

Antibiotic Resistance prevention in Developing Countries Like Bangladesh : A Narrative Review

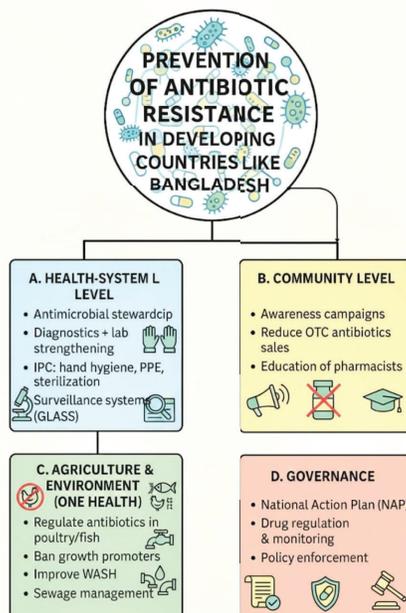
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Abstract

Antibiotic resistance (AR) has emerged as one of the greatest public health challenges globally, disproportionately affecting developing countries such as Bangladesh. The burden is intensified by widespread misuse of antimicrobials, inadequate diagnostic capacity, weak regulatory systems, over-the-counter access, poor infection prevention and control (IPC), suboptimal sanitation, and limited antimicrobial stewardship (AMS) programs. Bangladesh, like many low-resource South Asian nations, faces rapidly rising resistance among gram-negative organisms, methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant enterococci (VRE), extended-spectrum β -lactamase (ESBL)-producers, and carbapenem-resistant Enterobacterales (CRE). This narrative review summarizes the magnitude, drivers, consequences, and evidence-based strategies for antibiotic resistance prevention in Bangladesh and similar settings. Emphasis is placed on AMS in hospitals and the community, surveillance strengthening, One Health approaches, vaccination, water–sanitation–hygiene (WASH) improvements, regulatory reforms, and public awareness. The review also highlights successful global and regional interventions that may be adapted for Bangladesh.

Keywords: Antibiotic resistance, antimicrobial stewardship, Bangladesh, developing countries, One Health, infection prevention, ESBL, CRE.

Visual Abstract



Introduction

Antibiotics have transformed modern medicine, reducing morbidity and mortality from infectious diseases and enabling complex surgeries, transplantation, cancer chemotherapy, and intensive care treatment. However, the growing crisis of antibiotic resistance (AR) threatens to reverse these gains. The problem is particularly acute in developing countries such as Bangladesh, India, Pakistan, Nepal, and several African nations, where weak health systems, inadequate regulation, and widespread antibiotic misuse accelerate resistance development¹.

Globally, antibiotic-resistant infections caused approximately 4.95 million deaths in 2019, including 1.27 million deaths directly attributable to AR². Southeast Asia is among the highest-burden regions. Bangladesh, with high population density, large burden of infectious diseases, unregulated antibiotic sales, and limited

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laboratory diagnostic capacity, faces an escalating crisis³. ESBL-producing Enterobacterales, MRSA, multidrug-resistant (MDR) Acinetobacter, fluoroquinolone-resistant *Salmonella Typhi*, and carbapenem-resistant organisms are increasingly common⁴.

Research Strategy :

a) Study Design

This work adopted a narrative review design, aimed at synthesizing evidence on antibiotic-resistance (AMR) prevention in developing countries, with a special focus on Bangladesh.

b) Search Strategy

A comprehensive literature search was conducted between January 2010 and December 2024. The following electronic databases were systematically searched: PubMed/MEDLINE, Scopus, Web of Science, Google Scholar EMBASE, WHO Global Index Medicus, Bangladesh Journals Online (BanglaJOL), CDC and WHO AMR portals (grey literature)

c) Search Terms

Search strings combined medical subject headings (MeSH) and free-text keywords using AND/OR logic. Examples include: “antimicrobial resistance” OR “antibiotic resistance” “prevention” OR “control” OR “stewardship” “developing countries” OR “low- and middle-income countries” OR “LMICs” “Bangladesh” “infection prevention” OR “IPC” “antibiotic misuse” OR “prescribing practices” “one health” OR “environmental resistance”

