

Antimicrobial Resistance: A Growing Global Public Health Emergency; A Narrative Review of Epidemiology, Drivers, and Strategies for Mitigation

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Abstract

Background: Antimicrobial resistance (AMR) is ranked by the World Health Organization (WHO) among the top ten global public health threats. In 2019, bacterial AMR was associated with an estimated 4.95 million deaths worldwide and was the direct cause of 1.27 million deaths, surpassing HIV/AIDS and malaria combined as a cause of death. Updated 2024 modelling suggests the annual toll now exceeds one million directly attributable deaths and could cumulatively reach 39 million deaths between 2025 and 2050 without intensified action.

Objective: This narrative review synthesizes current, peer-reviewed and official evidence on the global epidemiology, principal drivers, and health-economic consequences of AMR, and critically evaluates the effectiveness of existing surveillance, stewardship, and policy responses.

Methods: A narrative literature review was conducted using PubMed, Web of Science, Google Scholar, and the official repositories of WHO, the US Centers for Disease Control and Prevention (CDC), the World Bank, and the United Nations, covering publications and official reports from 2015 to 2025. Search terms combined “antimicrobial resistance” or “antibiotic resistance” with terms denoting burden, surveillance, stewardship, One Health, and economic impact. Priority was given to systematic reviews, meta-analyses, large multi-country modelling studies, and official global reports.

Results: AMR burden is driven by overlapping human, agricultural, and environmental factors, including inappropriate antibiotic prescribing, weak infection prevention and control, and the substantial and rising use of

antimicrobials in food-animal production. The World Bank estimates that unmitigated AMR could reduce global GDP by up to 3.8% and push tens of millions of people into poverty by 2050. The antibiotic development pipeline remains thin and fragile: as of 2025, only 90 antibacterial agents were in clinical development, of which just 15 were classified as genuinely innovative, and the sector remains dependent on small, poorly capitalized biotechnology firms. Antimicrobial stewardship programmes reliably reduce antibiotic consumption (by roughly a quarter on average) but the evidence that stewardship alone measurably reduces resistance rates is more limited and heterogeneous. Global governance has strengthened through the WHO Global Action Plan, the GLASS surveillance system, the 2024 WHO Bacterial Priority Pathogens List, and a 2024 United Nations political declaration committing to a 10% reduction in AMR-associated deaths by 2030, but financing and surveillance capacity remain especially weak in low- and middle-income countries, which bear the highest mortality burden.

Conclusion: AMR is an accelerating but not inevitable crisis. Meeting internationally agreed 2030 targets will require sustained, multisectoral One Health investment that combines stewardship, infection prevention, equitable access to effective antimicrobials, strengthened surveillance, and re-engineered incentives for antibiotic research and development.

Keywords: antimicrobial resistance; antibiotic resistance; global health; One Health; antimicrobial stewardship; public health policy.

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1. Introduction

Antimicrobial resistance (AMR) occurs when bacteria, viruses, fungi, and parasites evolve so that the medicines once used to treat the infections they cause no longer work. The consequence is that common, previously treatable infections become difficult or impossible to cure, medical procedures that depend on effective infection control become riskier, and the risk of severe illness, onward transmission, and death rises correspondingly. The World Health Organization has repeatedly identified AMR as one of the top ten global public health threats facing humanity.

The scale of the problem has become clearer over the past decade as global data collection has improved. A landmark 2022 analysis synthesizing 471 million individual health records from 204 countries and territories estimated that bacterial AMR was directly responsible for 1.27 million deaths in 2019 and was associated with 4.95 million deaths overall, a toll that already exceeded global deaths from HIV/AIDS and malaria combined [1]. An updated 2024 analysis extending the time series back to 1990 and forward with forecasts to 2050 confirmed that the annual death toll directly attributable to bacterial AMR now exceeds one million, and projected that, absent stronger intervention,

cumulative deaths from drug-resistant bacterial infections could reach 39 million between 2025 and 2050 [2]. Notably, this later analysis found a shifting age pattern: mortality attributable to AMR among children under five has been declining, likely reflecting improvements in vaccination, sanitation, and clinical care, while mortality among adults over 70 is rising, reflecting global population ageing [3].

AMR does not affect all regions equally. Low- and middle-income countries (LMICs), home to most of the world's population, bear a disproportionate share of the mortality burden, with the highest attributable death rates recorded in western sub-Saharan Africa [1]. Paradoxically, many of the same countries that suffer the highest resistance-related mortality also have the least reliable access to newer, last-resort antibiotics needed to treat resistant infections, an “access versus excess” dilemma discussed later in this review.

