** (TOP RIGHT), POLICY ANALYST ON HEALTH AND HYGIENE, WATERAID UK AND **Yael VELLEMAN** (BOTTOM), SENIOR POLICY ANALYST ON HEALTH AND HYGIENE, WATERAID UK



This article focuses on three neglected elements of WASH (Water, Sanitation and Hygiene) and AMR in healthcare facilities and the environment. It highlights the importance of WASH for mothers and newborns, and on synergizing WASH policies and approaches to support the continuum of care from healthcare settings to the home. At the environmental level, reducing antibiotic consumption and misuse through improved community WASH is explored. Finally, the article discusses the importance of WASH for preventing epidemics and outbreaks of drug-resistant infections.

The impact of lack of water, sanitation and hygiene (WASH) on antimicrobial resistance (AMR) is multifaceted and complex. In earlier editions, AMR Control has highlighted several critical aspects of the role of WASH in addressing AMR in the environment and healthcare settings. These have highlighted water, sanitation (1) and hygiene (2, 3), specific needs as well as the cumulative impacts of addressing WASH together (4). Despite identifying needs and actions relating to water, sanitation and hygiene (WASH) and infection, prevention and control (IPC), many challenges remain in terms of interventions and research.

The scale of this challenge cannot be underestimated. Approximately one in three people worldwide live without access to improved sanitation and a billion people still practise open defecation (5). Whilst data on hygiene behaviours are limited, studies have estimated that the percentage of people washing their hands with soap after contact with excreta may be below 20% (6). These aspects contribute to a vicious cycle of common infections such as diarrhoeal diseases, and overreliance and misuse of antibiotics (7). Additionally, in low- and middle-income countries almost 40% of healthcare facilities do not have a water supply, 19% do not provide adequate sanitation and 35% do not have hand hygiene facilities (8). Urgent action is required to improve WASH in all settings, including the community and healthcare facilities.

To complement previous WASH-related AMR Control

publications and highlight why scaled up and accelerated efforts to improve WASH are critical to tackling AMR, this article focuses on three neglected elements of WASH and AMR in healthcare facilities and the environment. At the healthcare setting level, it highlights the importance of WASH for mothers and newborns, and on synergizing WASH policies and approaches to support the continuum of care from health settings to the home. At the environmental level, reducing antibiotic consumption and misuse through improved community WASH is explored. Finally, the article discusses the importance of WASH for preventing epidemics and outbreaks of drug-resistant infections.

## Water, sanitation and hygiene to reduce antimicrobial transmission in healthcare settings, communities and the environment

The recent *Lancet* series on AMR (9) highlights that hospital infections are the third major driver of AMR globally. Reducing the spread of healthcare-associated infections (HCAIs) requires improving IPC and WASH in healthcare settings, and this is also crucial to deliver quality healthcare that can limit the spread of drug-resistant infections and the emergence of new strains (10), particularly among high-risk individuals, including mothers and newborns (11). Furthermore, healthcare facilities can generate large amounts of human waste, medical waste and wastewater, which, when poorly managed, can

contaminate nearby environments and communities (12). Healthcare facilities without adequate WASH provisions can become epicentres of disease transmission that impact directly on surrounding communities.

#### *Resistance in healthcare settings: The vulnerability of mothers and newborns*

In September 2016, the high-level political declaration on AMR at the UN General Assembly urging governments and partners to act on AMR (13) was agreed. In the same week, the *Lancet* released its Maternal Health Series (14). While both milestones provide key actions for improving human health, beyond recognizing the potential impact of AMR on women and newborns during childbirth, the political declaration did not provide clear action statements to address the needs of this high-risk population. This missed opportunity demands renewed attention and action to align AMR activities with quality of care efforts to improve maternal and newborn health.

In low- and middle-income countries (LMICs), the majority of women are now reaching a health facility to give birth, and this upward trend in facility deliveries is predicted to continue in coming years (15). Without adequate hygiene and IPC, mothers and newborns are particularly vulnerable to infections at birth (16). With an increasing number of women delivering in facilities, a high number of facilities with poor WASH, and the growing threat of AMR, a perfect storm is emerging that may compromise global successes in maternal and newborn health.

While disease surveillance for HCAs in LMICs is poor, a systematic review of HCAs contracted in healthcare settings, carried out in Africa in 2011, found HCAI rates as high as 45.6% in some countries (17). Furthermore, in sub-Saharan Africa studies have shown up to 20% of women have a wound infection following a Caesarian section (18). This threat requires urgent action. Improving IPC, WASH and the quality of care in maternity settings will reduce the risk of infection for mothers and newborns, reduce the need for unnecessary routine prophylactic use of antibiotics, and, subsequently, AMR. Particular attention should also be given to other vulnerable groups, including people living with HIV/AIDS, who have compromised immune systems and are therefore susceptible to opportunistic infections. Improved WASH practices are essential to preventing opportunistic infections, and should be an integral part of HIV/AIDS programmes (19).