d) Eligibility Criteria

i) Inclusion Criteria

- Articles published in English (Please mention the publication year such as; (2010 to 2024)
- Studies conducted in developing countries / LMICs
- Publications related to AMR prevention, surveillance, stewardship, IPC, policy, community practices, animal health, or environmental resistance
- All study designs: observational, interventional, experimental, reviews, meta-analyses, surveillance reports
- Grey literature where appropriately validated (WHO, CDC, DGHS Bangladesh, FAO, OIE, World Bank, UN reports)

ii) Exclusion Criteria

- Studies focusing exclusively on high-income-country settings

- Articles lacking clear methodology
- Case reports unrelated to resistance prevention
- Conference abstracts without full text
- Duplicated studies

e) Ethical Considerations

As this review used publicly available published data without involving human participants, ethical approval was not required.

Discussion

This narrative review synthesizes evidence on drivers, consequences, and practical strategies for AR prevention in developing countries with specific emphasis on Bangladesh.

A) Magnitude of Antibiotic Resistance in Developing Countries

i) Global overview

The World Health Organization (WHO) has repeatedly warned about the rapid spread of resistant pathogens. High resistance rates to first-line agents for common infections—such as urinary tract infection (UTI), pneumonia, sepsis, gonorrhoea, and diarrheal diseases—have been documented across Asia and Africa⁵. MDR tuberculosis remains a major problem. Resistance among gram-negative bacteria is particularly problematic due to limited new drug development.

ii) Burden in South Asia

South Asia is one of the world’s largest consumers of antibiotics. Studies show alarmingly high resistance rates to penicillins, cephalosporins, fluoroquinolones, and carbapenems among Enterobacterales⁶. ESBL prevalence exceeds 60% in several tertiary hospitals. Carbapenem resistance is rising among *Klebsiella pneumoniae* and *Acinetobacter baumannii*

iii) Bangladesh-specific data

In Bangladesh, community and hospital resistance rates are increasing faster than in many comparable countries. A nationwide antimicrobial surveillance program from 2016–2020 reported high resistance rates among priority pathogens⁷. ESBL-producing *E. coli* and *Klebsiella* exceeded 70% in some regions; MRSA rates surpassed 40%; and Acinetobacter showed >60% carbapenem resistance. An increasing trend in fluoroquinolone-resistant *Salmonella Typhi* has also been documented⁸.

The combination of overuse, counterfeit drugs, and poor infection control contributes significantly to the growing resistance burden.

B) Drivers of Antibiotic Resistance in Bangladesh and Developing Countries

i) Over-the-counter antibiotic sales

One of the strongest contributors is unrestricted access: antibiotics are widely available without prescription in Bangladesh⁹. Local pharmacies frequently dispense broad-spectrum antibiotics such as cephalosporins or azithromycin for viral illnesses including colds, fever, and acute gastroenteritis.

ii) Inappropriate prescribing by healthcare providers

Studies reveal that up to 60–70% of prescriptions in Bangladesh are inappropriate, often unnecessary, or dosed incorrectly¹⁰. Contributing factors include lack of continuing medical education (CME), patient pressure, limited diagnostics, and pharmaceutical promotions.

iii) Poor infection prevention and control (IPC)

Overcrowded hospitals, lack of trained personnel, inadequate hand hygiene, insufficient isolation rooms, and limited microbiology support enable rapid transmission of resistant organisms¹¹.

iv) Substandard and counterfeit antibiotics

Weak regulatory systems allow entry of counterfeit or low-quality antimicrobials, which contribute to treatment failure and selective pressure for resistance¹².

v) Agricultural antibiotic use

Antibiotics are extensively used in poultry, aquaculture, and livestock in developing countries. In Bangladesh, misuse of colistin, tetracyclines, and macrolides in animal feed is widespread¹³. Resistant bacteria can transfer to humans through food and water.

vi) Poor sanitation and WASH gaps

Poor hygiene practices, contaminated water, and inadequate waste disposal facilitate the spread of pathogens. Sewage systems often contain high levels of antibiotic residues and resistant organisms¹⁴.

vii) Limited surveillance and diagnostic capacity

Many hospitals lack functioning microbiology laboratories, limiting evidence-based prescribing and masking real resistance trends¹⁵.

