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Research Article

Social (In)equities and Ethical Challenges: Role of Information Practices in Antimicrobial Resistance in India

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Abstract

Antimicrobial resistance has been described as a "slow-moving Tsunami" and one of the top global health threats that affect social groups inequitably, especially in low- and middle-income countries (LMICs). This paper analyses social inequities and ethical implications related to antibiotic use in India and how information systems can help mitigate them. India is a global antimicrobial resistance (AMR) hotspot, showing relative policy inertia in addressing this grand challenge. The paper describes two interconnected streams of work. First, it takes an ecosystem perspective to understand inequities in practices around the prescription, dispensing, and consumption of antibiotics. Second, it analyzes the digital's potential role in addressing these inequities. As a result, the paper identifies four key determinants of social inequity and their ethical implications. Next, the paper identifies the opportunities and challenges in applying digital to address these inequities. This paper thus seeks to make a vital contribution to IS research on an area of immense societal value, particularly in informing how the potential of the digital can be effectively materialized.

Keywords: AMR; Information System; Inequity; Ethics; Digital Surveillance; Antibiotics Information Practices; India

1. Background

The World Health Organization (WHO) described antimicrobial resistance (AMR) as 'a global crisis' and the perfect example of complex, multi-sectoral, multi-stakeholder challenges increasingly facing the world (1). Antimicrobial resistance is endangering the future of societies (2), including the achievement of all sustainable development goals (SDGs) (3). Antimicrobial resistance is a lifestyle disease (4) impacting the world inequitably, with low- and middle-income countries (LMICs) amongst the worst hit due to the high prevalence of infectious diseases, overcrowding, poor sanitation, weak access to diagnostics, inadequate monitoring, indiscriminate antibiotic use, and poor regulations. India is the world's AMR capital (5), reporting an annual AMR attributed mortality of 700,000, estimated to reach 10 million by 2050 (2). India is the biggest producer (Srividhya, 2021) and consumer of antibiotics globally, as reflected in the 100% increase in antibiotic use between 2000 and 2015 (6). Antimicrobial resistance affects social groups inequitably, particularly the poor and disadvantaged, with adverse implications on ethical issues of human rights, freedom, privacy, and well-being (7). Antimicrobial resistance is both the cause and consequence of social inequities with adverse ethical consequences, reflected in the massive increase in multi-drug resistant tuberculosis (TB) (8).

Effective digital surveillance is an essential tool to combat these inequities AMR by making the problem better visible at required levels of granularity (age, sex, income) to monitor and respond at policy and practice levels. One hundred sixty-three countries have developed national action plans (NAP) to combat AMR, but only 55% of surveillance systems monitor the consumption of antibiotics (9). Surveillance of antibiotics is particularly complex as processes of prescriptions, consumption, and dispensing in LMICs tend to be primarily informal and "under the radar" (10-13), compounded by the lack of availability of functioning electronic medical record systems, making it challenging to link patient clinical conditions with antibiotic prescriptions (14).

Unfortunately, information system (IS) research has been largely silent about this significant societal problem. There are increasing calls for building one-health approaches to AMR research (15), where digital surveillance plays a fundamental role, requiring the active engagement of IS research. This paper contributes to

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this agenda by studying AMR-related ethical challenges shaped by social inequities and the potential role of the digital. The empirical focus in India includes two parallel and ongoing initiatives: (1) the study of information practices within an ecosystem perspective comprising physicians, pharmacists, patients, and Medical Representatives (MRs), to understand the inter-connected determinants of inequity and their ethical implications; and (2) engaging in efforts to implement an AMR surveillance system in a public hospital, to analyze the role the digital can play and the underlying challenges. Health equity provides the conceptual lens to analyze the following research question:

What are the ethical implications of social inequities around AMR, and how can they be best addressed through digital surveillance systems?

After this brief introduction motivating this study, in the next section, we provide a conceptual understanding of health inequities, their relevance, and their ethical implications in the context of the AMR challenge. In section 3, we describe the methods followed by the case study and its analysis in sections 4 and 5. Finally, the study conclusions are presented.

1.2. AMR-Related Inequities and Ethical Implications

Equity has multiple meanings, broadly implying "the quality of being fair and impartial," and is fundamentally constitutive of the person's well-being, directly impacting their capabilities to pursue health goals they value (16). Health is the most important condition of human life, and a person deserves a fair and just opportunity to achieve good health and be free from escapable illness and immature immortality (17). A focus on health equity seeks to provide everyone with a fair opportunity to be healthy irrespective of their social status and income.