Existing efforts, such as the WHO and UNICEF Global Action Plan for WASH in healthcare facilities (20) and the recently launched WHO Standards for Improving Quality of Maternal and Newborn Care in Health Facilities (21), are driving progress. Success will depend on intensifying actions, forging new collaborations and ensuring efforts to improve IPC and WASH in healthcare facilities are central to quality of care improvement

initiatives (22). All AMR, WASH and IPC activities should be embedded within national health strategies and systems, and support efforts to achieve Universal Health Coverage.

#### *Resistance in humans: Reduce infections, reduce antibiotic use*

Improvements in the environment in which people live, including water and sanitation infrastructure, have played a fundamental role in reducing the burden of infectious diseases and improving health outcomes globally since the nineteenth century. Despite such progress, people in many low- and middle-income countries continue to live in poverty without these basic services, and this contributes to a substantial burden of infectious diseases. Many of these diseases, including diarrhoea, pneumonia and cholera, are commonly treated with antibiotics, despite being easily prevented through basic improvements in WASH (23). Preventing infections from occurring in the first place reduces the pressures that drive resistance (24).

Diarrhoea, in particular, continues to be a leading cause of child morbidity and mortality, with over 1.7 billion cases globally every year (25) and contributing to 9% of all deaths among children under five (26). With 58% of these deaths directly resulting from poor WASH (27), this contributes to more than 300,000 under-five deaths annually (28). A consequence of this substantial burden is that millions of cases of diarrhoea are treated with antibiotics every year, including for non-bacterial causes such as viral diarrhoea, for which antibiotics are redundant (29). It has been estimated that in four middle-income countries alone, Brazil, Indonesia, India and Nigeria, 494 million cases of diarrhoea are treated annually with antibiotics; preventing diarrhoea occurring through universal access to improved water and sanitation could reduce the volume of antibiotics consumed by 60% in these four countries (30).

Overuse and misuse of antimicrobials is of growing concern with evidence to show a direct correlation between the use of antibiotics and resistance (31), and as such, countries consuming higher levels of antibiotics show higher rates of resistance (32). It is difficult to quantify the extent to which antimicrobials, and particularly antibiotics, are incorrectly used and prescribed; however, a recent study by the Centers for Disease Control and Prevention (CDC) estimated that at least 30% of antibiotics in outpatient settings in the United States are unnecessarily prescribed, resulting in around 47 million excess prescriptions each year (33). Overuse of antibiotics in low-income settings is even more challenging to control given common prophylactic use to prevent sepsis and other infections in some healthcare settings (34). Although overuse and misuse of antibiotics is driven by a multitude of factors, reducing the number of infections from occurring is a critical first step to reduce their use (35).

**Resistance in the environment: Limit transmission and emergence**

The role of the environment in the transmission of resistance and the emergence of new resistance is a relatively unexplored but critical domain in the context of AMR. Resistance in the environment can originate from humans, animals or the environment itself, and the complex interplay between these ecologies means that resistance can move between each, transferring resistance and creating new forms of clinically-relevant resistant strains (36). Wastewater and faecal waste (from open defecation and poor sanitation) are common sources for a multitude of bacteria and other microbes, including antimicrobial-resistant bacteria and AMR genes (37); therefore, efforts to break the chain of transmission between humans and the environment through improving water and sanitation infrastructure is vital to not only limiting the spread of resistance, but also in reducing the risk of new resistance forming. Veterinary medicine, agriculture, human medicine and the environment often act in silos; however, the interplay of resistance between these domains requires a much more comprehensive strategy in line with the One Health approach.

**Universal water and sanitation access to prevent looming epidemics of drug-resistant diseases**

Recent history has shown that the threat of epidemics and pandemics has not disappeared with the advent of new medical advances and better information systems. As outbreaks of severe diseases, such as SARS, Avian Influenza, Swine Flu, and more recently Ebola and Zika have shown, this threat is ever present, and is even more worrying if the threat of AMR is taken into consideration.

**Vector-borne disease**

The day-biting *Aedes* mosquitos are particularly relevant to water supply and environmental sanitation aspects, due to their preference for breeding in water tanks used in areas without piped water systems, clogged storm drains or solid waste such as cans or tyres. The threat caused by the habitat expansion of these mosquitoes has been largely overlooked by the international community until the Zika virus and its links with microcephaly and Guillain-Barré syndrome burst into public consciousness following a large outbreak in Brazil and the rest of the Americas (38). Less attention has been paid to the related threats of dengue, yellow fever and chikungunya – all transmitted by the same vector. With annual dengue cases increasing dramatically (39) and recent concerns that the increased use of new vaccines in previously unexposed populations may increase the severity of the disease (40), environmental prevention has never been more crucial. Although the risks presented by yellow fever have been reduced through widespread vaccine use, recent outbreaks serve as a reminder that large epidemics can occur when

the virus enters highly populated areas with low vaccination use (41).

