Antimicrobial resistance (AMR) has and continues to pose both development & public health threats across the world. While the scourge is well disseminated globally, persons living in low- & middle-income countries (LMICs) are most at risk. In Kenya, AMR represents a pivotal driver of morbidity & mortality as infections that are resistant to antibiotics have continued to rise lately. Empirical data on the state of AMR in Kenya and other LMICs is conspicuously low or completely lacking. This has significantly muffled intervention strategies as explicit understanding of AMR faculties remains a bottleneck. We conducted a scoping review to understand the nexus between practice of ethical principles of biomedicine & occurrence of AMR. PRISMA guidelines were strictly referenced at every step of this review. PubMed, EMBASE & Cochrane databases were searched using google for relevant articles. A total of 187 articles were initially generated. Several filters were applied in order to develop a shortlist of the most relevant articles. They include: conformity to the stated study objective & research design, publication in highly refereed journal type, consistency with medical subject headings (MeSH) and lack of potential conflict of interest (Col). Finally, a total of 5 articles were identified and the results they represent well synthesized. Balancing provisions of the practice of ethical principles of biomedicine by clinicians & other critical players remains an important challenge. A prescription & practice model that considers a balance of provisions of the four ethical principles of biomedicine should be developed and implemented. Empirical research should be continuously conducted to generate updated knowledge that informs progressive policy formulation and development of effective intervention strategies.

**Keywords:** Antibiotic agents, antimicrobial resistance, ethical principles.

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I. INTRODUCTION

The discovery of antibiotics is one of the delectable events in the practice of medicine. The pre-antibiotic era vastly featured: low life expectancy, high burden of disease, escalated mortality rates as well as general poor quality of life [1]. Infectious agents greatly facilitated global epidemics and pandemics that tremendously devastated humanity. The discovery of Salvarsan, Prontosil, and penicillin during early 19th century triggered a cascade of cutting-edge antibiotic development, which then significantly led to the reversal of the trend [2]. Morbidity and mortality due to infectious diseases took a downturn, life expectancy at birth increased from an average of 47 to 78 years, and the proportion of the older population increased [3]. In the history of medicine, it won’t be unreasonable to postulate that antimicrobial agents constitute the greatest discovery.

Today, one event that is antimicrobial resistance (AMR) seems well capacitated to draw back the gains so far made [4]. Microbial agents have become extraordinarily unresponsive to antibiotics. This development represents a major threat to humanity, geographical borders notwithstanding. A solution, optimally viable has to be urgently coined because the reverse may result in outcomes dreadful than those of COVID-19 (C-19). If not contained on time, AMR will claim 10 million lives and upturn treatment costs by $1 trillion every year by 2050 [5]. This loosely translates to: 4.2 million, 138,000 and 5,787 deaths every month, day and hour respectively. The highest number of deaths due to C-19 ever reported as of 30th January, 2022 has yet to come close to these figures. Unfortunately, the world already seems perfectly headed in this direction. A total of 2.8 million AMR cases with well over 35000 mortalities are reported in USA each year [6]. Over 200,000 newborn deaths attributable to AMR are occurring in Africa and other LMICs annually [7]. There seems to be no clear-cut data on the AMR pedigree in Africa. This paucity constitutes a major interventional setback as any targeted and precise AMR mitigation strategies require up to date and accurate data. USA is a big player in matters healthcare, prides itself on the best medical specialists, operates one of the best hospital systems and runs a robust drug use
regulatory framework [8]. That 2.8 million AMR cases are reported in such a country every year may only mean that the situation in Africa and other LMICs is exceptionally worse.

Prospective and almost obvious consequences are unimaginable. The burden of disease shall skyrocket; healthcare facilities and workers shall be strained; the global economy shall recess worse than the 2008 case; life expectancy at birth shall diminish and, thousands of people will be involuntarily shoved into extreme poverty [9]. While low- and middle-income countries (LMICs) shall bear the greatest weight of these enervating effects, industrialized ones may not be any better. After all, AMR is reasonably indiscriminative and lacks respect for jurisdictional, economic and topographical frontiers. Even more threatening is that the envisaged economic recession may be worse than the 2008 one [10]. It will be hard and almost impossible to reverse.