This review synthesizes current epidemiological, economic, and policy evidence on bacterial AMR. It aims to: (1) summarize the global and regional burden of AMR; (2) examine its principal human, agricultural, and environmental drivers; (3) assess its health and economic consequences; (4) evaluate the global policy response, including surveillance systems, the antibiotic development pipeline, and antimicrobial stewardship; and (5) propose evidence-informed recommendations for public health practice and policy.

2. Methods

This is a narrative review rather than a formal systematic review; no PRISMA protocol was registered, and no formal risk-of-bias or quality-appraisal tool was applied across sources. This design choice was made because the objective was to synthesize and critically integrate evidence across epidemiology, economics, and policy domains that formal systematic-review methodology, built for single-question clinical evidence synthesis, does not accommodate well.

Literature and official reports were identified through PubMed, Web of Science, and Google Scholar, supplemented by direct searches of the official repositories of the World Health Organization, the United States Centers for Disease Control and Prevention, the World Bank, and the United Nations. Search terms combined “antimicrobial resistance” or “antibiotic resistance” with “global burden,” “epidemiology,” “surveillance,” “stewardship,” “One Health,” “economic impact,” and related terms. The search was restricted to English-language sources published between 2015 and 2025, with priority given to systematic reviews and meta-analyses, large multi-country modelling studies (notably the Global Burden of Disease AMR collaborations), and official global reports and declarations. Case reports, single-institution clinical series, and purely laboratory-bench studies without population-level relevance were excluded. Reference lists of key sources were also hand-searched for additional relevant material (snowball sampling).

3. Results and Discussion

3.1 Global and Regional Burden of Antimicrobial Resistance

The most comprehensive estimate of the global burden of bacterial AMR to date comes from the Global Research on Antimicrobial Resistance (GRAM) collaboration, which analyzed data on 23 pathogens and 88 pathogen drug combinations across 204 countries and territories for the year 2019 [1]. The study found that six pathogens *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Streptococcus pneumoniae*, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa* accounted for 929,000 of the 1.27 million deaths directly attributable to resistance and 3.57 million of the 4.95 million associated deaths. Lower respiratory infections were the single most burdensome infectious syndrome, contributing to more than 1.5 million associated deaths, followed by bloodstream infections and intra-abdominal infections [1].

Regional disparities are starting. The all-age death rate directly attributable to resistance was estimated at 27.3 per 100,000 population in western sub-Saharan Africa compared with just 6.5 per 100,000 in Australasia, more than a four-fold difference [1]. Children under five years of age account for roughly one in five AMR-attributable deaths globally, underscoring the outsized impact of resistant infections on pediatric populations in high-burden settings.

A 2024 follow-up analysis by the same collaborative network extended these estimates back to 1990 and forward with forecasts to 2050 [2]. It confirmed that current annual mortality directly attributable to bacterial AMR exceeds one million deaths and projected that, without more effective intervention, cumulative global deaths from drug-resistant bacterial infections could reach approximately 39 million over the 2025–2050 period. This 2024 update also identified an important demographic shift: attributable mortality among children under five has been falling, while mortality among adults over 70 has been rising a pattern the authors attribute to the combined effects of an ageing global population and continued gains in child survival from vaccination and improved care [2,3].

These global estimates should be interpreted with appropriate caution. Even the GRAM study's central estimate of 1.27 million directly attributable deaths carried a wide 95% uncertainty interval (0.91–1.71 million) [1], reflecting substantial gaps in laboratory surveillance capacity, particularly in low-income settings where AMR burden is likely most severe but least well measured. This uncertainty is discussed further in Section 4.

Table 1 summarizes the key global statistics referenced throughout this review.