Anything that adversely affects the health and well-being of individuals is an ethical issue underpinned by human rights concerns of eliminating health disparities (18), particularly those preventable and avoidable. Disparities are rooted in inequities of health access and resources (19), framed in conditions of social and economic ordering and other social determinants of health (20). To improve health for all and "leave no one behind" (SDG3), becomes a social and ethical imperative, where digital surveillance has a key role to play (21) and is a grand challenge for IS research.

Antimicrobial resistance is a distinct ethical and not just a medical or a technical issue, affecting societies inequitably since a large burden of infectious diseases falls on the poor and socially disadvantaged. India has largely non-existent surveillance systems and poor diagnostic facilities (22), resulting in unequal distribution of the disease (7). Antimicrobial resistance is rife with inequities at both macro and micro levels. Countries with the biggest problems tend to have the least resources, knowledge, and political will to address them, as reflected by the significant correlation between low Gross National Income per Capita (23) and increased AMR prevalence (24). While effective digital surveillance is key to implementing the WHO Global Action Plan (25), most countries (90% of 163) have failed to materialize them in practice (9), resulting in manifold ethical challenges (26). A mere 2.3% of surveillance systems globally are in LMICs (6) contributing to the vicious cycle of a poor evidence base on the AMR challenge, magnifying associated inequities and ethical challenges.

2. Methods

2.1. Research Design and Settings

This is a longitudinal study ongoing since 2019 in two northern states of India, Haryana and Himachal Pradesh (HP), pursuing two objectives: (1) understanding the practices of different stakeholders shaping the (in)equitable consumption, dispensing, and consumption practices of antibiotics; and (2) supporting the implementation of a digital AMR surveillance system in a public hospital in HP.

2.2. Research Settings

The study was done in two districts of Hisar (Haryana, site I) and Kangra (HP, site 2), which offer interesting contrasts. HP reports more progressive health and social indicators than Haryana and a stronger commitment to public systems. With 90% of the state population (as compared to 60% in Haryana) resident in rural areas (27), there is stronger reliance on the public systems, making reliance on private players relatively marginal. HP reports higher literacy levels of 83% and a sex ratio of 972 compared to 75% and 879, respectively, in Haryana. The National Health Survey, 2017 - 18, reported that only 19% of the Haryana population are treated at public facilities, while 68% do so in HP (28, 29) Arguably, HP relies more strongly than Haryana on the public infrastructure for antibiotics, with apparent implications for inequities. The surveillance study is taking place at a public teaching hospital at site 2 with an application developed by a local NGO team (which includes both authors of this paper) to monitor the antimicrobial susceptibility test (AST) results at the microbiology lab. This facility, typical of most public hospitals, suffers from constraints of weak diagnostics and infrastructure (29), with data on antibiotics largely currently invisible.

2.2.1. Data Collection

Data collection covered both streams of empirical work and is summarized in Table 1.

Table 1. Data Collection Methods

Data Collection Methods	Site I	Site II
Interviews	Physicians n = 10; Pharmacists n = 10; People from the community n = 10; MRs n = 4	Physicians n = 5; Pharmacists n = 4; People waiting for consultation at the hospital n = 10; Microbiologists n = 5
Observations	Got access only if we had to wait for the physicians and pharmacists for the interviews	Physicians while prescribing and pharmacists while dispensing
Discussions		With Physicians, Microbiologists, and staff at the microbiology department
Study of policies and documents	National/State-specific policies and guidelines	National/State-specific policies and guidelines
AMR surveillance application design and development		Engaged in the design, development, and implementation of the AMR surveillance system

In both sites, qualitative methods guided the understanding of physicians' prescription practices, pharmacists' dispensing, self-medication of patients, and influences of MRs. Semi-structured, open-ended interview guides were used with physicians from both human and veterinary domains representing public and private settings. The respondents represented a mix of different ages, gender, and income groups to better understand social inequities. In site II, discussions were held with staff at the microbiology lab to understand how information about antibiotics was represented in the AST sample recording and testing processes. Policy documents, both national and state-specific, were important secondary sources to understand the gap between policy and practice.

2.3. Data Analysis

Data analysis was conducted in multiple sequential steps.

- Step 1, data collation and organization: All data collected, including interview notes, observations, and study of documents studied, were organized and collated to facilitate analysis.

