

Medical Ethics in Antibiotic Prescription and Use: a Comprehensive Review

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ABSTRACT

Antibiotics are among the most consequential medical discoveries of the twentieth century, yet their effectiveness is a shared and depletable resource. Every prescription simultaneously serves an individual patient and exerts selective pressure that contributes to antimicrobial resistance (AMR), a condition now associated with millions of deaths each year [1,2]. This dual character places clinicians in a distinctive ethical position: the duty to act in the best interest of the patient in front of them may pull against the duty to preserve antibiotic effectiveness for present and future populations. This review examines the ethical dimensions of antibiotic prescription and use across the continuum from bedside decision-making to global governance. We first summarise the epidemiological and behavioural context of antibiotic misuse and overuse. We then analyse the issue through the four principles of biomedical ethics, public health ethics, the commons framework, contractualism, virtue ethics and relational approaches, and discuss specific dilemmas including patient expectations, diagnostic uncertainty, defensive practice, vulnerable populations, end-of-life care, access and equity, conflicts of interest, agricultural use, and the ethics of antibiotic research and development. We consider policy, legal and institutional responses, with attention to low- and middle-income settings and to India, and present a practical ethical decision framework, illustrative case vignettes, and a research agenda. We argue that antibiotic stewardship should be understood not only as a technical quality-improvement programme but as an ethical obligation grounded in justice, professional integrity and intergenerational responsibility, and that ethical competence in antibiotic use should be taught, assessed and supported systemically rather than left to individual conscience.

Keywords: antibiotic prescribing; antimicrobial resistance; medical ethics; antimicrobial stewardship; bioethics; public health ethics; informed consent; justice; One Health

1. INTRODUCTION

The introduction of penicillin and the sulfonamides transformed medicine. Infections that once killed young and healthy people became treatable, and entire fields of practice, including surgery, oncology, transplantation, neonatal intensive care and joint replacement, came to depend on reliable antibacterial therapy. It is now widely recognised that this achievement is fragile. The Global Research on Antimicrobial Resistance analyses estimated that bacterial AMR was directly responsible for about 1.27 million deaths and associated with nearly 4.95 million deaths worldwide in 2019 [1]. A subsequent analysis estimated about 1.14 million attributable and 4.71 million associated deaths in 2021, and forecast that attributable deaths could reach approximately 1.91 million and associated deaths 8.22 million annually by 2050 [2]. Earlier projections of ten million annual deaths by 2050 [3] have been debated methodologically, but the direction of the trend is not seriously contested.

Antibiotics differ from most other medicines in one ethically crucial respect. The benefit of a cardiac drug, an analgesic or an antidiabetic agent accrues almost entirely

to the person who takes it, and its risks are borne by that person. The use of an antibiotic, by contrast, changes the microbial ecology of the patient, their household, the hospital ward and ultimately the community, and each course of therapy therefore imposes a small cost on everyone who may need antibiotics in the future [4,5]. Antibiotic effectiveness is thus a common-pool resource, and antibiotic prescribing is a domain in which individually rational, well-intentioned decisions can aggregate into collectively harmful outcomes [6,7].

Medical ethics has traditionally been organised around the individual clinician-patient relationship. Codes of professional conduct emphasise fidelity to the patient, and the ethical vocabulary of consent, confidentiality and best interests is designed for dyadic encounters. Antibiotic prescribing strains this vocabulary. A clinician who declines to prescribe an antibiotic for a probable viral illness may be acting ethically with respect to the population but may be experienced by the patient as neglectful. A clinician who prescribes a broad-spectrum agent to a septic patient of uncertain diagnosis acts appropriately by the standard of beneficence, yet the same

decision, replicated thousands of times, accelerates resistance. The literature has increasingly described these tensions as a distinct form of ethical challenge [8,9].

The aim of this review is to provide a comprehensive and structured account of the ethical issues in antibiotic prescription and use, to synthesise the theoretical frameworks available for analysing them, to describe how these issues arise in practice, and to identify strategies by which clinicians, institutions and policy-makers can embed ethical reasoning in everyday antibiotic use. The review is intended for clinicians, medical educators, stewardship teams, ethicists and policy-makers.

2. SCOPE AND APPROACH OF THE REVIEW

This is a narrative review. It draws on the bioethics, public health ethics, infectious diseases, health policy and behavioural science literatures on antibiotic prescribing and antimicrobial resistance. [Authors to complete before submission: databases searched (for example PubMed/MEDLINE, Scopus, Web of Science, PhilPapers), date of last search, search strings combining terms such as "antibiotic*", "antimicrobial resistance", "prescrib*", "ethic*", "stewardship", "justice" and "autonomy", inclusion and exclusion criteria, and whether a formal reporting checklist such as SANRA was followed.] Reference management is intended to be carried out in Mendeley; a companion RIS file of all references cited in this draft is supplied for direct import. The review addresses human medicine principally but considers veterinary and agricultural use where the ethical questions are inseparable from those of clinical practice. Because the ethical issues differ in emphasis between high-income and low- and middle-income countries (LMICs), the review draws explicit comparisons, with particular reference to the South Asian and Indian context. Normative claims are presented as arguments with stated premises rather than as settled conclusions, and areas of genuine disagreement are identified.

3. CLINICAL AND EPIDEMIOLOGICAL CONTEXT

3.1 Burden of antimicrobial resistance

The burden of AMR is unevenly distributed. The 2019 estimates indicated the highest all-age attributable death rates in western sub-Saharan Africa and the lowest in high-income regions [1]. In Europe, modelling suggested that infections with antibiotic-resistant bacteria caused several hundred thousand infections and tens of thousands of deaths annually, with a burden comparable to influenza, tuberculosis and HIV combined [10]. South Asia carries a very large absolute burden, reflecting high infection incidence, high population density, limited sanitation, and heavy and often unregulated antibiotic consumption [11,12]. The World Health Organization has published a priority list of resistant pathogens, including carbapenem-resistant *Acinetobacter baumannii*, *Pseudomonas aeruginosa* and Enterobacterales, to guide research and development [13].