Indicator	Estimate	Source
Deaths directly attributable to bacterial AMR (2019)	1.27 million (95% UI 0.91–1.71 million)	Murray et al., 2022 [1]
Deaths associated with bacterial AMR (2019)	4.95 million (95% UI 3.62–6.57 million)	Murray et al., 2022 [1]
Current annual deaths directly due to bacterial AMR	Just over 1 million per year	GBD 2021 AMR Collaborators, 2024 [2]
Projected cumulative deaths, 2025–2050, without stronger action	Up to 39 million	GBD 2021 AMR Collaborators, 2024 [2]

Indicator	Estimate	Source
Highest regional attributable death rate (2019)	27.3 per 100,000 — western sub-Saharan Africa	Murray et al., 2022 [1]
Lowest regional attributable death rate (2019)	6.5 per 100,000 — Australasia	Murray et al., 2022 [1]
US antibiotic-resistant infections/deaths per year	>2.8 million infections; >35,000 deaths (>48,000 with <i>C. difficile</i>)	CDC, 2019 [5]
Global GDP loss by 2050 (World Bank scenarios)	1.1% (low-impact) to 3.8% (high-impact)	World Bank, 2017 [9]
Cumulative GDP loss, 2015–2050 (present value)	Up to US\$85 trillion	Ahmed et al., 2017 [10]
People pushed into extreme poverty by 2030 (high-AMR scenario)	Up to 24.1 million (18.7 million in low-income countries)	Ahmed et al., 2017 [10]
Antibacterial agents in clinical development (2025)	90 (only 15 classed as innovative)	WHO, 2025 [7]
Countries participating in WHO GLASS surveillance (end 2022)	127, covering ~72% of world population	WHO, 2022 [4]
UNGA 2030 target for AMR-associated deaths	10% reduction from the 2019 baseline of 4.95 million	UN/WHO/FAO/UNEP/WOAH, 2024 [17]

3.2 Drivers of Antimicrobial Resistance

AMR emergence and spread are driven by overlapping factors across human medicine, agriculture, and the environment, consistent with the One Health framework adopted by WHO, the Food and Agriculture Organization (FAO), and the World Organization for Animal Health (WOAH) [11].

In human health systems, inappropriate antibiotic prescribing and use remain a central driver. WHO's Global Antimicrobial Resistance and Use Surveillance System (GLASS) found that reported antibiotic use varies by roughly a factor of ten between the highest- and lowest-using participating countries, territories, and areas, reflecting a combination of overuse in some settings and inadequate access in others [4]. Many countries fall short of the United Nations target that at least 70% of human antibiotic consumption should come from the WHO “Access” category of antibiotics, which carry a comparatively low risk of selecting for resistance; broader-spectrum “Watch” category antibiotics continue to represent a disproportionate share of use in many settings [4].

Agricultural and veterinary antimicrobial use is the second major driver. The first global map of antimicrobial consumption in food-producing animals, covering 228 countries, estimated global use at approximately 63,151 tons in 2010 and projected a 67% increase to roughly 105,596 tons by 2030, driven substantially by rising meat demand and the intensification of livestock production in Brazil, Russia, India, China, and South Africa [12]. Subsequent

modelling explored policy scenarios such as a global cap of 50 milligrams of antimicrobial use per kilogram of meat produced that could substantially curb this projected growth [13]. More recent analysis using updated data suggests a somewhat more modest growth trajectory than originally projected, with global use in food animals estimated at around 99,500 tons in 2020 and forecast to reach approximately 107,500 tons by 2030, with China remaining the largest single national consumer.

Additional drivers include gaps in infection prevention and control (IPC) and inadequate water, sanitation, and hygiene (WASH) infrastructure in health care facilities, both of which increase reliance on antimicrobials to manage otherwise preventable infections; weak pharmaceutical regulation and widespread over-the-counter or informal-market access to antibiotics without prescription in many LMICs; and environmental discharge of antimicrobial residues from manufacturing, agricultural run-off, and inadequately treated wastewater, which can promote the selection and spread of resistance genes in the environment [17].

3.3 Public Health and Economic Consequences

The clinical consequences of AMR extend well beyond the infections it directly causes. As common bacterial infections become harder to treat, procedures that depend on effective peri-operative infection control and prophylaxis major surgery, cancer chemotherapy, organ transplantation, and neonatal intensive care all become riskier, threatening decades of progress in modern medicine.

National-level data illustrate both the scale of the problem and the potential for progress. In the United States, the CDC's 2019 Antibiotic Resistance Threats Report estimated that antibiotic-resistant bacteria and fungi cause more than 2.8 million infections and over 35,000 deaths annually, rising to more than 3 million infections and 48,000 deaths when *Clostridioides difficile*, an infection strongly associated with antibiotic use, is included [5]. Using an improved surveillance methodology, this estimate was nearly double the mortality estimate reported in 2013. Encouragingly, however, the same report found that deaths from antibiotic-resistant infections had declined by 18% overall and by nearly 30% in hospital settings between 2013 and 2019, a trend attributed to sustained investment in infection prevention and stewardship, and improved antibiotic use [5]. This demonstrates that the trajectory of AMR mortality is not fixed and can be meaningfully altered by sustained public health investment.