- Step 2, transcription: All primary data were transcribed, translated from Hindi to English wherever needed, and digitized.

- Step 3, thematic analysis: First, responses were grouped by different stakeholders, and themes were identified for each group. Next, a comparative analysis of themes was conducted to examine similarities and differences across stakeholder responses. For example, both physicians' and pharmacists' practices were influenced by the fear of losing a patient, so they were grouped. Similarly, physicians and pharmacists shared the theme of having a sense of authority to informally prescribe and dispense antibiotics, although for different reasons.

- Step 4, identification of determinants of inequities and their ethical implications: Four determinants of inequitable use of antibiotics were identified across stakeholders: (1) practices, (2) knowledge and awareness, (3) regulations, and (4) reporting and their ethical implications.

- Step 5, identification of the role of digital in addressing the equities: The determinants were further analyzed to understand the AMR-related health inequities from a patient's perspective and the role surveillance can play.

- Step 6, theoretical analysis: The determinants and implications were related to the concept of equity.

3. Case Description and Analysis

In this section, we provide the case narrative in three sequential steps: (1) the existing ecosystem of actors, their practices, and underlying justification; (2) how these practices shape determinants of inequities across stakeholders; and (3) analysis of the ethical implications of inequities.

3.1. Stakeholders' Ecosystem and Their Underlying Practices

The ecosystem comprising patients, physicians, pharmacists, and MRs, is depicted in Figure 1.

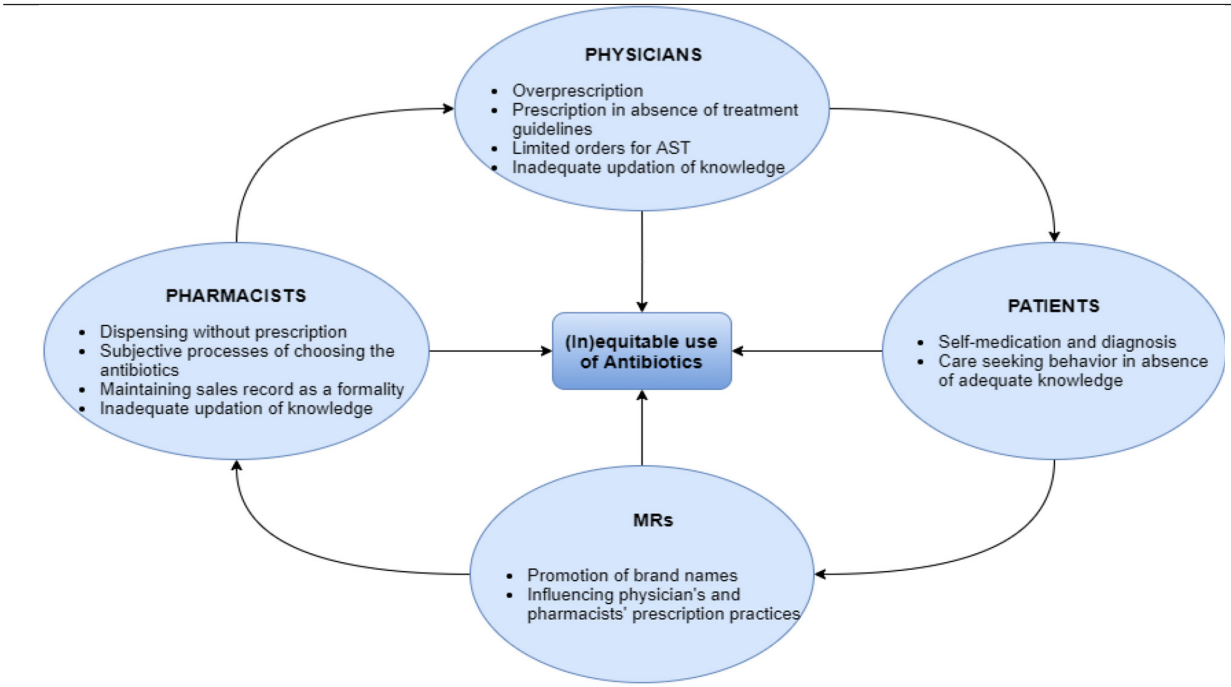

Figure 1. Stakeholders' ecosystem and practices shaping inequities in antibiotics

Table 2 summarizes the practices of stakeholders and their justifications.