C) Consequences of Antibiotic Resistance

i) Increased morbidity and mortality

Resistant infections are associated with longer illness duration, complications, and high mortality¹⁶.

ii) Higher healthcare costs

Resistant infections require expensive drugs, longer hospital stays, and intensive care utilization, imposing financial burdens on low-income populations¹⁷.

iii) Treatment failures

Rising resistance to first-line agents forces clinicians to use last-resort antibiotics such as colistin, tigecycline, or carbapenems, accelerating resistance to these agents¹⁸.

iv) Impact on healthcare systems

Surgeries, cancer therapy, and neonatal intensive care units (NICUs) are particularly threatened due to increased infection risk¹⁹.

D) Prevention Strategies

i) Antimicrobial Stewardship Programs (AMS)

AMS programs aim to optimize antibiotic use through guidelines, audits, feedback, and clinician education. Implementing AMS in Bangladeshi hospitals can significantly reduce unnecessary prescriptions (20). Core AMS components are

- Prospective audit and feedback
- Formulary restriction
- Pre-authorization
- Education and training
- Dose optimization
- De-escalation based on culture results

ii) Strengthening laboratory capacity and surveillance

Accurate diagnosis and culture-based therapy are essential. Strengthening national surveillance networks enables monitoring of resistance trends²¹.

iii) Infection prevention and control (IPC) strengthening

- Hand hygiene programs
 - Clean hospital environments
 - Isolation of MDR patients
 - Sterilization protocols
 - Adequate PPE
 - Water and sanitation improvements.
- Evidence from low-resource settings shows that proper IPC reduces healthcare-associated infections by up to 50%²².

iv) Regulation of antibiotic sales

Banning over-the-counter (OTC) antibiotic sales would substantially reduce misuse. Bangladesh's Directorate General of Drug Administration (DGDA) has taken early steps, but enforcement remains weak²³.

v) Public awareness and behavior change

Community-level interventions include: • Mass media campaigns • School-based education • Social media communication • Counseling by pharmacists. These strategies have significantly reduced unnecessary antibiotic use in multiple low-resource settings²⁴.

vi) One Health approach

Human, animal, and environmental health are interconnected. Strict regulation of antibiotic use in agriculture is essential²⁵.

vii) Vaccination

Vaccines reduce the need for antibiotics and prevent resistant infections. Pneumococcal conjugate vaccine (PCV) and typhoid conjugate vaccine (TCV) have shown substantial benefits²⁶.

viii) Improving WASH infrastructure

Access to safe water, sanitation, and hygiene reduces gastrointestinal and respiratory infections, decreasing antibiotic consumption²⁷.

ix) Research and training

Local research capacity must be enhanced to monitor resistance, develop local guidelines, and innovate context-specific solutions²⁸.

E) Country-Specific Recommendations for Bangladesh**i) National policy strengthening**

Bangladesh's National Action Plan (NAP) on AMR provides a framework, but implementation needs major investment and coordination²⁹.

ii) Hospital AMS implementation

Every tertiary hospital should establish an AMS committee staffed by infectious disease (ID) physicians, microbiologists, pharmacists, and nurses³⁰.

iii) Community interventions

It includes • Limit OTC sales • Engage local pharmacies in responsible dispensing training • Educate rural populations through community health workers³¹.

iv) Regulation in livestock and aquaculture

Banning growth-promoting antibiotics, enforcing veterinary supervision, and promoting vaccination in livestock³² are key determinants

v) Improving laboratory network

At least one microbiology lab per district hospital is

needed, supported by trained technologists and external quality assurance (EQA)³³.

vi) University and medical curriculum reforms

Antibiotic stewardship and AMR education should be mandatory in MBBS and postgraduate curricula³⁴.

F) Successful Global Models Adaptable to Bangladesh**i) Rwanda's national stewardship program**

Rwanda achieved significant reductions in inappropriate antibiotic use through strong government commitment and training programs³⁵.

ii) Thailand's antibiotic smart use (ASU) program

The ASU program successfully reduced antibiotics for acute respiratory infections by >30% through nationwide public campaigns³⁶.

iii) Vietnam's One Health model

Vietnam's integrated human-animal surveillance offers a practical model for Bangladesh³⁷.

iv) India's Chennai Declaration

A landmark multi-stakeholder roadmap led to improved national AMR policies and AMS programs (38).