The economic consequences are similarly severe. A 2017 World Bank analysis modelled the impact of AMR on global economic growth and poverty and found that, by 2050, unmitigated AMR could reduce annual global GDP by between 1.1% (a lower-impact scenario) and 3.8% (a higher-impact scenario), with low-income countries facing losses exceeding 5% of GDP [9]. A companion technical analysis estimated that cumulative losses between 2015 and 2050 could total as much as US\$85 trillion in GDP and US\$23 trillion in global trade in present-value terms, and that under the high-impact scenario, an additional 24.1 million people could be pushed into extreme poverty by 2030, 18.7 million of them in low-income countries [10].

An earlier and even more widely cited projection, from the UK government-commissioned 2016 Review on Antimicrobial Resistance chaired by economist Jim O'Neill, estimated that AMR could cause 10 million deaths per

year by 2050 and cost the global economy up to US\$100 trillion [14]. This figure has been extensively repeated in media, political, and institutional communications, including by WHO and the United Nations. However, a peer-reviewed methodological critique published in PLOS Medicine argued that this estimate rests on extrapolations from limited and heterogeneous underlying data rather than robust, population-based surveillance, and cautioned that such projections should always be reported alongside explicit uncertainty bounds [15]. This critique is a useful reminder that, while the direction and severity of the AMR threat are not in serious scientific dispute, individual point estimates, particularly long-range forecasts, should be interpreted as illustrative of magnitude rather than as precise predictions.

3.4 Global Policy Response: Governance and Surveillance

The foundation of the international policy response is WHO's Global Action Plan on Antimicrobial Resistance, endorsed by the Sixty-Eighth World Health Assembly in May 2015 [11]. The plan set out five strategic objectives: improving awareness and understanding of AMR; strengthening surveillance and research; reducing the incidence of infection; optimizing the use of antimicrobial agents; and building a sustainable economic case for investment in new medicines, diagnostics, and vaccines. Critically, the plan formalized a cross-sectoral “One Health” approach, coordinating action across human medicine, veterinary medicine, agriculture, and the environment, in partnership with FAO and WOAHA [11].

To operationalize surveillance under this plan, WHO launched the Global Antimicrobial Resistance and Use Surveillance System (GLASS) in 2015. By the end of 2022, 127 countries, territories, and areas covering roughly 72% of the world's population were participating [4]. The fifth GLASS report, summarizing 2020 data, found resistance levels above 50% in bacteria commonly responsible for hospital bloodstream infections, including *Klebsiella pneumoniae* and *Acinetobacter* species, and for the first time incorporated national-level antimicrobial consumption data [4].

Political commitment reached a new high-water mark in September 2024, when the 79th United Nations General Assembly convened its second High-Level Meeting on AMR. Member states adopted a political declaration committing to reduce the estimated 4.95 million annual AMR-associated deaths by 10% by 2030, relative to the 2019 baseline [16,17]. The declaration also set targets for at least 70% of human antibiotic use globally to fall within the WHO Access category; for 100% of countries to provide basic water, sanitation, hygiene, and waste-management services in all health care facilities; for 90% of countries to meet WHO's minimum infection prevention and control requirements; and for at least 60% of countries to have adequately financed National Action Plans on AMR by 2030, supported in part by a pledged US\$100 million in catalytic funding [16,17]. On the agricultural side, countries committed to meaningfully reducing the quantity of antimicrobials used in agri-food systems by 2030 [17].

A parallel and complementary tool is the WHO Bacterial Priority Pathogens List (BPPL), first published in 2017 and substantially revised in 2024. The updated list scores 24 antibiotic-resistant bacterial pathogens across eight criteria including mortality, incidence, ten-year resistance trends, transmissibility, treatability, and pipeline availability

and groups them into critical, high, and medium priority tiers to guide research, development, and public health investment [18]. Table 2 summarizes the pathogens included in each tier.

