The Value of Vaccines in Mitigating Antimicrobial Resistance in India

GARP-India Policy Brief

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TABLE OF CONTENTS

List of Abbreviations and Acronyms 5

Executive Summary 7

Background 9

Vaccines That Target Antimicrobial Resistance 10

High Priority Vaccines 11

Medium Priority Vaccines 13

Low Priority Vaccines 14

Conclusion 15

References 16

LIST OF TABLES

Table 1. Fluoroquinolone Nonsusceptible (FQNS) Typhoid Cases, Multidrug-Resistant (MDR) Typhoid Cases, and Deaths Averted over 10 years 11

LIST OF ABBREVIATIONS AND ACRONYMS

ACIP	Advisory Committee on Immunization Practices
AIIMS	All India Institute of Medical Sciences
ALRI	acute lower respiratory infection
AMR	antimicrobial resistance
CDC	Center for Disease Control and Prevention
CI	confidence interval
CMCH	Christian Medical College and Hospital
CSMCH	Centre of Social Medicine and Community Health
CTX-M	Cefotaximase-Munich
DDDs	defined daily doses
DRSP	drug-resistant *Streptococcus pneumoniae*
FQNS	fluoroquinolone non-susceptible
GARP	Global Antimicrobial Resistance Partnership
GBD	Global Burden of Disease
GRAM	Global Research on Antimicrobial Resistance
HPV	human papillomavirus
ICMR	Indian Council of Medical Research
IHBAS	Institute of Human Behaviour and Allied Sciences
IHME	Institute for Health Metrics and Evaluation
IMA	Indian Medical Association
IPD	invasive pneumococcal disease
LHMC	Lady Hardinge Medical College
MDR	multidrug-resistant
MMR	measles, mumps, and rubella

LIST OF ABBREVIATIONS AND ACRONYMS

MoHFW	Ministry of Health and Family Welfare
NAP-AMR	national action plan on antimicrobial resistance
NCDC	National Centre for Disease Control
NTAGI	National Technical Advisory Group on Immunization
OHT	One Health Trust
PCV	pneumococcal conjugate vaccine
PCV10	10-valent pneumococcal conjugate vaccine
PCV13	13-valent pneumococcal conjugate vaccine
PCV14	14-valent pneumococcal conjugate vaccine
PCV20	20-valent pneumococcal conjugate vaccine
RR	risk ratio
RSV	respiratory syncytial virus
SAGE	Strategic Advisory Group of Experts (on Immunization)
SDGs	Sustainable Development Goals
TCV	typhoid conjugate vaccine
Tdap	tetanus, diphtheria, and pertussis
TWG	technical working group
UIP	Universal Immunization Programme
VPCI	Vallabhbhai Patel Chest Institute
VPDs	vaccine-preventable diseases
WHO	World Health Organization
XDR	extensively drug-resistant

EXECUTIVE SUMMARY

Antimicrobial resistance (AMR) is a major global health crisis, making infections harder to treat and increasing the health and economic burden worldwide. In India, AMR is driven by high infectious disease burden and antibiotic misuse, causing an estimated 267,000 deaths and factoring in nearly 987,000 others. India's National Action Plan on AMR (NAP-AMR 2.0, 2025–2029) emphasizes preventing infections as a key strategy, and vaccination offers a powerful, cost-effective tool to reduce infections and antibiotic use.

The Global Antibiotic Resistance Partnership (GARP) in India convened national experts in public health, immunization, and AMR to guide the development of this policy brief. It provides expert insights and recommendations on how to prioritize vaccines based on their ability to address disease burden and their potential impact on AMR in India.

High Priority Vaccines

- **Typhoid conjugate vaccine (TCV):** The vaccine is highly effective (~80–95 percent), with strong evidence for reducing antibiotic use for undifferentiated febrile illnesses and drug-resistant infections. It is recommended for routine childhood immunization, with catch-up campaigns for up to 15 years of age and expansion to adults in high-risk settings.
- **Pneumococcal conjugate vaccines (PCVs):** India introduced PCV in childhood immunization in 2017. Expanding coverage and introducing adult vaccination (≥65 years and high-risk groups) could significantly reduce antibiotic consumption for respiratory infections and prevent deaths. Domestically manufactured and affordable higher-valency PCVs tailored to India's infectious disease burden are needed for scale-up.