3.2 Patterns of antibiotic consumption

Global antibiotic consumption rose substantially in the early twenty-first century, with the most rapid growth

occurring in LMICs, where consumption converged toward the levels seen in high-income countries [14]. Two opposite problems coexist. In many settings antibiotics are overused: prescribed for viral respiratory infections, self-limiting diarrhoea and non-specific fever, or used in excessively broad or prolonged courses. Studies of ambulatory care in the United States have found that roughly a third of antibiotic prescriptions are unnecessary, with the largest share attributable to acute respiratory conditions of predominantly viral aetiology [15]. At the same time, an estimated large number of deaths from bacterial pneumonia, neonatal sepsis and other treatable infections occur because effective antibiotics are unavailable, unaffordable or delivered too late [16,17]. Ethics must therefore address both excess and access; a stewardship agenda concerned only with restriction would be incomplete and, in some settings, harmful.

3.3 Drivers of inappropriate prescribing

The drivers of inappropriate prescribing are multiple and interacting. Clinical drivers include diagnostic uncertainty, difficulty distinguishing bacterial from viral illness, fear of missing serious infection, and lack of rapid diagnostics. Patient-related drivers include expectations, demand for a visible therapeutic response, limited health literacy and prior experience of antibiotics "working" [18,19]. Perceived patient expectation, whether or not accurately perceived by the clinician, is a strong predictor of prescribing [20]. Structural drivers include time pressure, payment systems that reward throughput, medico-legal pressures, weak regulation of sales, promotion by pharmaceutical companies, and inadequate infection prevention which increases the underlying infection burden [21-23]. Behavioural science research shows that prescribing is shaped by social norms, professional hierarchies, habits and heuristics rather than by knowledge deficits alone [24,25].

Non-prescription access is a further driver. A systematic review found that non-prescription antibiotic use is common worldwide and particularly prevalent where regulation is weak or enforcement lacking, with pharmacies, informal vendors and drug shops acting as major sources [26]. Studies in New Delhi documented a high volume of antibiotic use among outpatients, much of it of broad-spectrum agents and fixed-dose combinations, and in the private sector [27]. Such patterns raise ethical questions about the role of pharmacists, informal providers and regulators as well as physicians.

3.4 The COVID-19 pandemic as a natural experiment

The COVID-19 pandemic illustrated the ethical stakes of uncertain-diagnosis prescribing. Early in the pandemic, a large proportion of hospitalised patients received empirical antibiotics, although bacterial co-infection at presentation was relatively uncommon, with pooled estimates in the range of a few per cent to low double digits depending on setting and definition [28,29]. Clinical uncertainty, fear and limited evidence led to widespread empirical use, and such use illustrates how emergency conditions can suspend ordinary stewardship norms. It also raises the question of what ethical standards should govern prescribing under uncertainty: how much

collective harm is justified by an individual patient's plausible but unproven benefit?

4. ETHICAL FRAMEWORKS FOR ANTIBIOTIC USE

No single ethical theory captures the full moral landscape of antibiotic prescribing. Several frameworks illuminate different aspects, and a comprehensive analysis draws on them in combination.

4.1 Principlism: autonomy, beneficence, non-maleficence and justice

The four-principle approach of Beauchamp and Childress remains the most widely used framework in clinical ethics [30,31]. Applied to antibiotics, each principle produces recognisable dilemmas, summarised in Table 1 and elaborated in Section 5.

Table 1. The four principles applied to antibiotic prescribing

Principle	Core obligation	Typical antibiotic dilemma
Respect for autonomy	Honour informed, voluntary choices of patients; disclose information; obtain consent	Patient requests antibiotics for a probable viral illness; patient declines a recommended course; disclosure of ecological and personal risks of antibiotics
Beneficence	Act to promote the patient's welfare	Empirical broad-spectrum therapy in suspected sepsis; prophylaxis in high-risk procedures; treating uncertain infection "just in case"
Non-maleficence	Avoid causing harm	Adverse drug reactions, Clostridioides difficile infection, microbiome disruption, patient-level resistance selection
Justice	Fair distribution of benefits, burdens and risks; equitable access	Preserving effectiveness for future patients; access gaps in LMICs; allocation of last-line agents; fairness in restriction policies

The standard four-principle analysis was developed for the individual patient. Its extension to antibiotics requires that non-maleficence and justice be interpreted broadly enough to include third parties and future persons who are statistical rather than identifiable [4,5]. Critics of principlism note that the principles offer limited guidance when they conflict, and that the weight assigned to justice against individual beneficence is precisely what is at issue in antibiotic use.

4.2 Public health ethics

Public health ethics accepts that interventions may sometimes limit individual liberty or interests for the protection of the population, provided they are necessary, proportionate, effective, the least restrictive alternative, and transparent. The Nuffield Council on Bioethics' intervention ladder provides a useful heuristic, ranging from providing information through enabling choice, guiding choice through incentives and default options, to restricting or eliminating choice [32]. Stewardship interventions occupy the whole ladder: educational campaigns, decision support and audit-and-feedback lie at the lower rungs, whereas formulary restriction, pre-authorisation requirements and prescription-only regulation lie at the higher ones. A public health ethics analysis asks whether restriction of clinician or patient discretion is justified by the magnitude of collective harm, whether less intrusive measures have been tried, and whether the burdens of restriction fall fairly.

4.3 The commons framework

Hardin's account of the tragedy of the commons describes how rational individuals, each pursuing their own interest, may deplete a shared resource [6]. Antibiotic effectiveness closely resembles such a resource: it is non-excludable in use and rivalrous in the sense that use by one reduces the value available to others through the evolution of resistance. The commons framing highlights the importance of coordination mechanisms, whether regulation, professional norms, or institutional governance, but it also has limits. Antibiotic resistance is not a simple depletion of a fixed stock; resistance emerges nonlinearly, interacts with infection control and travel, and may be partially reversible. Moreover, the commons image can suggest that the cause is greedy individual users, obscuring structural determinants such as poverty, inadequate sanitation and health-system weakness, which are largely beyond individual control [7,21].