Table 2. Summary of Stakeholder Practices and the Underlying Justifications

Stakeholders and Key Practices	Underlying Justification
Physicians	
Overprescription of antibiotics	Fear of losing the patient; patient pressure to prescribe antibiotics
Limited orders for ASTs	Limited ASTs due to availability, costs, and time taken
Formal treatment guidelines are rarely followed.	Unawareness of standard treatment guidelines and regulations; limited sources to update knowledge
Pharmacists	
Dispensing of antibiotics without prescription (over-the-counter)	Feeling of entitlement; Cannot deny a patient their demands
Subjective processes of choosing the antibiotics to be dispensed	Competitive market forces; limited knowledge of antibiotics and AMR
Maintaining sale records as a formality	Only formal compliance for audit; absence of strict regulations
Community members	
Self-medication and diagnosis	Limited resources to pay for consultations and tests; consultation is unnecessary for minor ailments; anything for a quick recovery; the influence of friends and family; lack of awareness about AMR
Medical representatives (MRs)	
Pharmaceutical promotion	Push by the supplier and manufacturer; market competition
Influencing physician's prescription practices	Favors/financial incentives

3.2. Analysis of Antibiotic-Related Practices at Sites I and II

3.2.1. Physicians

3.2.1.1. The Practice of Over-Prescription of Antibiotics

Physicians tend to (over)prescribe antibiotics to patients with varying justifications.

- Fear of losing patients: The fear of losing a patient to other physicians or pharmacists drives over-prescrip-

tion. A physician at a private hospital at Site I said: "Patients do not like being taught, and there is no time to teach the patient about resistance and convince them not to take antibiotics. If I start teaching people, they will rather go and get medicine from another physician or pharmacist." A physician at a busy public hospital at site I explained: "Patients go to the physician who treats them faster." However, a general physician at site II said: "The department is always full and crowded, and patients get free medicines from the hospital pharmacy. I only write whatever is needed."

- Patient pressure: Physicians felt pressurized by patients who were unsatisfied unless an antibiotic was prescribed, which created pressure, as expressed by a practicing physician at a private clinic at site I: "Doctors are compelled to write antibiotics because if the patient is asked to wait for a day or two, they will not return and go elsewhere. The patient believes that physicians call them again to get additional consultation fees and does not understand it is for their good." Patient pressure was exhibited differently at site II, where a physician said: "I cannot wait for AST results if the patient is in a critical situation. Prescribing antibiotics is essential, and the prescription can be changed based on the AST results if the patient survives by then or if he/she does not respond to the treatment."

3.2.1.2. The Practice of Prescription of Antibiotics Without Following Treatment Guidelines

Physicians tend not to order ASTs but rely on clinical symptoms presented by the patient. The absence of treatment guidelines reflects a certain degree of risk-taking.

- AST cannot be prescribed to all: Physicians say that they cannot send all patients for ASTs because of its high costs (particularly in private facilities) and limited availability of diagnostics. Physicians generally order an AST when patients come to them after multiple prior consultants and courses of antibiotics. Under such circumstances, it was impossible to wait for AST results. A general physician at a hospital at site I said, "I cannot ask all patients to get a lab test done here. Most people do not come for consultation because of the fee and take drugs from a pharmacist. If AST is prescribed to all patients, they would rather go elsewhere."

- Limited and time taking diagnostic facilities: ASTs are prescribed to patients who are referred by another physician, present symptoms of infections, or have a history of taking multiple antibiotics. Physicians say it is impossible to prescribe an AST for ailments like fever, cough, and allergies due to patient reluctance who prefer physicians who prescribe drugs. A physician practicing at a tertiary hospital at site I said, "AST is done when the patient is referred by another physician and has come after visiting 4 - 5 doctors. Sometimes patients come with small illnesses, and AST is not done in such cases. I prescribe antibiotics because if I do not, another will. Sometimes the patient cannot pay for tests; in that case, the patient says I have come for medicines, and the doctor is sending for tests and so would rather go to some other doctor". A general physician at site II said, "An AST is generally prescribed when the patient is critical and has a history of taking antibiotics without improvement. All patients cannot be prescribed an AST since we only get results in three days, and it is a time-consuming process."

3.2.1.3. The Prescription Practice of Antibiotics Without Following Treatment Guidelines

Most physicians, clinicians, and veterinarians are unaware of treatment guidelines, which do not exist or are inaccessible. Access to new knowledge about antibiotics is limited for multiple reasons.