Medium Priority Vaccine

- **Influenza vaccine:** Seasonal influenza drives high antibiotic prescribing for respiratory illness. Annual vaccination, targeting children, older adults, health care workers, and high-risk populations, can reduce antibiotic use by 20–30 percent and prevent secondary bacterial infections.

Low Priority but Supportive Interventions

- **Respiratory Syncytial Virus (RSV) and other adult catch-up vaccines:** RSV immunization and adult booster vaccines (tetanus, diphtheria, and pertussis; measles, mumps, and rubella; zoster; and human papillomavirus) can indirectly reduce inappropriate antibiotic use by preventing viral infections often treated empirically with antibiotics.

*Photo source: PradeepGaurs 2023

Prioritizing typhoid and pneumococcal vaccines, with influenza vaccination as a complementary strategy, can substantially reduce infection burden, antibiotic consumption, and AMR in India. A prioritized vaccination framework for vulnerable groups aligned with surveillance and domestic vaccine production is essential for controlling AMR emergence and spread.

BACKGROUND

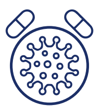
Antimicrobial resistance (AMR) poses a serious and growing threat in India. Modeling estimates for 2021 in India from the World Health Organization (WHO)/Institute for Health Metrics & Evaluation (IHME) Global Research on Antimicrobial Resistance study suggest that 266,734 and 987,254 deaths were directly attributed to or associated with AMR, respectively. This places India among the countries with the highest age-standardized mortality rate per 1,00,000 associated with AMR (IHME 2022; Murray et al. 2022). Tackling AMR demands a coordinated approach consistent with NAP-AMR 2.0, encompassing stronger antimicrobial stewardship and regulatory enforcement, enhanced surveillance, improved infection prevention and control, clinical innovation, and sustained investment in implementation research (Murray et al. 2022; Government of India 2025).

Vaccines are recognized as an innovative preventive strategy under NAP-AMR 2.0's Strategic Priority 3. By preventing infections, vaccines reduce inappropriate antibiotic prescribing and lower the selection pressure that drives AMR emergence. In addition, vaccination reduces hospitalizations and associated health care costs, offering both clinical and economic benefits. However, although it is gaining traction in the animal health sector, vaccination rates are stagnating in the human sector, especially among adults (Government of India 2025).

Antibiotic use for respiratory and gastrointestinal syndromes is widespread. Introducing pneumococcal and rotavirus vaccines among children in low- and middle-income countries and adult influenza vaccination has been shown to reduce antibiotic use by approximately one-third (van Heuvel et al. 2023). Additionally, WHO global estimates suggestthat optimal use of vaccines against priority bacterial pathogens could avert up to 2.5 billion defined daily doses of antibiotics annually, equivalent to nearly 22 percent of global antibiotic consumption, underscoring the broader public health benefit of immunization to reduce antimicrobial use (WHO 2024b).

However, leveraging vaccines as an AMR control strategy requires a steady supply chain through domestic manufacturing, low-cost and adequate infrastructure to ensure maintenance of the cold chain, mechanisms to facilitate clinical development, demonstration of efficacy/effectiveness, licensure, and sustainability. India has the capacity for large-scale, domestic vaccine production, which can mitigate costs. This has enormous potential for implementing vaccination as a key strategy to control AMR. Although India has taken great strides in implementing childhood vaccination and reaching United Nations Sustainable Development Goals thresholds, adult coverage remains low due to limited awareness, inadequate access, and an absence of national immunization programs for vulnerable populations and adults. Hence, innovative solutions and public health advocacy with legal and administrative support are needed to strengthen adult immunization.

Numerous recommendations for adult vaccination already exist, including those from the WHO, Geriatric Society of India, Advisory Committee on Immunization Practices from the Centers for Disease Control and Prevention Atlanta, Association of Physicians of India (Expert Panel), Research Society for Study of Diabetes in India, Indian Society of Nephrology, and Indian Medical Association (Koul et al. 2020). This policy brief provides an implementation framework and evidence on vaccines as an important preventive tool for reducing antibiotic consumption. It also proposes a sequential stepwise introduction of vaccines for children and adults within a national governmental framework.



VACCINES THAT TARGET ANTIMICROBIAL RESISTANCE

The GARP-India Technical Working Group (TWG) convened at Christian Medical College Vellore, Tamil Nadu, on June 6, 2025, to examine the role vaccination could play on mitigating AMR. The experts concluded that strategic vaccination could drastically reduce the consumption of antibiotics by preventing primary infections and secondary bacterial complications in both children and adults.