Pathogen (resistance type)	WHO 2024 priority tier
Acinetobacter baumannii, carbapenem-resistant	Critical
Enterobacterales, carbapenem-resistant	Critical
Enterobacterales, third-generation cephalosporin-resistant	Critical
Mycobacterium tuberculosis, rifampicin-resistant	Critical
Pseudomonas aeruginosa, carbapenem-resistant	High
Staphylococcus aureus, methicillin-resistant (MRSA)	High
Enterococcus faecium, vancomycin-resistant	High
Salmonella Typhi, fluoroquinolone-resistant	High
Non-typhoidal Salmonella, fluoroquinolone-resistant	High
Shigella spp., fluoroquinolone-resistant	High
Neisseria gonorrhoeae, cephalosporin- and/or fluoroquinolone-resistant	High
Streptococcus pneumoniae, penicillin-non-susceptible	Medium
Haemophilus influenzae, ampicillin-resistant	Medium
Group A and Group B streptococci (new to the 2024 list)	Medium

3.5 The Antibiotic Innovation Gap

Even where surveillance and stewardship succeed in slowing the spread of resistance, the pipeline of new antimicrobials to replace those that fail remains dangerously thin. WHO's 2023 analysis of antibacterial agents in clinical and preclinical development identified 97 agents in clinical development: 57 traditional antibiotics and 40 non-traditional agents. Of the 32 antibiotics under development against WHO priority pathogens, only 12 met pre-defined criteria for genuine innovation (such as a new mechanism of action or absence of known cross-resistance), and only 4 of those 12 were active against at least one pathogen in the WHO “critical” priority tier [6].

A subsequent WHO update released in October 2025 found the situation had deteriorated further: the clinical pipeline had shrunk from 97 to 90 antibacterial agents, of which only 15 were classified as innovative [7]. WHO also identified 232 projects in earlier, preclinical development, but noted that approximately 90% of the 148 companies involved employ fewer than 50 people, highlighting the fragility of an antibiotic research and development ecosystem

now largely dependent on small, thinly capitalized biotechnology firms rather than large pharmaceutical companies, for whom the economics of antibiotic development (short treatment courses, stewardship-driven restrictions on use, and low prices) remain comparatively unattractive relative to other therapeutic areas [7]. Since WHO began tracking the pipeline in 2017, only 17 new antibacterial agents targeting priority pathogens have received market authorization [7]. Addressing this gap will likely require a combination of “push” incentives (grants and subsidies for early research) and “pull” incentives (guaranteed market rewards or subscription-style payment models that reward successful development independent of sales volume), a policy direction increasingly discussed in the global health economics literature but not yet implemented at scale.

3.6 Antimicrobial Stewardship: What Evidence Shows

Antimicrobial stewardship programmes (ASPs) coordinated interventions designed to optimize antimicrobial prescribing are among the most widely promoted interventions against AMR, and the evidence for their impact on antibiotic use itself is robust. A meta-analysis of 32 studies encompassing more than nine million in-hospital patient-days across 20 countries found that stewardship programmes, particularly when combined with infection control measures such as hand hygiene, significantly reduced the incidence of infection and colonization with antibiotic-resistant bacteria and *C. difficile* [19]. A broader systematic review and meta-analysis of 52 studies (40 from high-income and 12 from low- and middle-income settings) found that stewardship programmes reduced antibiotic prescribing by approximately 10% and overall antibiotic consumption by approximately 28% on average, with substantially larger reductions observed in pediatric hospitals and for broad-spectrum antibiotic classes such as fluoroquinolones and carbapenems.

The evidence linking stewardship directly to measurable reductions in resistance rates, as opposed to reductions in antibiotic consumption, is more mixed. A systematic review of 26 studies published between 2012 and 2017 found that only seven showed clearly positive effects on resistance emergence, with substantial heterogeneity in stewardship interventions and study designs across the literature; the authors concluded that solid evidence for stewardship alone reducing resistance in hospital settings was still lacking and called for more rigorously controlled study designs. Taken together, this body of evidence suggests that stewardship reliably curbs unnecessary antibiotic use, a necessary precondition for slowing resistance, but that translating reduced consumption into measurably lower resistance rates likely requires stewardship to be combined consistently with infection prevention and control measures, diagnostic stewardship, and adequate surveillance, rather than being deployed as a stand-alone intervention.

3.7 The Equity Dimension: Access versus Excess

A recurring theme across the evidence reviewed here is that AMR is not simply a story of global overuse. Low- and middle-income countries simultaneously bear the highest mortality burden from resistant infections and the least reliable access to antibiotics needed to treat them, including newer, last-resort “Reserve” category agents. GLASS antimicrobial-use data have found that some LMICs report little or no use of Reserve antibiotics, even though these are precisely the agents needed to treat infections caused by the most resistant bacteria [4]. This “access versus excess”

dilemma means that public health responses focused narrowly on reducing antibiotic consumption risk worsening outcomes in settings where under-treatment of genuine bacterial infections, not overuse, is the more immediate threat to survival. Effective policy must therefore pursue appropriate use rather than simple reduction, ensuring that antibiotics reach patients who need them, in the right drug, dose, and duration, while curbing unnecessary use elsewhere.