**Ebola**

It is increasingly recognized that poor access to water and sanitation services contributed to the rapid spread of the Ebola virus in the West Africa outbreak in 2014. Infection prevention and control measures in healthcare settings, as well as reduction of human-to-human transmission in affected communities, are greatly hampered by the absence of sufficient water supplies and measures to contain human and medical waste and the compromised practice of essential hygiene measures, such as handwashing with soap (42).

**Cholera: Facing an old enemy with fewer weapons**

Despite the well-known mechanisms of transmission for this old water-borne scourge, cholera remains an ongoing challenge globally. Exacerbated by climate change, conflict and poor access to water supply and sanitation in outbreak-prone locations, scientists estimate millions of cases and tens to hundreds of thousands of deaths annually (43). While it is hoped that vaccines can play a role in reducing the severity of outbreaks, challenges of timely and complete coverage as well as relatively low efficacy make this an inadequate tool to respond to the magnitude of the challenge. Severe cases of cholera often require antimicrobial treatment to reduce the volume and duration of diarrhoea, which can be undermined by AMR (44). Recent reports have documented some tetracycline- and fluoroquinolone-resistant *V. cholerae* strains, and increasing multidrug resistance (45).

The above challenges are compounded by the deep changes to population movement and habitation patterns globally. Not only are people moving around more and faster, but they are also living more closely together in rapidly-expanding cities. While the proportion of urban population residing in slums in developing countries has decreased overall since 1990 (from 46% to 30% in 2014), absolute numbers have grown from 689m to 880m over the same period (46). Coupled with poor sanitation conditions and lack of safe water, disease outbreaks become harder to control even if the disease itself is not, strictly speaking, water-borne. The public health hazards that characterize urban slums are numerous, and include crowding, poor sanitation and poor storm drainage (47). These threats exacerbate the risk of outbreaks, and of further spread. As the world comes to terms with the implications of AMR, the international community must keep a keen eye on the horizon for the next emerging threat.

**Recommendations**

➔ Prioritize the prevention of infectious diseases through

improvements in water, sanitation and hygiene within priority plans to overcome AMR at global, national and local levels. Investments in universal WASH should be prioritized within healthcare settings, and in communities with the highest rates of infectious diseases and those at highest risk of infection.

- ➔ Improve IPC and WASH as a central component of healthcare facility improvement initiatives and in national health strategies as part of efforts to achieve quality Universal Health Coverage.
- ➔ Increase awareness of and research into the environmental dimensions to AMR threats using a One Health approach, and the role of WASH in limiting and breaking the transmission of resistance between humans, animals and the environment. Research institutions should seek to fund more multidisciplinary research on AMR through the One Health approach.
- ➔ Strengthen national and global institutions to plan for and respond to emerging health threats through a comprehensive and preventive approach, focused on reducing exposure and transmission, including strengthening surveillance and early warning systems across multiple domains. ■

*Alison Macintyre, BA, BSc, MPH, is Health Advisor at WaterAid Australia. She holds a BA and BSc (Hons) from Latrobe University and the University of Melbourne, respectively, and a Master of Public Health from the University of Melbourne. She has been working with WaterAid since 2013 leading WaterAid Australia's work on the intersection of water, sanitation and hygiene with human health. She supports health-related research, programming*

*and policy work in the South-East Asia and Pacific regions as well as supporting WaterAid's global policy and advocacy. Since 2015, Alison has been seconded part-time to WHO in Geneva to support the Global Action Plan on WASH in healthcare facilities with a particular focus on policy, advocacy and leadership.*

*Yael Velleman, BA, MSc, is Senior Policy Analyst on Health and Hygiene at WaterAid UK. She holds a Bachelor's degree in Development Studies from the University of East Anglia, and a Master's degree in Health Policy, Planning and Financing from the London School of Hygiene and Tropical Medicine and the London School of Economics and Political Science. She has been working with WaterAid since 2008, leading the organization's policy and advocacy on global health, and championing policy, programming and research innovation on comprehensive approaches to public health. Her experience includes linking water, sanitation and hygiene aspects with programmes to improve maternal and newborn health and nutrition. Since 2015, she has been seconded part-time to WHO in Geneva to support efforts to control neglected tropical diseases through improvements in water, sanitation and hygiene.*

*Megan Wilson-Jones, BSc, MSc, is Policy Analyst on Health and Hygiene at WaterAid UK. She holds a BSc (Hons) in Biochemistry from the University of St Andrews, and a MSc in Global Health and Public Policy from the University of Edinburgh. She has been working at WaterAid since 2015 in the global policy team, contributing to the organization's policy, advocacy and programme work to integrate water, sanitation and hygiene into health and nutrition approaches. Prior to joining WaterAid, Megan worked in various roles within global health including NGOs and academia.*

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