Vaccines were categorized into priority tiers to guide a phased national implementation roadmap.

High priority: TCV and PCVs
Medium priority: Influenza vaccine
Low priority: RSV vaccine
Selection criteria and rationale: The TWG assigned these tiers based on India's disease burden, rollout feasibility, and potential for AMR mitigation. High-priority vaccines target clinical syndromes where antibiotic misuse is rampant and multidrug resistance is rising rapidly—notably for typhoid (with increasing carbapenem resistance) and pneumococcal disease (associated with high mortality and substantial antibiotic consumption). Influenza was prioritized as a major driver of inappropriate antibiotic prescribing for respiratory illnesses.

The proposed roadmap outlines phased implementation of high-priority vaccines, beginning with immediate prioritization of TCV and PCVs, followed by pilot and scale-up of adult influenza immunization, and culminating in a sustained national life-course vaccination framework aligned with AMR surveillance and stewardship goals.

*Photo source: Chaturvedi 2019

HIGH PRIORITY

TCV

The emergence of carbapenem-resistant *Salmonella typhi* strains carrying blaNDM-5 (a potent molecular indicator of AMR) has recently been reported in India, signaling an impending escalation in drug-resistant typhoid, reinforcing the urgency of TCV scale-up as a preventive AMR strategy (Patil et al. 2025). Emerging genomic evidence of CTX-M–mediated resistance in *S. typhi* further highlights the evolving resistance landscape, potentially driven by the widespread use of third-generation cephalosporins, such as ceftriaxone, in typhoid management (Rai et al. 2022; Dahiya et al. 2023).

Active surveillance (2017–2020) among children aged 6 months to 14 years revealed a high burden of blood culture–confirmed typhoid, with incidence of 576–1,173 per 100,000 child-years in urban sites (Vellore: 1,173, Kolkata: 714, and Delhi: 576), compared with only 35 in rural Pune (Haposan et al. 2025; Lamichhane et al. 2025).

TCVs have demonstrated strong efficacy in South Asia, providing ~85 percent direct protection and ~57 percent overall population protection against blood culture–confirmed typhoid in children 9 months to <16 years (Lamichhane et al. 2025). During an extensively drug-resistant (XDR) typhoid outbreak in Hyderabad, Pakistan, a single dose of Typbar TCV showed ~95 and ~97 percent effectiveness against culture-confirmed typhoid and XDR *S. typhi*, respectively, in children 6 months to 10 years. Real-world evidence from multiple countries further confirms that TCV reduces typhoid incidence irrespective of resistance patterns, supporting its role in both routine immunization and outbreak control (The Gavi Alliance 2025).

Following the WHO Strategic Advisory Group of Experts on Immunization recommendations of 2017, eight countries (Pakistan, Liberia, Zimbabwe, Nepal, Fiji, Burkina Faso, Kenya, and Samoa), successfully integrated TCV into their national immunization programs, vaccinating millions of children (Haposan et al. 2025; Lamichhane et al. 2025). India's National Technical Advisory Group on Immunization recommended including TCV in its Universal Immunization Programme (UIP) in 2022, but nationwide integration and rollout under UIP are still pending. Four licensed TCVs with excellent efficacy are available in India; three have been WHO prequalified: Typbar TCV® (Bharat Biotech), TYPHIBEV® (Biological E), SKYTyphoid™ (SK bioscience), and ZyVac® TCV (Zydus Lifesciences Limited). TCV is highly cost-effective. Delivery costs in the Navi Mumbai campaign were estimated at US$0.37–0.53 per dose, with a unit cost of approximately US$2.93 (Song et al. 2023, Mogasale et al. 2024). Mathematical modeling indicates that introducing routine immunization at 9 months of age, with a catch-up campaign up to 15 years, could avert 46–74 percent of all typhoid fever cases in 73 Gavi-eligible countries (Birger et al. 2022).

Table 1. Fluoroquinolone Nonsusceptible (FQNS) Typhoid Cases, Multidrug-Resistant (MDR) Typhoid Cases, and Deaths Averted over 10 years

Outcome (10 years, 73 countries)	FQNS Typhoid Cases Averted	MDR Typhoid Cases Averted	Deaths Averted (FQNS)	Deaths Averted (MDR)
Global (TCV, catch-up to 15 years)	42.5 million	21.2 million	506,000	342,000
India (FQNS only)	21.1 million	———	———	———

Source: Birger et al. (2022)

PCVs

Invasive pneumococcal disease (IPD) contributes to significant morbidity and mortality among children and elderly people in India. While pneumonia deaths have significantly decreased among children—dropping by 57 percent in those under 5 and 41 percent in those aged 5–14 between 2000 and 2019—they have risen among older adults, increasing by 33 percent in the 50–69 age bracket and 55 percent in those over 70. Consequently, mortality is now clustered at the extremes of age, with 672,000 deaths in children under 5 and 1.2 million deaths in adults over 69 (Murray et al. 2022).