4.4 Contractualism

Millar has argued from Scanlon's contractualism that antibiotic use should be governed by principles that no one could reasonably reject, and that this requires constraining use to circumstances where the expected benefit is meaningful [33]. On this view a physician need not maximise the interest of the current patient irrespective of cost to others; rather, prescribing norms should be those that all stakeholders, including future patients, could accept. Contractualism helps to explain why a person with a mild self-limiting infection cannot

reasonably demand an antibiotic whose collective costs are borne by others, while a person with a life-threatening infection has an overwhelming claim to effective therapy.

4.5 Virtue ethics and professional integrity

Virtue ethics shifts the question from "which rule applies" to "what would a practically wise and conscientious clinician do". Relevant virtues include prudence, honesty, humility about diagnostic uncertainty, courage to resist inappropriate demands, compassion in explaining why an antibiotic is unnecessary, and justice as a disposition toward fair treatment of unseen others. Empirical studies of hospital prescribers show that clinicians frequently feel torn between what they perceive as protecting the individual patient and protecting society, and they often resolve the tension in favour of the patient, especially when seniors, peers or organisational culture reinforce a precautionary stance [34,35]. A virtue-based approach emphasises professional formation and the cultivation of role models rather than rule enforcement alone.

4.6 Relational, solidarity-based and intergenerational perspectives

Relational accounts of autonomy emphasise that patients and clinicians decide within networks of relationships and obligations. Solidarity-based approaches, prominent in European public health ethics, emphasise shared vulnerability: everyone is potentially a future recipient of antibiotic therapy and a potential victim of untreatable infection. The intergenerational dimension is also significant. Resistance accumulated by present use will be inherited by those who follow, who have no voice in present decisions. This connects antibiotic stewardship to wider debates about responsibilities to future generations and sustainability [4,9].

4.7 Reconciling the frameworks

The frameworks are complementary rather than competing. Principlism supplies a familiar vocabulary and an appropriate default of patient-centredness. Public health ethics and commons analysis supply arguments for limits on individual discretion. Contractualism explains why some limits are justified as fair. Virtue ethics and relational approaches explain how such limits are enacted in real relationships. Stewardship can therefore be justified as an expression, rather than a betrayal, of the medical professional's role: physicians are custodians of a shared therapeutic resource as well as advocates for individual patients [36,37].

5. ETHICAL DILEMMAS AT THE BEDSIDE

5.1 Autonomy, informed consent and patient expectations

Respect for autonomy in antibiotic prescribing operates in two directions. First, patients have a right to information about the risks and benefits of treatment. Yet consent for antibiotics is rarely explicit, and most patients are not told that an antibiotic may cause adverse effects, alter their microbiome, or contribute to resistance that may affect them personally, for example through subsequent difficult-to-treat urinary or skin infections. Secondly, patients sometimes request antibiotics that are not

clinically indicated. Autonomy is a right to accept or refuse treatment offered by a clinician; it is not a right to demand any treatment. A clinician is not obliged to prescribe an intervention that is not medically indicated, and respecting a person's autonomy is compatible with declining a request while explaining why.

Qualitative and quantitative studies show that clinicians often overestimate patient expectation of antibiotics, and that perceived expectation drives prescribing more strongly than reported expectation [18-20]. Ethically, this means that a considerable proportion of "patient-driven" prescribing reflects clinician assumption rather than patient preference. Models of the clinician-patient relationship that emphasise deliberation rather than either paternalism or consumerism fit this situation best [38]. Communication training and shared decision-making improve outcomes: a cluster randomised trial in primary care demonstrated that training in enhanced communication skills, alone or with C-reactive protein point-of-care testing, substantially reduced antibiotic prescribing for lower respiratory tract infection without harming recovery [39]. Delayed or "wait-and-see" prescribing, in which a prescription is given with instructions to use it only if symptoms fail to improve, is a strategy that respects patient concern while reducing use [40]. The ethical merit of such strategies lies in their honesty: they involve the patient in the reasoning rather than substituting a prescription for a conversation.

A related issue is the therapeutic or placebo use of antibiotics. Prescribing an antibiotic to a patient primarily to satisfy or reassure them, when the clinician believes it has no biological benefit, involves a mild deception, imposes risk without benefit and may reinforce the belief that antibiotics are appropriate for viral illness. It is difficult to justify ethically. Communicating "care" through other means, such as symptomatic treatment, safety-netting advice and follow-up, is preferable.

Patients may also decline recommended antibiotics or fail to complete a course. The traditional instruction to "always finish the course" has been criticised as lacking evidence for many conditions, and shorter courses are often as effective. Ethical practice requires that the clinician explain the intended duration and rationale honestly, and updated guidance based on evidence should replace inherited dogma.

5.2 Beneficence against non-maleficence: individual benefit and collective harm

The central tension is between the immediate welfare of the patient and the long-term integrity of antibiotics as a shared resource. Three points deserve emphasis. First, in most acute severe infection, the patient's interests should predominate. Delay or under-treatment of sepsis increases mortality, and no stewardship principle justifies withholding effective therapy from a person who is seriously ill. The ethical focus in such settings is not restraint but reassessment: early cultures, prompt narrowing of therapy once results are known, and clear stop dates. Second, in low-risk situations such as uncomplicated upper respiratory infection, the individual benefit is negligible and the cumulative collective cost non-trivial; here restraint is ethically justified and clinical

benefit is not sacrificed. Third, in the large intermediate zone of genuine uncertainty, ethical judgement must weigh probability and severity of harm to the patient against the marginal contribution to resistance, and should be transparent and documented.

Empirical studies of doctors' reasoning suggest that many clinicians accept collective responsibility in principle but find it psychologically remote at the point of decision, because the harm of a single prescription to society is diffuse, delayed and statistically invisible, whereas the harm of withholding an antibiotic from a patient who then deteriorates is concrete, immediate and personally attributable [34,35]. This asymmetry biases individual clinicians toward over-prescribing and provides part of the argument for system-level support rather than reliance on individual virtue.