G) Future Directions

Future strategies should include genomic surveillance, rapid diagnostic tests, AI-assisted prescribing, and expanded research on environmental AMR in rivers, soil, and sewage systems. Telemedicine may reduce unnecessary antibiotic use in rural areas.

Conclusion

Antibiotic resistance is a major threat to public health in developing countries, especially Bangladesh. The crisis requires a comprehensive, multisectoral approach involving stewardship, strong regulation, diagnostics strengthening, IPC, WASH interventions, and public awareness. Learning from global successful examples and tailoring interventions to local contexts is essential to protect antibiotic effectiveness for future generations.

References

1. Laxminarayan R, Sridhar D, Blaser M, Wang M, Woolhouse M, Scott C, et al. Achieving global targets for antimicrobial resistance. *Lancet*. 2016;387(10015):168–75.
2. Murray CJL, Ikuta KS, Sharara F, Swetschinski L, Aguilar GR, Gray A, et al. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *Lancet*. 2022;399(10325):629–55.

3. Ahmed I, Rabbi MB, Sultana S, Rahman A, Begum N, Haque R, et al. Antimicrobial resistance in Bangladesh: a systematic review. *Infect Drug Resist.* 2019;12:2129–43.
4. Monjur F, Rahman M, Hossain M, Kamruzzaman M, Faruque S, Khan A, et al. Trends of antimicrobial resistance in Bangladesh: an overview. *J Glob Antimicrob Resist.* 2021;25:430–8.
5. WHO Global Antimicrobial Resistance Surveillance System (GLASS) Report. World Health Organization; 2021.
6. Browne AJ, Chipeta MG, Haines-Woodhouse G, Kumaran EAP, Rao P, Sills G, et al. Global antibiotic consumption and resistance patterns in LMICs. *eLife.* 2021;10:e58205.
7. National AMR Surveillance Bangladesh 2016–2020. IEDCR, Dhaka.
8. Islam MS, Parvin M, Kabir M, Sultana R, Hossain MA, Alam M, et al. Rising fluoroquinolone-resistant *Salmonella* Typhi in Bangladesh. *Clin Infect Dis.* 2021;72(3):e605–12.
9. Chowdhury F, Sturm-Ramirez K, Al Mamun A, Imai N, Ahmed RN, Bhuiyan MU, et al. OTC antibiotic sales in Bangladesh: a cross-sectional survey. *BMJ Open.* 2021;11:e051215.
10. Rahman MS, Huda S, Khan M, Ahsan MR, Begum T, Rahman M, et al. Inappropriate antibiotic prescribing in Bangladesh: a multicenter analysis. *PLoS One.* 2020;15:e0235659.
11. Allegranzi B, Nejad SB, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of healthcare-associated infections globally. *Lancet.* 2011;377:228–41.
12. Almuzaini T, Choonara I, Sammons H, Ahmed F, Rahman S, Hossain A, et al. Substandard antibiotics in low-income countries: a review. *BMJ Glob Health.* 2021;6:e003480.
13. Hasan B, Sandegren L, Melhus Å, Drobní M, Hernandez J, Waldenström J, et al. Antibiotics in poultry in Bangladesh: ecological impact. *Sci Total Environ.* 2020;735:139384.
14. Hendriksen RS, Munk P, Njage P, van Bunnik B, McNally L, Lukjancenko O, et al. Global sewage resistome. *Nat Commun.* 2019;10:1124.
15. Okeke IN, Aboderin OA, Byarugaba DK, Ojo KK, Opintan JA, Rahman M, et al. Diagnostics gaps in Africa and Asia. *Clin Infect Dis.* 2020;70:533–7.
16. Cosgrove SE, Sakoulas G, Perencevich EN, Schwaber MJ, Karchmer AW, Carmeli Y, et al. Mortality associated with resistant infections. *Clin Infect Dis.* 2003;36:53–9.