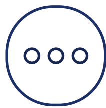
The ICMR AMR Surveillance Report 2024 reveals that invasive pneumococcal serotypes were adequately covered by PCV13, exploring the potential role of high-valency PCVs in limiting drug-resistant *S. pneumoniae* and reducing pneumococcal disease burden in India. The available conjugate vaccines in India are PCV13, PCV10, PCV14 and PCV20 (ICMR 2025).

Introducing PCVs has been associated with 8 percent lower antimicrobial use in vaccinated groups (Finland) and reduced antibiotic prescriptions in the United States and France. In Malawi, PCV13 reduced IPD by 74 percent in children under 5 and 47 percent in adolescents and adults, even though adults were not directly vaccinated. Similar indirect effects are anticipated in India as coverage expands (Mogasale et al. 2024). In India, time-series analyses have shown a measurable decline in antibiotic consumption 3–4 years after PCV introduction, indicating that vaccination leads to substantial reductions in antibiotic use and will likely translate into reduced resistance over time (Schueller et al. 2021).

India introduced PCV in 2017 into its UIP and completed its nationwide rollout by 2021, targeting approximately 27 million annual birth cohorts. Recently, PCV14, manufactured by Biological E. Ltd as PNEUBEVAX 14™, was adopted into the UIP to provide broader coverage.

In adults, PCV-13 demonstrates 45.6 and 75 percent efficacy against vaccine-type community-acquired pneumonia and IPD, respectively. Emerging evidence also suggests additional benefits, including reduced all-cause mortality, myocardial infarction, and dementia risk among elderly people. Although PCV use is growing in the private sector, public-sector coverage for adults remains absent (ICMR 2025, Schueller et al. 2021, Maggi et al. 2025)

PCV20, recently introduced in India, offers broader serotype coverage and the advantage of a simplified single-dose schedule for adults, although longer-term durability and cost-effectiveness data are still emerging (Walters et al. 2017). However, its high cost may limit widespread public-sector implementation, underscoring the need for affordable, domestically manufactured higher-valency PCVs to support vaccination of older adults (≥65 years) and other high-risk groups.



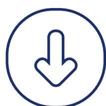
MEDIUM PRIORITY

Influenza

In 2024, India reported 15,266 laboratory-confirmed influenza A (H1N1) cases and 1,128 deaths by May 31 (National Centre for Disease Control 2024). Influenza activity in India occurs year-round, with approximately 30 percent positivity from December to May and 70 percent from June to November, based on WHO FluNet surveillance data. Despite being in the Northern Hemisphere, India sees variations in influenza seasonality by latitude. Cities north of 30°N tend to have winter peaks, and cities south of 30°N experience summer/monsoon-related peaks, highlighting the need for region-specific vaccination timing (Dhar et al. 2020).

A 2023 meta-analysis shows that influenza vaccination reduces the proportion of people receiving antibiotics by about 37 percent (RR 0.63, 95 percent CI: 0.51–0.79) and antibiotic courses by approximately 21 percent (RR 0.79, 95 percent CI: 0.65–0.97) (van Heuvel et al. 2023). A similar meta-analysis found high-certainty evidence that it can reduce days of antibiotic use among healthy adults by 28.1 percent and moderate evidence that it can reduce antibiotic use in children (Buckley et al. 2019). Vaccination reduces both viral load and duration of infectivity, thereby limiting the period of possible transmission. In addition, it is associated with a ~26 percent reduced risk in myocardial infarction, ~33 percent reduction in cardiovascular mortality, and a reduced risk of dementia (RR 0.87, 95 percent CI 0.77–0.99) (Maggi et al. 2025; Omidi et al. 2023).

India's Ministry of Health and Family Welfare recommends annual influenza vaccination for high-risk groups, particularly adults aged ≥65 years, children under 5, and pregnant women, for whom influenza-associated mortality is highest (Joseph et al. 2025). These findings underscore the need to prioritize these high-risk groups in future vaccination policies and strengthen influenza surveillance systems to improve disease burden estimates (Narayan et al. 2020).