5.3 Dual loyalty and the clinician's role

Clinicians in hospitals and health systems also owe obligations to their institution, colleagues and payers. Stewardship programmes may require prior authorisation for restricted agents, and clinicians may feel that this interferes with clinical autonomy. Ethical analysis distinguishes between legitimate constraints grounded in good evidence and transparent process, and constraints motivated primarily by cost containment that compromise care. The former are consistent with professional duty; the latter raise concerns about dual loyalty. Good stewardship governance therefore requires transparency about rationale, rapid access to expert advice, a clear route for appeal in urgent cases, and monitoring for unintended harms such as delayed appropriate therapy [41,42].

5.4 Diagnostic uncertainty, defensive practice and moral distress

Diagnostic uncertainty is the principal legitimate cause of unnecessary prescribing. Rapid diagnostics, biomarkers such as C-reactive protein or procalcitonin, and clinical decision rules can reduce uncertainty, but they are unevenly available and cannot eliminate it [39]. When uncertainty persists, the prevailing ethic tends to favour over-treatment because the consequences of missed infection are more visible and more likely to attract complaint or litigation. Defensive medicine, where clinicians order tests or treatments primarily to reduce legal exposure, has been documented widely in high-risk specialties [43]. In such contexts, prescribing an antibiotic serves the clinician's interests as much as the patient's. Ethically, a clinician should recognise that self-protective prescribing may masquerade as beneficence. At an institutional level, medico-legal systems that punish under-treatment but never over-treatment create perverse incentives, and reforms to litigation culture and guidelines that offer explicit protection to evidence-based restraint are ethically relevant.

Clinicians may also experience moral distress when they feel constrained from acting in accordance with their ethical judgement, for example when a senior colleague insists on continuing unnecessary broad-spectrum therapy or when local culture treats restraint as negligent. Institutions have an ethical responsibility to foster psychological safety, so that junior clinicians, pharmacists

and nurses can question prescribing without fear [24,37].

5.5 Special populations

5.5.1 Children

Paediatric prescribing is heavily influenced by parental anxiety, school and childcare attendance requirements, and clinician reluctance to accept risk. Parents are legitimate decision-makers, but their decisions must remain grounded in the child's best interest, and children bear the risks of over-treatment, including adverse events and disruption of the developing microbiome. Studies show that clinicians' perception of parental expectation strongly predicts antibiotic prescribing [20]. Ethical practice requires honest communication with parents, with attention to reassurance, safety-netting and the trajectory of self-limiting illness. Paediatric contexts are also where access failures cause the greatest loss of life, for example neonatal sepsis and childhood pneumonia in LMICs, so restraint must not be confused with rationing of necessary care [16,17].

5.5.2 Older adults and end-of-life care

Older adults, particularly nursing-home residents, receive high volumes of antibiotics, often for non-specific symptoms or asymptomatic bacteriuria. In residents with advanced dementia, antimicrobial therapy is frequently given in the last weeks of life without clear evidence of benefit, and it may prolong dying, cause distress through adverse effects or through parenteral administration, and drive resistance [44]. Ethical decision-making here should integrate goals of care, prognosis, and the preferences of the patient or surrogate. Antibiotics are not ethically special: as with other life-prolonging therapies, they may be appropriately withheld or withdrawn when burdens outweigh benefits, but decisions must follow shared discussion rather than default assumptions in either direction. Withholding antibiotics from a patient who would want them, or delivering them to one who would decline them, both violate respect for persons.

5.5.3 Immunocompromised patients and high-risk surgery

For patients receiving chemotherapy, transplantation or major surgery, the risk-benefit balance for prophylaxis and empirical therapy is different. Febrile neutropenia is a paradigm case in which prompt broad-spectrum therapy is life-saving and delay is unethical. Here the ethical imperative is to treat early and then de-escalate. The corollary is that institutions treating such patients bear a heightened responsibility for surveillance, infection control and stewardship to preserve options for those who most depend on them [41].

5.5.4 Pregnancy and the unborn

Antibiotic prescribing in pregnancy involves the interests of two related parties, and the fear of harm to the foetus may cause inappropriate withholding of necessary therapy, while overuse may expose both to avoidable risk. The ethical approach is to treat maternal infection promptly using agents with the best safety data, to avoid unnecessary use, and to inform the woman honestly of uncertainties.

5.6 Prophylaxis, empirical therapy and duration

Surgical and medical prophylaxis, empirical therapy and duration of treatment each embody ethical choices. Prolonged postoperative prophylaxis beyond guideline recommendations, for example, adds harm without benefit but is common. Empirical therapy should reflect local resistance data and be reviewed at 48 to 72 hours. Ethical practice includes a commitment to reassessment, since an empirical prescription is a provisional hypothesis, not a completed decision [41,45]. Leaving patients on unnecessary antibiotics through inertia is a subtle but real ethical failing.

5.7 Critical care and sepsis

In critical care, time-sensitive decisions must be made with incomplete information, and an ethical stewardship approach will not compel restraint in these circumstances. Rather, it emphasises a "start smart, then focus" approach: adequate initial coverage, cultures before antibiotics where feasible, and prompt narrowing. Ethical concerns are more prominent at the margin, for example prolonged duration in patients who have recovered, or repeated escalation in patients with persistent fever and no source. Here the clinician has a duty to challenge automatic escalation.

6. JUSTICE, ACCESS AND EQUITY

6.1 Excess and access: two faces of the same injustice

Justice in antibiotic use has at least four dimensions: distributive (who gets access to effective drugs), procedural (who decides on restriction and how), intergenerational (fairness to future patients) and global (obligations between richer and poorer countries). The relationship between excess and access is central. Many people in LMICs die because they cannot obtain a first-line antibiotic, whereas in the same countries the wealthy may consume unnecessary broad-spectrum agents [16,17]. A restriction-focused stewardship agenda applied without attention to access risks entrenching injustice, whereas an access-only agenda risks accelerating resistance. The Lancet series on antibiotic access argued that the goals are complementary and that a balanced framework, ensuring that appropriate antibiotics reach those who need them while limiting inappropriate use, is essential [16,17].