- Unawareness of standard treatment guidelines: Physicians are unaware of standard government treatment guidelines for infectious diseases and rely on personal experience about the success rates of antibiotics. A physician at a hospital at site I with a huge patient load said, "In most cases, antibiotics are prescribed based on experience from clinical practice and understanding of the success rate of an antibiotic. I prefer giving the best brands available in the market." Physicians were unaware of treatment guidelines from the hospital or the state and national governments.

- Limited sources to update existing knowledge: The primary source of information about an antibiotic or a new drug for a physician was the internet or the MRs who regularly visited them. Physicians at both Sites I and II expressed their dearth of learning opportunities: "There are no sources except the Internet, journals, and getting reviews from MRs on the introduction of new drugs in the market."

- Absence of strict regulations: Most physicians at private facilities prescribed brand names, which they were free to choose. A pharmacist said: "No physician ever writes generic names. There are always brand names. Every physician has set brands that he prescribes."

3.2.2. Pharmacists

3.2.2.1. The Practice of Dispensing Antibiotics Without Prescription (Over-the-Counter, OTC)

It is a common practice for pharmacists to dispense antibiotics without prescription. Besides, their stocking practices are guided by the need for maximizing sales and justified accordingly.

- Feeling of entitlement: Pharmacists felt entitled and qualified to dispense antibiotics, experiencing an unsaid authority to treat patients without prescriptions. A pharmacist outside the premises of a tertiary hospital at Site I said, "I know what to prescribe based on the experience of dispensing for more than 25 years and the knowledge gained from my pharmacy degree." At site II, there was

relatively more accountability, as pharmacists are an integral part of the whole process of prescription audits. The in-house hospital pharmacist keeps a scanned copy of the fraction of the prescriptions he receives, audited by the prescription committee.

- Cannot deny a patient: Pharmacists feel they cannot deny patients for antibiotics without a prescription, and if they do not dispense it, some other pharmacists will do so. They need to survive in a competitive environment, as often there are shop clusters in an area. A pharmacist at site I said, "There are many pharmacies nearby. If I do not give medicine, someone else will. So, I give patients whatever they ask for." The same practice was followed by a private pharmacy store inside the hospital at site II "I dispense the medicine if the patient has been waiting for too long in line and asks to give him something so he can go home. Otherwise, all patients are asked to go to a physician."

3.2.2.2. The Practice of Subjective Processes of Choosing the Antibiotics to Be Dispensed

If a patient comes to the pharmacy without a prescription, the pharmacist chooses the antibiotics to dispense based on the symptoms explained and their prior experience. The pharmacists gauge the ability of the patients to pay to decide on the drugs. Prior relationships with patients also influence their decisions.

- Competitive market and patient pressure: Patients often return to the pharmacists and complain that their symptoms were not relieved by their drugs. The pharmacists often change the antibiotics or supplement them with steroids. A pharmacist at site I said, "If a patient comes with a throat ache, I will advise a pain killer, an antibiotic, and steroid, and he will feel better. Doctors also prescribe similar medicines as us, so if patients come to us, we give the medicines as well as antibiotics and steroids".

Pharmacists feel pressured by patients who express an inability to afford consultation fees or wait in long queues for medicines. A pharmacist at a busy tertiary hospital at Site I said, "Some patients don't want to pay consultation fees and come for medicines without prescriptions. Some patients don't feel the need to pay fees of 500 -1000 INR (10 USD) for a fever and cough. In such cases, I cannot deny them because if I will, the pharmacist across the road will give it. I cannot afford to lose my patient."

- Lack of knowledge about antibiotics and AMR: Pharmacists at both sites showed limited knowledge about AMR, some not even having heard the term before. Pharmacists in semi-urban areas were better informed about resistance and the role of ASTs in identifying what antibiotic is relevant. Pharmacists in rural areas showed no idea of what resistance is. A pharmacist at a private pharmacy at site I said, "Ideally, no antibiotic should be sold (without prescription), but this does not happen in practice. The patient can get antibiotics from another pharmacy if he is denied one. I can't afford to lose the patient."

3.2.2.3. The Practice of Maintaining Sale Records as a Formality

We found limited records of antibiotics dispensed, with most pharmacies keeping a register where they put details of a few bills. At site II, sale records were maintained as they were subject to hospital audits.

- Compliance for audit purposes: This was mostly done as a formality to show compliance to audit requirements, and sales were not reported to authorities. A pharmacist said, "I don't put all sales on the register, only a few daily entries to just maintain a record. It is impossible to write all sale data daily, so we maintain a formality for drug inspector visits for audits. It is not used anywhere else."