LOW PRIORITY

Respiratory infections caused by RSV and influenza are often presumptively treated with antibiotics in the absence of affordable, rapid, and confirmed etiological diagnosis, despite these being viral pathogens. RSV and routine catch-up vaccines are placed in the low-priority tier because current evidence suggests their contribution to AMR prevention is more indirect, with less consistent data on reductions in antibiotic consumption or resistant infections (WHO 2024b).

RSV

RSV is a leading cause of bronchiolitis and pneumonia in young children and frequently treated with antibiotics, often due to diagnostic uncertainty, especially in settings with limited laboratory resources. A systematic review and meta-analysis estimated ~12.6 million RSV-associated acute lower respiratory infection (ALRI) cases, ~8.5 million outpatient visits, ~1 million hospitalizations, and ~36,700 deaths in children under five in India in 2020. The review found that around 87 percent of the deaths were in infants under 1 year and RSV-ALRI accounted for ~4.4 percent of under-5 deaths (Joseph et al. 2025).

Studies show that a significant proportion of children with confirmed RSV infections still receive antibiotics. A maternal RSV vaccine was associated with a 12.9 percent reduction in antibiotic use among infants in their first 3 months, and a long-acting RSV monoclonal antibody led to a 23.6 percent decrease in antibiotic prescriptions for infants (Heikkinen et al. 2017).

Modeling analyses estimate that effective RSV immunization programs could avert tens of millions of antibiotic courses globally each year (Atkins et al. 2018). A study on influenza, a comparable viral respiratory illness, found that vaccination prevented 5.6 percent of acute respiratory illnesses and 1 in every 25 antibiotic prescriptions (Smith et al. 2020), suggesting that this may be applicable to RSV as well. RSV vaccines are not yet available in India, justifying its current low-priority status.

Adult Catch-Up Vaccinations

Adult catch-up vaccinations are strongly recommended for individuals who missed childhood immunizations or boosters, including tetanus, diphtheria, and pertussis (Tdap) and measles, mumps, and rubella (MMR), especially for those over 60. These vaccines help prevent infections that often present fever or respiratory symptoms, which frequently lead to unnecessary empirical antibiotic use.

Key Viral Vaccines for Adults in India

MMR: recommended for adults (19–60 years old) who haven't been vaccinated or lack documented proof of vaccination. Human papillomavirus (HPV) vaccine: recommended for young adults (15–45 years) to prevent HPV-related cancers. Zoster (Shingles): recommended for adults over 60. Tdap: booster dose recommended for adults if their last tetanus-containing vaccine was more than 10 years ago.

CONCLUSION

Vaccination is a highly effective strategy to reduce the incidence of infections in both children and adults, minimizing unnecessary antibiotic use and helping combat the growing threat of AMR. The GARP-India TWG recommends prioritization and implementation of TCV and PCVs given their strong potential to reduce bacterial infections, including those resistant to current treatments.

Medium-priority vaccines, such as seasonal influenza, should be introduced in a phased manner among high-risk adult populations, including elderly adults, individuals with comorbidities, and health care workers. Although RSV vaccination is placed in the low-priority tier due to gaps in availability and local effectiveness data, an effective vaccine, capable of significantly reducing antibiotic consumption in early childhood, would offer substantial public health benefits.

To translate these recommendations into action, India must restructure financial pathways, promoting domestic low-cost production, and apply appropriate health technology assessments to study the cost-effectiveness of large-scale implementation. Equally critical are community and health care worker engagement strategies to address vaccine hesitancy and regulatory and policy support by regulatory authorities to implement vaccines as effective tools in the fight against AMR.

In summary, prioritizing adult vaccination is not only a sound public health strategy but also a forward-thinking investment in the nation's well-being and economic strength. Through increased awareness, professional education, and strong government action, India can make significant strides in reducing the burden of vaccine-preventable diseases and curbing the rise of AMR.

*Photo source: PhotoBankIndia 2022b

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Initiated in 2008, the Global Antibiotic Resistance Partnership (GARP) has played a critical role in advancing country-led national strategies and policies to address antimicrobial resistance (AMR) in several countries in Africa and Asia.

GARP's current focus is generating cross-disciplinary evidence highlighting the impact of vaccines on AMR in country-specific contexts.

This policy brief lays out the situation in India and recommends policy measures to use vaccines as tools to control AMR in the country.

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