17. Howard DH, Scott RD, Packard R, Jones E, O'Neill J, McGowan J, et al. Economic burden of antimicrobial resistance. *Health Aff.* 2021;40:1110–7.
18. Nation RL, Li J, Cars O, Gow N, Zavascki AP, Hawkey PM, et al. Last-resort antibiotics and resistance. *Lancet Infect Dis.* 2020;20:e223–33.
19. Allegranzi B, Pittet D, Sax H, Boyce J, Donaldson L, Storr J, et al. IPC importance in healthcare systems. *J Hosp Infect.* 2017;96:1–5.
20. Barlam TF, Cosgrove SE, Abbo LM, MacDougall C, Schuetz AN, Septimus EJ, et al. AMS guidelines in healthcare settings. *Clin Infect Dis.* 2016;62:e51–77.
21. O'Neill J, Smith R, Coast J, Millar M, Phillips I, Daborn C, et al. Surveillance strategies for AMR. Review on Antimicrobial Resistance. 2016.
22. Allegranzi B, Storr J, Dziekan G, Leotsakos A, Donaldson L, Pittet D, et al. Impact of IPC interventions. *Lancet Infect Dis.* 2016;16:125–38.
23. Mamun R, Rahman S, Hanif M, Sultana R, Karim F, Hossain M, et al. Regulation of antibiotic dispensing in Bangladesh. *Health Policy Plan.* 2020;35:910–9.
24. Huttner B, Goossens H, Verheij T, Harbarth S, Bonten M, Cars O, et al. Public awareness campaigns. *Lancet Infect Dis.* 2010;10:17–31.
25. Robinson TP, Bu DP, Carrique-Mas J, Fèvre EM, Gilbert M, Grace D, et al. One Health approaches. *Philos Trans R Soc Lond B Biol Sci.* 2016;371:20160190.
26. Wahl B, O'Brien KL, Greenbaum A, Majumder A, Liu L, Zlotorzynska M, et al. Vaccine impact on antibiotic use. *Lancet Glob Health.* 2018;6:e26–34.
27. Prüss-Ustün A, Wolf J, Bartram J, Clasen T, Cumming O, Higgins J, et al. WASH and infection reduction. *Int J Hyg Environ Health.* 2019;222:765–77.
28. Tacconelli E, Carrara E, Savoldi A, Harbarth S, Mendelson M, Monnet DL, et al. Research needs for AMR. *Lancet Infect Dis.* 2018;18:318–27.
29. Ministry of Health and Family Welfare, Bangladesh. National Action Plan on Antimicrobial Resistance 2017–2022.
30. Davey P, Marwick CA, Scott CL, Charani E, McNeil K, Brown E, et al. Hospital AMS effectiveness. *Cochrane Database Syst Rev.* 2017;2:CD003543.
31. Biswas M, Roy DN, Karim M, Islam M, Zaman F, Hasan I, et al. Community use of antibiotics in Bangladesh. *Trop Med Int Health.* 2020;25:944–54.
32. Van Boeckel TP, Brower C, Gilbert M, Grenfell BT, Levin SA, Robinson TP, et al. Global trends in antimicrobial use in food animals. *Proc Natl Acad Sci USA.* 2015;112:5649–54.
33. Balakrishna S, Teklu AM, Assefa Y, Trivedi K, Perovic O, Moyo S, et al. Strengthening lab networks in LMICs. *BMJ Glob Health.* 2021;6:e006017.
34. Dyar OJ, Nathwani D, Monnet DL, Gyssens IC, Stålsby Lundborg C, Pulcini C, et al. Education on AMS in medical schools. *J Antimicrob Chemother.* 2018;73:17–26.
35. Semret M, Muvunyi CM, Shah M, Mugabe D, Rwabukwisi FC, Mwikarago EI, et al. AMS success in Rwanda. *Lancet Reg Health Afr.* 2022;9:100223.
36. Sumpradit N, Wongkongkathep S, Poonpolsu S, Phumart P, Janejai N, Boonyarit P, et al. Thailand's ASU program. *J Infect Dev Ctries.* 2012;6:404–11.
37. Nguyen NT, Nguyen HM, Nguyen CV, Nguyen TV, Nguyen MT, Thai QH, et al. One Health AMR surveillance in Vietnam. *J Glob Health.* 2021;11:04057.
38. Gandra S, Joshi J, Laxminarayan R, Levin S, Kotwani A, Sharma A, et al. Chennai Declaration and AMR policy changes. *Natl Med J India.* 2013;26:84–7.