- Absence of strict regulations: There is poor implementation of regulations allowing pharmacists to treat record-keeping only as a formality, as expressed by a pharmacist: "All antibiotics can be sold, but it is not necessary to maintain a record of all sales in a day. It is challenging to do and is just a formality."

3.2.3. People from the Community

3.2.3.1. The Practice of Self-Medication and Diagnosis

Often many patients did not feel the need to go to a physician for consultation for minor ailments like cold, cough, and fever. They either self-diagnosed and got medication from a pharmacy without a prescription or were referred to an older prescription given to them by friends/family or by a physician.

- Lack of resources: Patients at both sites said they did not have the time and money to spend on consultation and expensive medicines when it was cheaper for them to get them from pharmacists. A person from a rural area at site II explained, "It is impossible to wait for hours in a queue in a hospital all day when I can feel better by getting medicine from a pharmacist in no time for fever or cough." A person living in an urban area at Site I with many hospitals around said, "I keep some antibiotics at home, to be used when needed. In that case, antibiotics are bought by name from the pharmacy. I generally keep antibiotics like Cefixime, Azithromycin, and Ampicillin."

- Consultation unnecessary for minor ailments: Patients at both sites found it unnecessary to visit the physician for common ailments like fever, cough, and allergies. They preferred buying an antibiotic over the counter or storing antibiotics at home that can be used later when needed, rather than going to a physician for a consultation. These practices were seen across sites I and II in both urban and rural areas. A person in an urban area with no chronic diseases at site I said, "I have bought antibiotics many times from a pharmacist without prescriptions. I do not need to go to a physician all the time for the same problem when I know the drug he will prescribe." Another patient waiting in line at site II said, "If I have a viral fever and I do not feel better after taking Paracetamol for three days, I take antibiotics prescribed by a

doctor 2 - 3 years ago."

- Anything for a quick recovery: Patients just want to feel better faster and do not care about what the physician is giving, trusting their judgment. A type II diabetic patient at Site I said, "I prefer to go by doctor's prescription and trust his judgment. He knows best."

Influence of friends and family: Patients are influenced by the family and friends they are surrounded by, who often share their medicines and prescriptions. A person living in an urban area at site I said, "My doctor gave me cefixime for cough two years ago, and whenever anyone gets cough at my home, they take cefixime and feel better in 3 - 4 days." A similar pattern was seen with patients at site II.

- Lack of awareness about AMR: Doctors do not often explain the reason for prescribing or not prescribing antibiotics, even though patients often ask why. A person in an urban area at site I said, "Doctors never tell what they are prescribing and why. I sometimes ask for the reasons, but ultimately I trust the physician's judgment." A person at site II said, "Doctors do not have time to explain. Hospitals and clinics are generally overcrowded, and doctors cannot spend much time with the patients." There are no governmental community programs to educate patients and build awareness of AMR.

3.2.4. Medical Representatives (MRs)

3.2.4.1. The Practice of Pharmaceutical Promotion

Doctors tend to receive from MRs financial and other incentives (such as foreign travel for conferences) for promoting certain prescriptions, which leads to over-prescription.

- Push by the supplier and manufacturer: Physicians tend to get comfortable with a particular manufacturer or MR, associate with them over time, and favor the brands they promote. An MR who recently started working for a different supplier said, "Old and experienced doctors don't generally change because an MR visits them as they already have set practices and relations with an existing supplier. The physicians I visit regularly have good connections with me. So, if I work with some other company, the physicians I have good relations with will also use the new brand I am promoting."

3.2.4.2. The Practice of Influencing Physician's Prescription Practices

- Financial incentives: Physicians get financial incentives through MRs to prescribe particular brands. Additionally, many physicians have their own pharmaceutical companies linked with third-party manufacturers. An MR at site II said, "Almost 50% of doctors have their pharmaceutical manufacturing units linked with a third-party manufacturer. The physicians then prescribe these medicines only."