Human, not microbial activities bordering on ethics are responsible for this unfortunate situation. Microbes may not be guilty after all. They do not deliberately choreograph strategies to wreck human health. Instead, they leverage ethical and moral lapses around the use of antimicrobials to further their progeny. They have a right to live and multiply anyway. However, this should not be to the peril of human health. Knowledge as well as the practice of the four principles of biomedical ethics constitutes critical elements in the occurrence and dissemination of AMR in Kenya. Respect for patient’s autonomy, justice, beneficence, and none-maleficence [11]. Three parties are central to these ethical provisions: clinicians, pharmacists, and patients. It is expected that qualified clinicians and pharmacists have adequate knowledge on the ethics of medical care. Local and international regulatory bodies continuously provide information regarding safe prescription and dispensing practices [12]. Continuous medical education (CMEs) sessions constitute a major avenue for dissemination of knowledge of biomedical ethics to healthcare workers. Fact is they know. Clinicians know what, how and when to prescribe. Pharmacists and pharmaceutical technicians know that some drugs like antibiotics are not to be sold over the counter. Do they stick to the available guidelines when prescribing and dispensing antimicrobial agents? Evidence suggests otherwise [13]. Patient demands fueled by the principle of autonomy and to some extent justice guide their decisions. Unfortunately, respect for patient’s drug preferences amount to the compromise of the principle of “do no harm”. This is because at the tail end, it leads to occurrence of AMR which affects the greater society including the patients.

Sometimes clinicians and pharmacists are guided by reasons other than beneficence [14]. The need to make quick money and remain a float within competitive business space. Clinicians knowingly overprescribe to make more profits. On the other hand, pharmacists dispense antibiotics without prescriptions; they sell counterfeits and sometimes employ quacks. The net outcome is development and spread of AMR. There is evidence that up to 50% of the use of antibiotics among humans is gratuitous. Considering that the process of acquisition of the agents must involve a clinician and/or pharmacy practitioner somehow, the principle of non-maleficence is often defied. Whether it is due to pressure from patients accentuated by the need to respect the principle of autonomy or; whether it is due to the practitioner’s thirst for unjustified antimicrobial sales, the cumulative fact is deliberate disrespect to the ethical practice of biomedicine. Regulators in Kenya have published guidelines on the practice of all facets of medicine as well as pharmacy. They even have systems in place to ensure that the set regulations are well understood and implemented to the latter. Unfortunately, the “black market” still thrives. Unregistered clinics and pharmacies operated by unqualified persons often trading in counterfeit drugs is no vocabulary. Moreover, there is evidence of quacks hawking antimicrobial agents to vulnerable and naïve persons in Kenya’s major towns. This “may” mean that the regulator’s torch has become too dim to enable clarity or; that some enforcers are working in cahoots with merchants of the black market to advance the illicit trade.

Whichever is the case, the principles of justice and beneficence are defied. The absolute outcome is provision of impetus to the phenomena of AMR. Unfortunately, the impropriety is advanced by a few errand persons while; the negative outcomes affect everyone. Farming constitutes another critical avenue of AMR dissemination. The global population is bulging by day and with it, the need for farmers to produce enough food for every household. In such environment, the pressure to enhance agricultural production via “not so good” strategies increasingly becomes untenable. From acceleration of animal and crop growth to administration of prophylactic antibiotics, the farm represents a perfect yet innocent platform for dissemination of resistant microbial genes. In the face of this, practioners of veterinary medicine as well as laws governing their practice are well in place. Do they intentionally defy available and known ethical practices or they are simply caught up in a catch-22 situation? In an effort to control the spread of AMR, some countries like the United Kingdom and United States of America have enacted strict laws that regulate acceleration of farm produce. While these may reduce prevalence of AMR, the composite effect may be direr as food production is likely to reduce. Obviously, it won’t constitute a viable intervention for low- & middle-income countries (LMICs) as these countries are already food insecure. The approach must therefore be wholesome as absolute application of ethical principles of drug use on the farm may mean severe reduced food production.