6.2 Global inequities and shared responsibility

Resistance genes cross borders through travel, trade and migration, and no country can protect its population by stewardship alone. High-income countries have contributed disproportionately to historical resistance through decades of heavy use, and they bear special responsibility for funding surveillance, diagnostics, infection prevention and access programmes in LMICs. LMICs face parallel challenges of weak regulatory capacity, poor infrastructure and limited diagnostic services, and in many of these settings surveillance data are scarce, which itself is an equity problem because policy is made without evidence about local conditions [46,47]. Ethical approaches to global AMR governance emphasise shared but differentiated responsibilities: all countries must contribute, but expectations and support

should reflect capacity [9,48].

6.3 The AWaRe classification

The WHO Access, Watch, Reserve (AWaRe) classification categorises antibiotics according to their resistance potential and their role in treatment and provides a practical tool for aligning use with ethical priorities: Access antibiotics should be widely available and used for the majority of common infections, Watch agents should be monitored and used for specific indications, and Reserve agents should be held for multidrug-resistant infections [49,50]. The classification supports both access and conservation goals. Its ethical value lies in the transparent link it draws between prescribing choices and collective consequences. It should not, however, be applied mechanically, because individual patients may require Watch or Reserve agents on clinical grounds and because availability of even Access agents remains limited in some regions.

6.4 Allocation of last-line agents and shortages

Newer agents active against carbapenem-resistant organisms are expensive, often available in only a few countries, and may be unavailable in the settings with the highest need. Decisions about who receives these agents raise classical distributive justice questions. Ethical allocation frameworks should be transparent, based on clinical need and likelihood of benefit rather than ability to pay, and developed with input from affected communities. Drug shortages of older, essential antibiotics such as benzylpenicillin and amoxicillin are also common and force clinicians to use broader-spectrum alternatives, with consequences for resistance and cost. Shortage management is an underappreciated ethical problem.

6.5 Language, framing and moral communication

Communication about antibiotic resistance can affect ethical responsiveness. Terms such as "superbug", "war on bugs" and "magic bullet" evoke militarised metaphors that may mislead the public and obscure the fact that resistance arises from ordinary selection processes. Mendelson and colleagues have argued that the language used about resistance is confusing and that terminology should be clarified for policy and public engagement [51]. Framing also matters morally: emphasising blame of individual patients or prescribers may induce defensiveness, whereas framing use as a shared stewardship responsibility may prompt cooperation [37].

7. PROFESSIONAL, INSTITUTIONAL AND COMMERCIAL ETHICS

7.1 Codes of professional conduct

Professional codes traditionally emphasise the duty to act in the interests of the patient, to practise within one's competence and to prescribe rationally. In India, the Indian Medical Council (Professional Conduct, Etiquette and Ethics) Regulations 2002 required registered practitioners to prescribe drugs with generic names and to avoid irrational, hazardous or unnecessary prescriptions [52]. Rational prescribing of antibiotics is therefore an existing professional obligation, not a novel demand. Yet codes seldom refer explicitly to the collective dimension

of antibiotic use, and there is a strong case for explicit incorporation of stewardship duties in professional codes, curricula and licensing requirements [8,53].

7.2 Stewardship programmes as ethical infrastructure

Antimicrobial stewardship has been defined as a coherent set of actions which promote the responsible use of antimicrobials [36]. Core elements include leadership commitment, accountability, drug expertise, action through policies and interventions, tracking, reporting and education [41,42]. Systematic reviews indicate that hospital stewardship interventions increase compliance with prescribing policy, reduce unnecessary duration of therapy and are not associated with increased mortality [54]. Meta-analytic evidence shows reductions in colonisation and infection with resistant bacteria and in *Clostridioides difficile* infection [55], and economic reviews suggest stewardship programmes are generally cost-saving or cost-effective [56]. From an ethical perspective, the significance of stewardship programmes is that they distribute responsibility. Instead of leaving individual clinicians to resolve the tension between individual and collective good alone, well-designed programmes provide expertise, diagnostic support, feedback and shared accountability. This is consistent with the ethical principle that the design of systems should make right action easier [37,45].

7.3 The roles of nurses, pharmacists and other health workers

Prescribing is a team activity. Pharmacists dispense, review and counsel, nurses administer therapy and often collect cultures and monitor response, and in many LMICs informal providers, community health workers and drug sellers are the first point of care. Ethical responsibility for antibiotic use is therefore shared across professions. Pharmacists have a professional duty to question inappropriate prescriptions and, where the law permits, to refuse to dispense antibiotics without prescription; nurses have a role in prompting timely review of ongoing therapy. Empowering these professions requires institutional cultures that allow them to challenge physicians [24].

7.4 Conflicts of interest and commercial influence

Physician interactions with the pharmaceutical industry, including gifts, sponsored education, sample provision and promotional visits, are associated with changes in prescribing behaviour and attitudes toward industry [57]. In the antibiotic domain, promotion of newer and broader-spectrum agents may conflict with conservation goals. Financial relationships between clinicians and dispensing outlets, in settings where clinicians sell drugs directly, produce a structural conflict in which income depends on volume of prescriptions. Ethical practice requires disclosure and, wherever possible, avoidance of such conflicts, and education about antibiotic use should be independent of commercial sponsorship. Separation of prescribing from dispensing, where feasible, removes one incentive for over-prescribing.

7.5 Telemedicine, digital tools and artificial intelligence

Telemedicine and online consultation platforms raise concerns that prescriptions may be issued without physical examination and under commercial pressure to satisfy customers. Evidence on inappropriate prescribing in some direct-to-consumer telehealth services suggests that ethical governance frameworks need to be adapted to digital care. Clinical decision-support and artificial intelligence tools may reduce uncertainty and improve stewardship but raise concerns about transparency, bias in training data, accountability, and the risk that tools trained on data from high-income settings perform poorly in LMICs. Clinicians should retain responsibility for final decisions, and developers and regulators should require validation in the populations where tools will be used.