3.3. Surveillance System at Site II

The microbiology lab of a tertiary hospital introduced an AST recording and reporting system in 2019. Other hospital departments had no existing digital infrastructure, so the focus was on the lab processes. A data entry module was first designed based on existing paper-based processes to record details from the AST indent form sent by physicians to the lab and then the test results. The indent form received at the lab with each sample included details of the patient and sample but missed details of the patient's clinical symptoms, diagnosis, and antibiotics treatment plan. A microbiologist said, "The indent form received with each sample from either the sample collection unit for outpatients or wards/in-patient departments is incomplete or illegible. There is no information on diagnosis and antibiotic treatment plans. We can only look at the data for the current sample and patient and prepare reports, but the information is incomplete in the absence of data about prescription or diagnosis or the name of the treating physician. Since this can't be added to the application, a clear picture cannot be received about the patient's treatment or prescription patterns of the physician or AMR in general."

Data on antibiotics prescription and their link to the patient's clinical condition are not explicitly available and amenable for digitization. This information resides partially in the heads of patients, doctors, and microbiologists. The challenge for the IS designer is how these can be usefully translated into digital form.

4. Case Analysis and Discussion

This section is divided into two parts: (1) analyzing determinants of inequity and their ethical implications; and (2) analyzing the potential role of the digital in addressing these challenges.

4.1. Determinants of Inequity and Ethical Implications

Stakeholder practices have implications for inequitable use as they shape patient behavior towards antibiotics, as summarized in Table 3.

Table 3. Social Inequities from a Patient's Perspective

Social Inequities	Ethical Implications for Patients
Poor access to basic healthcare services	Inability to enjoy the rights to appropriate, cost-effective care and diagnostics, which impinge on their rights to good health and well-being
Compromised quality of treatment driven by financial logic	Financial discrimination impinging on patient rights to enjoy good health and human dignity
Poor access to knowledge and inadequate awareness	Limited choices for patients on prescriptions and dispensing, adversely affecting their rights to exercise self-determination
Increased risk of resistance	Poor surveillance keeps patient problems invisible, making them and their families unfairly vulnerable to resistance

The Universal Declaration of Human Rights (30) grants all the right to life, liberty, and security, to the right to a standard of living adequate for their health and well-being. While the national charter of patient's rights in India emphasizes generating widespread public awareness and educating citizens about what they should expect from their governments concerning health (31), social inequities and unethical practices contribute to a significant gap between policy and practice (Ghooi and Deshpande, 2012), (32), particularly magnified in the case of AMR (1). Issues of ethics and inequity in AMR primarily find a place in policy discourses (26, 33) but not in research and practice (34). Further, equity studies have primarily focused on one stakeholder group, typically clinicians or pharmacists (35) at facility or community levels (36) to study either prescription (Nair et al., 2019), dispensing, or consumption of antibiotics (37). Our analysis highlights the need for a holistic ecosystem perspective focused at the micro-level.

4.1.1. Poor Access to Basic Healthcare Services

While access to quality healthcare is a fundamental human right, various factors impede its realization contributing to ethical challenges. Patients are unable to exercise the right to quality care, particularly the poor and disadvantaged who cannot afford to pay high consultation fees or lose their daily wages standing in queues waiting for consultations. They then rely on the pharmacists' experience and good intentions to get appropriate drugs. Patients suffer from their inability to enjoy the right to access basic care, particularly in rural areas and urban slums suffering from poor infrastructure. Traveling to access better care also comes with time and cost implications, so patients tend to self-medicate, particularly for ailments they consider "minor." This often leads to the consumption of unnecessary antibiotics. The inability of patients to exercise the right to access diagnostic facilities, typically available at distant tertiary hospitals or costly private clinics, prevents appropriate testing, which has implications for inappropriate treatment and use of antibiotics (38).

4.1.2. Compromised Quality of Treatment Driven By Financial Logic

Financial favors offered by MRs and pharmaceutical companies adversely shape inequities, leading to the patient's inability to enjoy the right to health and human dignity. Physicians and pharmacists are often driven by market logic, which translates to unethical costs to patients and drives them towards self-medication, often not appropriate. Over-the-counter availability of antibiotics promotes self-medication practices, compromising patient care processes and increasing the chances of future resistant infections for them and their families. There is significant financial discrimination in the prescription and dispensing of antibiotics, driven by financial compulsions of stakeholders, all coming at a cost to the patients. For example, they are being given expensive branded drugs instead of generic ones, which the government regulates but does not adequately enforce.

4.1.3. Poor Access to Knowledge and Inadequate Awareness

Poor access to knowledge and awareness all around creates an inability for patients to exercise the right to self-determination. Their choices get limited in following paths to better health and well-being they value. This makes patients more vulnerable to resistant infections and further magnifies their social disadvantages. Patients are subjected to less informed prescription and dispensing because even the physicians and pharmacists have limited sources to update their knowledge and often have to the MRs' sales pitch, which predisposes them to further health and social risks.