4. Synthesis: Three Converging Crises

The evidence reviewed here points to three simultaneous and mutually reinforcing crises. First, a rising resistance crisis: bacterial AMR already causes more deaths annually than HIV/AIDS and malaria combined, with a disproportionate and likely underestimated burden in low-surveillance-capacity regions [1,2]. Second, an innovation crisis: the clinical antibiotic pipeline has not only failed to keep pace with resistance but has recently contracted in absolute terms, from 97 agents in 2023 to 90 in 2025, and remains dependent on a fragile ecosystem of small biotechnology firms [6,7]. Third, a financing and governance crisis: although political commitment has strengthened considerably, culminating in the 2024 UN political declaration, implementation depends on national financing that, as of the declaration itself, only a minority of countries had secured [16,17].

At the same time, the evidence is not uniformly pessimistic. The documented 18–30% decline in US antibiotic-resistance deaths between 2013 and 2019 demonstrates that sustained investment in stewardship and infection prevention can measurably bend the mortality curve, even without new antibiotics [5]. This suggests that the primary constraint on progress against AMR globally is not an absence of effective interventions, but insufficient, inequitably distributed investment in deploying the interventions already known to work: surveillance, stewardship, infection prevention and control, WASH infrastructure, and appropriate access to existing antimicrobials, alongside longer-term investment in new antimicrobial development.

5. Recommendations

- Expand laboratory and surveillance capacity in low- and middle-income countries to close current GLASS coverage and data-quality gaps, which likely cause the true AMR burden in the highest-burden regions to be underestimated.
- Accelerate domestic financing of National Action Plans on AMR toward the UNGA 2030 target of at least 60% of countries having adequately funded plans, including through diversified funding mechanisms such as the AMR Multi-Partner Trust Fund.
- Combine “push” funding for early-stage antibiotic research with “pull” incentives (e.g., subscription-style payment models) to stabilize the small-biotechnology-dependent development pipeline identified by WHO.
- Expand diagnostic stewardship, including rapid point-of-care testing, to reduce empirical (unnecessarily broad-spectrum) antibiotic prescribing while preserving timely, appropriate treatment.

- Pair antimicrobial stewardship programmed systematically with infection prevention and control measures and WASH investment, rather than deploying stewardship as a stand-alone intervention, given the stronger evidence base for combined approaches.
- Implement the agreed agricultural commitments to meaningfully reduce non-therapeutic antimicrobial use in food-animal production, in coordination with FAO and WOA, while safeguarding food security in low-income settings.
- Address the equity dimension explicitly: pursue appropriate antimicrobial use rather than blanket consumption reduction and invest in equitable access to Reserve and Watch category antibiotics in underserved regions.
- Sustain public awareness and clinician education efforts to support prudent prescribing and appropriate patient expectations regarding antibiotic use.

6. Limitations of This Review

This review has several limitations. It follows a narrative rather than a systematic design, without a registered protocol, exhaustive database search, or formal quality appraisal of included sources, which introduces the possibility of selection bias toward prominent, English-language, and institutionally published sources. The review focuses specifically on bacterial AMR; resistance in viruses, fungi, and parasites, while acknowledged by WHO's overarching AMR definition, is addressed only briefly. Finally, given how rapidly this evidence base is evolving, illustrated by WHO's antibacterial pipeline estimate declining from 97 to 90 agents between its 2023 and 2025 reports some figures cited here may be superseded by newer data before or shortly after publication; readers requiring the most current statistics should consult the primary sources cited directly.

7. Conclusion

Antimicrobial resistance is an accelerating global public health emergency, but the evidence reviewed here indicates it is not an inevitable one. The tools required to slow it surveillance, stewardship, infection prevention and control, equitable access to existing antimicrobials, and sustained investment in new antimicrobial development are known and, where adequately resourced, demonstrably effective. The 2024 United Nations political declaration provides a measurable international benchmark: a 10% reduction in AMR-associated deaths by 2030. Achieving it will depend less on further evidence generation than on translating existing scientific consensus and political commitment into financed, equitably distributed, multisectoral action across human health, animal health, agriculture, and the environment.

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