8. ONE HEALTH: VETERINARY AND AGRICULTURAL USE

Ethical consideration of antibiotic use cannot be confined to human medicine. Global antimicrobial consumption in food animals was estimated at over 60,000 tonnes in 2010 and projected to increase substantially by 2030, driven by intensification of production in emerging economies [58]. Use for growth promotion and routine prophylaxis in crowded conditions contributes to resistance that may transfer to humans through food, environment and direct contact [59]. The ethical questions include whether non-therapeutic use of medically important antibiotics can be justified when the benefit is primarily economic and the harm is borne by the public, who bears responsibility for the transition to alternative production systems, and how the interests of smallholder farmers, who may have few alternatives, should be weighed against those of large industrial producers.

The One Health approach recognises that human, animal and environmental health are interdependent and that governance must be integrated [48,59]. Clinicians have a role in advocacy, since their professional voice carries ethical weight in policy debates about agricultural use. Environmental contamination from pharmaceutical manufacturing, where effluent from antibiotic production facilities in some regions has been found to contain very high antibiotic concentrations, raises further questions about corporate responsibility and the ethical obligations of purchasers, including health systems, to demand responsible manufacturing.

9. ETHICS OF ANTIBIOTIC RESEARCH AND DEVELOPMENT

9.1 Market failure and the conservation paradox

The development of new antibiotics faces a distinctive economic and ethical paradox. To preserve effectiveness, new drugs should be used sparingly, yet developers' revenue depends on volume. As a result, many large pharmaceutical companies have exited the field, and small companies that succeed in obtaining approval have sometimes failed commercially [60,61]. This market failure is an ethical problem because society's interest in a pipeline of effective antibiotics is not aligned with the incentives that drive private investment. Proposed solutions include "pull" incentives such as subscription

models and market entry rewards that delink revenue from volume, and "push" funding such as grants for early-stage research; the ethical requirements are fairness in how costs are shared between countries, transparency about pricing and access commitments, and ensuring that new drugs are available in LMICs where the need may be greatest [3,60].

9.2 Clinical trial ethics

Trials of new antibiotics raise specific ethical issues. Non-inferiority designs, often necessary because placebo controls are unethical in serious infection, require careful choice of margin and comparator. Trials in patients with resistant infections, for whom no effective alternative exists, may involve single-arm or pathogen-specific designs whose evidentiary limits should be transparent. Enrolment of critically ill patients raises consent challenges, requiring appropriate procedures for surrogate or deferred consent. Fair inclusion of children, pregnant women and populations in LMICs is an equity concern, as these groups are often underrepresented but disproportionately affected. Post-trial access obligations are particularly important where drugs are developed using trial participants from LMICs who may then be unable to obtain the product.

9.3 Diagnostics, vaccines and alternatives

Rapid diagnostics, vaccines and non-antibiotic alternatives, including phage therapy and monoclonal antibodies, are essential complements to new antibiotics, yet they receive far less investment. From an ethical standpoint, prevention of infection through vaccination, sanitation, hygiene and infection control is the most fair and effective approach to reducing antibiotic need, and imposes no trade-off between present and future patients. Investment in such measures is therefore an ethical priority in its own right [7,21].

10. LAW, REGULATION AND POLICY

10.1 Policy toolkit and evidence of effectiveness

The policy toolkit includes prescription-only status enforced by regulators, restrictions on promotion, national treatment guidelines, essential medicines lists, surveillance and reporting, public awareness campaigns, financial incentives and disincentives for prescribers, and requirements for hospital stewardship programmes. A systematic review and evidence map of government policy interventions identified a variety of interventions with evidence of effect, notably that many policies had limited evaluation and that evidence from LMICs was particularly sparse [62]. France's national campaign on antibiotic use, combining public messaging with tools for physicians, was associated with a substantial reduction in outpatient antibiotic use over five years [63]. Behavioural interventions targeting prescribers, such as peer comparison and accountable justification, have also reduced inappropriate prescribing in randomised trials [64]. These examples show that ethically acceptable, non-coercive measures can produce meaningful change, consistent with the lower rungs of the intervention ladder [32].

10.2 Regulation and the Indian context

India is among the largest consumers of antibiotics in absolute terms and has a very large burden of infectious disease, a substantial private sector, and a pharmaceutical industry that is also a leading global supplier of generic antibiotics [11,14]. Policy responses include the Chennai Declaration by Indian medical societies [65], the National Action Plan on Antimicrobial Resistance 2017 to 2021 [66], restrictions on over-the-counter sale of selected antibiotics through scheduled drug categories, and state-level action plans. Challenges include enforcement of prescription requirements, the prevalence of informal providers, fixed-dose combinations of uncertain rationale, limited laboratory capacity, and out-of-pocket expenditure on health. Ethically, regulators in this setting must balance the imperative to restrict inappropriate sales with the reality that pharmacies and informal providers are the main source of care for many people, particularly the poor; abrupt restriction without providing alternative access could harm the vulnerable [11,27]. [Authors should update this subsection with the most recent national policy documents and state action plans before submission.]

10.3 Legal liability and duty of care

Legal doctrines of negligence generally measure clinical conduct against a standard of reasonable professional practice. Failure to prescribe when indicated can constitute negligence, and over-prescribing that causes harm may also do so. The law rarely recognises harm to the collective as a basis for individual liability, which reinforces the asymmetry described above. Legal and professional guidance that explicitly defines evidence-based restraint as reasonable practice may help to correct this imbalance.

11. EMBEDDING ETHICS IN PRACTICE

11.1 Education and professional formation

Studies of prescriber education suggest that knowledge-based teaching alone rarely changes behaviour, and that effective programmes combine case-based learning, communication skills, feedback on own prescribing and engagement with local culture [25,53]. Undergraduate and postgraduate curricula should integrate the ethics of antibiotic use as a core competency rather than a peripheral topic. Learning objectives should include the ability to explain to a patient why an antibiotic is not needed, to recognise and manage diagnostic uncertainty, to articulate the trade-off between individual and collective benefit, and to challenge inappropriate prescribing by seniors respectfully. Role-modelling by senior clinicians is influential, and faculty development is thus part of ethical education. Assessment should include observed communication and reflective practice, not only knowledge tests.