4.1.4. Increased Risk of Resistance

Patients in LMICs are typically predisposed to various infections and are made to believe in the magic cure of antibiotics. Poor surveillance leading to inadequate evidence-based policies and practices makes the conditions of the disease mainly invisible to policy and clinical practice in the form of antibiotics guidelines and hospital infection prevention and control practices. Without information on what kinds of infections are coming from, which a good surveillance system should provide, policymakers and hospital administrators need to operate in the dark, magnifying the invisibility of the problem. A lack of strict regulations to enforce fair and just practices leads to various forms of malpractices. In India, the OTC sale of antibiotics is prohibited by law under the Drugs and Cosmetic Act, 1940 and the associated Drugs and Cosmetics Rules, 1945 (schedule H and H1). Under schedule H1, all third-generation and newer antibiotics are listed which require mandatory prescriptions and for pharmacists to maintain records of individual sales. However, these requirements are often compromised by financial compulsions. Weaknesses of existing information systems like the Integrated Disease Surveillance Project (IDSP) (39) further confound the understanding of the nature and extent of the AMR problem.

4.2. Role of the Digital

We now discuss how digital surveillance systems can contribute to making AMR-related inequities more visible and improving advocacy, policy, and practice. Key points are summarized in Table 4.

Table 4. Role of the Digital

Digital Technologies	Enabling Processes
Rapid community-based diagnostics integrated with surveillance systems	Digiting testing and sharing data with AMR surveillance systems deployed at tertiary hospitals
Digitization of prescription audits and extending to the broader ecosystem	Digitization of antibiotics prescriptions and consumption data and incrementally extending to public and private pharmacists
Use of innovative digital tools to strengthen community health promotion	Co-creating health promotion content with regulators and communities while using innovative digital platforms such as IVR and Mobile Apps to maximize dissemination
Use of EMR systems to link data on testing and antibiotics with clinical conditions of patients	Creating a unified electronic patient record with clinical, lab, and drugs data at the facility level, which is aggregated and reported to the policy level to support policy

While India's National Action Plan (NAP) on AMR has emphasized strengthening the knowledge and evidence-based action through surveillance and research, they have not been materialized in practice. LMICs face the double burden of high rates of infections and weak surveillance systems (29), and strengthening digital interventions can undeniably mitigate AMR. Expanding from the table above, we argue that the digitization of rapid and low-cost community-based portable diagnostics, which is now available (40) and their integration with AMR surveillance system typically available in tertiary hospitals, can firstly provide improved access to testing for the underserved and secondly help make the AMR problem more visible, mainly to improve clinical practice. Digitization of data from prescription audits, a practice successfully initiated by the government in HP to assess on a sample basis the prescriptions ordered by physicians on defined criteria of over/unnecessary prescriptions, dosage, and frequency of drugs given (41), will help to clinic data on drugs with a clinical condition. Such audits, currently manual, have highlighted 52% of irrational prescriptions (42), providing invaluable information to improve the more responsible use of antibiotics. Extending such audits to both public and private pharmacies can potentially limit OTC sales of antibiotics, particularly in the private sector-dominated health care, as seen in the case of Haryana. Building co-created health promotion content involving drug regulators, community groups, and researchers and maximizing their dissemination through the use of innovative digital platforms like interactive voice response (IVR) and Mobile Apps can go a long way in mitigating some of the inequities caused by gaps in knowledge and their ethical implications in the community about AMR and issues associated with consuming antibiotics without appropriate prescriptions. We have seen successful applications of such innovations, such as IVR-based Mobile Vaani in India (43), to build awareness in the social sector. Establishing robust EMR-based patient records for providing unified data on clinical conditions, labs, and drugs can go a long way in strengthening evidence-based clinical care. Further, the aggregation of these patient records can be sent to the state and national levels to improve policy-based interventions (29). Such interventions can enhance the quality of data and link to design frameworks emphasizing inequities and fairness (44) to support appropriate action.

5. Conclusion

Information system research needs to step up on its societal obligations and play a defining role in materializing the potential of digital technologies to address the grand challenge of AMR. Taking the conceptual lens of equity and ethics and materialized through the approach of information practices, this paper contributes to how IS can play a role in addressing this grand challenge.

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Yogita Thakral is the only author of the article and the study was solely carried out by the author.

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