Therefore, the war against AMR should not be directed at the innocent microbes; rather, at human behavior that fuel it. Profiling ethical and moral trends that compromise judicial use of antimicrobial agents is fundamental to drawing up effective interventions.

A. The Problem

The burden of AMR is gaining traction by day. While it is a global scourge, the greatest burden has a greater dwelling in Sub-Saharan Africa. Kenya especially, plays a pivotal role in both development and spread of AMR. If effective interventions are not invented and implemented on time, the scourge has adequate impetus to become the “greatest of all time” pandemic of our time. Resistant genes are quite
liberal, heavily omnipresent, and undiplomatic. The resistant version in Kenya can be as stubborn as the one in the Philippines. Complete paucity of respect for economic and jurisdictional stratifications. There is evidence and more is becoming available, that AMR shall claim up to 50 million lives every year by 2050. Trailblazing, shocking, and unprecedented. Enough reason to be concerned. Perforated ethical and moral faculties advanced by clinicians, pharmacists; regulatory institutions as well as drug development firms are almost entirely to blame. No single microbe is guilty. Ethical principles that guide safe practice of biomedicine (including antibiotic handling) have either been defied or, the involved parties are sometimes caught up in quandary. This review profiled the effect of application of ethical principles of biomedicine on the occurrence of AMR in Kenya.

B. Rationale

About 2.8 million and 35000 people are currently infected with and die due to resistant bugs in USA every year respectively [6]. America is a developed country with: a very advanced healthcare system, highly specialized medics, strong drug use regulations, relatively low burden of communicable diseases etcetera. Yet, AMR has its deep roots well established. On the flipside, Africa, where Kenya is located, is a hub of infectious diseases featuring flawed drug use regulations, a heavily perforated healthcare system, a handful of medical specialists as well as a poorly performing economy. Accurate and latest data on AMR prevalence is either sketchy or completely unavailable. How do you fight the scourge without a clear profile of its whereabouts? What is for sure is that the situation in Kenya is much worse than that in the US and other developed nations. The kinetics of specific causes must be established, how they work to pedal AMR be properly and accurately dissected and targeted interventions be coined to scale down the worrying trend. This scoping review sought to understand the dynamics of the ethical principles of biomedicine in the causation of AMR and how it can be leveraged to down regulate the rising trend in Kenya.

II. METHODOLOGY

A. Protocol and Registration

This review was conducted according to the study published by [15].

B. Selection Criteria

The criteria employed were as follows:

i. Published after 2011
ii. Main objective should be profiling the application of biomedicine ethics
iii. Published in English language and,
iv. The study should have been published in highly refereed as well as peer reviewed journal

C. Data Sources

PubMed, EMBASE and Cochrane databases were searched for articles that satisfy the outlined criteria. The databases were accessed between 1st of April to 25th December, 2021. Any information in the articles that was not clear was verified with corresponding authors.

D. Search Terms

Articles were searched under specific medical subject headings (MeSH) by use of Google Scholar. Specific terms used are as follows:

i. Antibiotic resistance or;
ii. Ethical principles of biomedicine or;
iii. i and ii

E. Data Collection Process

Synthesis of results was done as follows:

i. A total of 187 articles from 3 databases were sampled
ii. Using criteria outlined in “selection criteria” & “data items”, the articles were shortlisted to 5
iii. Each member of the review team was tasked to independently review each of the selected article
iv. Members of the review team jointly analyzed reviews in item iii above and,
v. A final set of results were recorded in Table II below.