11.2 Communication and shared decision-making

Practical communication techniques include eliciting the patient's actual concerns rather than assuming a wish for antibiotics, acknowledging symptoms and their impact, explaining the natural course of illness, offering symptomatic relief, providing safety-net advice about when to return, and, where appropriate, using delayed

prescriptions [18,39,40]. These techniques are ethically significant because they express respect for the patient as a partner and replace paternalism or capitulation with honest engagement. Decision aids and patient information leaflets can support such conversations. Communication should also be culturally appropriate and accessible to people with low literacy or language barriers.

11.3 Institutional design: making the ethical choice the easy choice

Nudges and choice architecture influence prescribing without removing choice: requiring an indication and planned duration to be recorded at the time of prescribing, defaulting to shorter durations, prompting review at 48 to 72 hours, and providing audit and feedback with peer

comparison [25,64]. These interventions are ethically acceptable provided they are transparent, do not manipulate clinicians deceptively, and are evaluated for unintended consequences. More restrictive measures such as pre-authorisation should be reserved for agents where the collective risk is highest, and should be implemented with rapid access to expert advice to avoid delays in urgent cases [41].

11.4 A practical ethical decision framework

Table 2 offers a structured set of questions that clinicians and stewardship teams may use to make ethical reasoning explicit. The framework does not replace clinical guidelines but complements them by prompting attention to dimensions that are often implicit

Table 2. A practical ethical checklist for antibiotic prescribing decisions

Step	Question to ask	Ethical principle engaged
1. Indication	Is there a reasonable likelihood of bacterial infection that will benefit from antibiotics?	Beneficence; non-maleficence
2. Severity and urgency	Is the patient seriously ill such that delay could cause serious harm? If yes, treat promptly and reassess.	Beneficence; duty of rescue
3. Diagnostics	Have appropriate cultures, rapid tests or biomarkers been obtained where available and feasible?	Non-maleficence; stewardship
4. Choice of agent	Is the narrowest effective agent chosen in line with local resistance data and the AWaRe category?	Justice; non-maleficence
5. Communication	Has the patient (or surrogate) been informed of expected benefit, risks and alternatives, and have their concerns been explored?	Respect for autonomy
6. Duration and review	Have a stop or review date and planned de-escalation been documented?	Non-maleficence; justice
7. Conflicts	Am I influenced by fear of complaint, commercial incentives or convenience rather than the patient's need?	Integrity; honesty
8. Equity	Would I make the same decision for a patient regardless of ability to pay, and does my decision consider access for others?	Justice

11.5 Ethical governance of stewardship

Stewardship teams themselves require ethical governance. Their interventions should be evidence-based, proportionate and open to challenge. Data on outcomes, including unintended harms, should be collected and shared. Members should declare conflicts of interest, and patient and public involvement in the design of stewardship policies would strengthen legitimacy. Clinical ethics committees can provide consultation for difficult cases, including decisions about withholding or withdrawing antibiotics at end of life or allocation of scarce last-line agents.

12. Illustrative Case Vignettes

The following composite vignettes, constructed for teaching purposes and not describing real individuals, illustrate how the frameworks above may be applied.
Case 1: The insistent parent
A father brings his four-year-old son with a two-day history of fever, runny nose and cough. The child is alert, eating and drinking, and has no signs of bacterial disease. The father says that the last time his son was like this, "only antibiotics worked", and that he cannot afford more days off work. The clinician is under time pressure and the waiting room is full.
Analysis: Principlism directs attention to beneficence and

non-maleficence for the child: antibiotics offer no benefit for a viral illness and expose him to risk. Respect for autonomy does not compel prescribing but does require respect for the father's concern and exploration of his underlying worries, which may relate to work and cost as much as to the child's health. A communication-based approach acknowledges the father's concern, explains the likely course, provides safety-net advice and possibly a letter for the employer. Where follow-up is difficult, a delayed prescription may be considered as a compromise, with clear instructions. The ethically weakest option is to prescribe reflexively to end the consultation [20,39,40].

Case 2: Empirical therapy in suspected sepsis

A 68-year-old woman with diabetes presents with fever, hypotension and a urinary source. Local resistance rates for extended-spectrum beta-lactamase producers are high. The stewardship policy recommends a narrower agent for community-acquired urinary infection, but the patient is unstable.

Analysis: The patient's life-threatening condition gives an overwhelming claim to prompt, effective broad-spectrum therapy, and delay for policy compliance would be unethical. The stewardship duty here lies in obtaining cultures before therapy, documenting the rationale, reviewing at 48 to 72 hours, and de-escalating when susceptibilities are known. A stewardship team should support rather than obstruct, with a rapid-access consultation pathway [41,45].

Case 3: Antibiotics at the end of life

An 87-year-old nursing-home resident with advanced dementia develops fever and reduced oral intake. The family, who have previously agreed to a comfort-focused plan, ask "shouldn't we at least give antibiotics?" The physician is uncertain whether antibiotics will improve comfort.

Analysis: The decision should be grounded in the patient's goals of care and previously expressed values. Antibiotics may sometimes relieve distressing symptoms, for example from a urinary or respiratory infection, and in these cases oral or subcutaneous therapy may be consistent with comfort. Where benefit is unlikely, burdens such as intravenous access, hospital transfer and adverse effects may outweigh benefit, and the ethical task is to explain this compassionately and to reassure the family that withholding a specific treatment is not abandonment [44].

Case 4: The pharmacy counter

A pharmacist in a densely populated area is asked by a customer, who has no prescription and cannot afford a doctor's visit, for a broad-spectrum antibiotic for diarrhoea. The regulations require a prescription, though enforcement is rare and other shops nearby sell without one.

Analysis: This case illustrates the interplay of legal, professional and justice considerations. The pharmacist's duty to comply with regulation and to avoid harm suggests declining, yet doing so may leave the customer with no access to care. An ethically thoughtful response includes counselling on oral rehydration, indicating warning signs that require medical attention, and referring to an affordable clinic. At the system level, the case highlights the responsibility of policy-makers to provide accessible

primary care, since restriction without access shifts the moral burden onto individual pharmacists and customers [17,26,27].

Case 5: The unnecessary continuation

On a surgical ward, a patient who underwent uncomplicated elective surgery continues to receive intravenous antibiotics on day five, although the guideline recommends a single pre-operative dose. The registrar notices but the consultant favours "just to be safe".

Analysis: The case illustrates the hierarchy problem. The registrar has an ethical duty to raise the concern, and the institution has a duty to make it safe to do so. Continued unnecessary prophylaxis imposes risk without benefit and reflects defensive or habitual practice. A psychologically safe culture, audit and feedback, and leadership from senior clinicians can help resolve such situations [24,25,41].

13. EMERGING CHALLENGES

13.1 Diagnostics and the ethics of testing

Rapid molecular and point-of-care diagnostics offer a route to reduce uncertainty, but they raise ethical questions of their own: unequal access, cost, over-reliance on tests with imperfect specificity, and the risk of detecting colonisation that leads to unnecessary treatment. Testing strategies should be evaluated for their effect on patient outcomes and resistance, not only for technical performance.

13.2 Genomic surveillance and data governance

Genomic and digital surveillance can provide detailed information about resistance patterns, but they involve data-sharing across institutions and borders, with issues of privacy, ownership, benefit-sharing and the risk of stigmatisation of countries or communities that report resistant strains. Transparent governance frameworks are needed to encourage reporting rather than penalise it [46,67].

13.3 Climate change, migration and conflict

Climate change, displacement and conflict are expected to alter infection patterns and disrupt health systems, with implications for antibiotic access and stewardship. Humanitarian settings, where infection prevention is difficult and resources limited, raise acute ethical tension between conserving effectiveness and treating the patients at hand. Ethical frameworks for AMR should be robust enough to guide decision-making in such conditions.

13.4 Lessons from the pandemic

The pandemic showed the weakness of stewardship under crisis and underscored the importance of preparedness: rapid guidance that addresses antimicrobial use in novel infections, surveillance capacity that remains functional during emergencies, and communication that helps clinicians avoid fear-driven prescribing [28,29].

14. GAPS IN KNOWLEDGE AND A RESEARCH AGENDA

Despite a growing literature, several gaps limit the ethical analysis and its translation into practice. First, most empirical research on prescriber decision-making has

been conducted in high-income settings; there is a need for studies in LMICs, including of informal providers, in which the constraints and moral reasoning may differ [34,46]. Second, few studies measure the ethical outcomes of stewardship, such as the frequency of delayed appropriate therapy, patient understanding and satisfaction, or equity of access, so that the balance of benefits and harms of restriction is incompletely known. Third, the normative literature has focused on principle-level analysis, and there is a need for practice-oriented ethical guidance that can be integrated into clinical workflows. Fourth, the perspectives of patients and the public on the trade-off between individual and collective benefit are underexplored, and deliberative methods could inform policy legitimacy. Fifth, ethical analysis of agricultural and environmental dimensions of antibiotic use remains less developed than analysis of clinical use, although these may contribute substantially to the resistance burden [58,59]. Sixth, evaluation of policy interventions has been limited, with sparse rigorous evidence from LMICs [62]. Finally, the ethics of emerging tools such as artificial intelligence decision support, genomic surveillance and novel therapeutics requires early and sustained attention.

15. RECOMMENDATIONS

Drawing on the foregoing analysis, the following recommendations are proposed for different stakeholders.

Clinicians: Recognise antibiotic prescribing as an act with both individual and collective consequences; explore patient concerns before prescribing; document indication, planned duration and review date; avoid self-protective or convenience-driven prescribing; and speak up when colleagues' prescribing is inappropriate.

Medical educators and regulators: Embed the ethics of antibiotic use in undergraduate, postgraduate and continuing education, with assessment of communication and reflective practice; incorporate explicit stewardship duties into professional codes and licensing.

Hospitals and health systems: Establish stewardship programmes with clear governance, rapid consultation pathways and monitoring for unintended harms; design electronic systems to support good prescribing; foster psychological safety so that all team members can question prescriptions.

Pharmacists and other providers: Counsel patients, question inappropriate prescriptions, and adhere to dispensing regulations, supported by systems that ensure patients have alternative routes of access to care.

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Policy-makers: Pursue policies that combine restriction of inappropriate use with expanded access to diagnostics, effective antibiotics, vaccines, sanitation and primary care; regulate promotion and sales; support surveillance and its transparent governance; and evaluate policies rigorously.

Global community: Share responsibility fairly by financing access and infrastructure in LMICs, supporting incentive models for antibiotic development that delink revenue from volume with access commitments, and integrating human, animal and environmental sectors.

Researchers and ethicists: Conduct empirical ethics research in diverse settings, develop practice-oriented guidance, and engage patients and communities in deliberation on the trade-offs.

16. CONCLUSION

Antibiotic prescription is a paradigmatic case of an ethical problem in which the interests of the individual and the collective are intertwined and, at times, in tension. Traditional medical ethics, centred on the clinician-patient dyad, provides essential foundations, notably respect for persons, beneficence and non-maleficence, but it must be supplemented by public health ethics, justice-based reasoning and attention to institutional and global structures. Ethical antibiotic use is neither blind restraint nor unlimited responsiveness to patient demand. It requires that antibiotics be available to all who need them, withheld from those who do not, chosen and dosed with care, and reviewed as evidence emerges.

Three conclusions follow from this review. First, stewardship is properly understood as an ethical obligation grounded in justice and professional integrity, not merely as cost control or quality improvement. Second, the burden of resolving the individual-collective tension should not fall on individual clinicians alone; institutions, regulators and governments have obligations to create conditions in which ethical prescribing is feasible, safe and supported. Third, restriction and access are two aspects of the same moral project, and policies that address only one are likely to fail or to cause harm. The preservation of antibiotic effectiveness is a shared responsibility across professions, sectors, countries and generations, and the ethical challenge of this generation of clinicians is to act on that responsibility while never losing sight of the patient in front of them [4,9,68,69]

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