III. DATA ITEMS

The main data items assessed include:

i. Title: needed to conform to MeSH
ii. Objectives
iii. Study design
iv. Results
v. Discussions
vi. Sources of funding and,
vii. Author affiliation

A. Risk of Bias in Individual Studies

The study methodology for the selected articles reviewed was keenly assessed to ensure that the design used does not in any way introduce a possibility of bias. Due to the low number of empirical studies currently available in this area, both research and review articles were included in the final analysis.

B. Risk of Bias Across all Studies

The GRADE system of imprecision/bias analysis according to [16] was used. Any study that exhibited the following features was rated downwards: inconsistency of results, indirectness of evidence, and possibility of publication bias and study limitations that could influence the quality and independency of results obtained. A summary of the article assessment criteria is presented in Table I.
IV. RESULTS

TABLE I: THE PRISMA REPRESENTATION OF THE ARTICLE SELECTION CRITERIA [17]

<table>
<thead>
<tr>
<th>Screening rationale</th>
<th>Three databases:</th>
<th>Applicable parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>NoR= 187</td>
<td>PubMed</td>
<td>Articles published in peer reviewed journals and</td>
</tr>
<tr>
<td>PubMed: 99</td>
<td>EMBASE</td>
<td>Articles published in highly referenced journals</td>
</tr>
<tr>
<td>EMBASE: 46</td>
<td>Cochrane</td>
<td>Article titles not conforming to the outlined MeSH were eliminated</td>
</tr>
<tr>
<td>Cochrane: 42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Journal type</td>
<td>NoR=99</td>
<td>Articles published in peer reviewed journals and</td>
</tr>
<tr>
<td>Article titles according to MeSH</td>
<td>NoR= 78</td>
<td>Articles published in highly referenced journals</td>
</tr>
<tr>
<td>Objective</td>
<td>NoR= 35</td>
<td>Article titles not conforming to the outlined MeSH were eliminated</td>
</tr>
<tr>
<td>Study design</td>
<td>NoR= 11</td>
<td>Inclusion criteria</td>
</tr>
<tr>
<td>Potential conflict of interest (CoI)</td>
<td>NoR= 5</td>
<td>All articles developed from empirical data</td>
</tr>
<tr>
<td>Final number of articles included</td>
<td>NoR=5</td>
<td>Reasons include:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Author affiliation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sources of funding</td>
</tr>
</tbody>
</table>

NoR: Number of records after application of the filtering criteria.

TABLE II: RESULTS AND FINDINGS

<table>
<thead>
<tr>
<th>Title &amp; References</th>
<th>Findings/Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AMR in hospitals</strong></td>
<td>Policies &amp; regulations aimed at extending the lifespan of antimicrobial drugs should be considered within an ethical framework.</td>
</tr>
<tr>
<td></td>
<td>Administration of antimicrobial agents prophylactically should be debated &amp; possibly reconsidered.</td>
</tr>
<tr>
<td></td>
<td>Restrictions on use of antimicrobial agents among farmers relatively scales down AMR prevalence while potentially compromising the quality of food produced &amp; growing negative economic consequences.</td>
</tr>
<tr>
<td></td>
<td>Though setting guidelines for antimicrobial stewardship in hospitals maybe beneficial, it is unethical to impose penalties on those not adhering to the guidelines due to differences in patient characteristics and infection types. This can be improved by strengthening diagnostic microbiology which is dependent on availability of resources as well as infrastructure. This presents a significant challenge especially among low- &amp; middle-income countries (LMICs).</td>
</tr>
<tr>
<td></td>
<td>The act of non-clinical managers taking the lead &amp; manipulating prescribing of antibiotics is unethical. Additionally, good &amp; ethical prescribing is not given high priority compared to other managerial undertakings.</td>
</tr>
<tr>
<td></td>
<td>A study conducted in the United States indicated that up to 50% of antibiotics used were either inappropriate or unnecessary. This has a connotation on the importance of targeted trainings regarding antimicrobial stewardship.</td>
</tr>
<tr>
<td></td>
<td>Prescribers require educational support to be more versed with balancing between the choice of anti-infectives and possible damage to the body of the recipient and the environment (non-maleficence &amp; beneficence).</td>
</tr>
<tr>
<td><strong>Control of Antimicrobial Resistance Requires an Ethical Approach [18]</strong></td>
<td>Community-based prescribers often engage in over prescribing, defensive prescribing or incorrect choice of anti-infectives. This is probably because they work in isolation and practice high regard to patient’s autonomy.</td>
</tr>
<tr>
<td></td>
<td>Patient autonomy unacceptably justifies purchase of antibiotics via online platforms, over the counter and from black markets without valid prescriptions and therefore worsens the spread of AMR.</td>
</tr>
<tr>
<td></td>
<td>Delayed or poor access to reliable diagnostic services precipitates prescription of broad-spectrum antibiotics which consequently increases the risk of development of AMR.</td>
</tr>
<tr>
<td></td>
<td>All these factors trigger an ethical dilemma between patient’s autonomy and stewardship requirements.</td>
</tr>
<tr>
<td></td>
<td><strong>General</strong></td>
</tr>
<tr>
<td></td>
<td>Control of AMR is incumbent upon both institutions and individuals. They include:</td>
</tr>
<tr>
<td></td>
<td>o Prescribers</td>
</tr>
<tr>
<td></td>
<td>o Educational institutions</td>
</tr>
<tr>
<td></td>
<td>o Pharmaceutical organizations</td>
</tr>
<tr>
<td></td>
<td>o Veterinary &amp; agricultural firms</td>
</tr>
<tr>
<td></td>
<td>o Drug discovery scientists</td>
</tr>
<tr>
<td></td>
<td>o End users of antimicrobial agents (lay persons)</td>
</tr>
<tr>
<td></td>
<td>o Government agencies &amp; the political class</td>
</tr>
<tr>
<td></td>
<td>Antimicrobial agents should satisfy immediate individual needs while respecting community common good. Current infections should be effectively treated and possible future resistance to the subject antimicrobial agent reduced</td>
</tr>
<tr>
<td></td>
<td>Between drug efficacy and risk of resistance, what takes presidency over the other? The principle of “do no harm” (non-maleficence) while maximizing immediate &amp; future benefits to patients and other related factors apply</td>
</tr>
<tr>
<td><strong>The Ethical Significance of Antimicrobial Resistance [19]</strong></td>
<td>AMR is a major threat in the 21st century.</td>
</tr>
<tr>
<td></td>
<td>AMR occurrence is aggravated by a range of factors. They include: socio-economic, behavioral, biological, environmental etc.</td>
</tr>
<tr>
<td></td>
<td>Key dilemma: control of excessive use of antibiotics in some regions while increasing access in other regions;</td>
</tr>
<tr>
<td></td>
<td>Justice: effective solutions to AMR require fair distribution of benefits &amp; burdens. However, the global burden of infectious diseases is unevenly distributed. As such:</td>
</tr>
<tr>
<td></td>
<td>o Developed countries expected to rapidly develop new drugs &amp; technologies, conduct research in areas that may not be directly aligned to their national priorities and beef up surveillance &amp; reporting systems</td>
</tr>
<tr>
<td></td>
<td>o Provision of high-quality drugs, enhanced expert care and diagnostic tools for LMICs</td>
</tr>
<tr>
<td></td>
<td>o Quality Assurance (QA) of drugs in LMICs</td>
</tr>
</tbody>
</table>
**Ethical Dilemmas in Antibiotic Treatment**

- Most antibiotic interventions are initiated empirically. Without appropriate knowledge of the organisms as well as their susceptibility profile. Inappropriate empirical treatment results in increased mortality;
- Present and future patient dilemma. The former whose infection is identified is treated sub-optimally in order to protect the latter whose infection is yet to be identified. Patients are often not consulted and therefore there right of autonomy compromised;
- Two models are proposed to balance present and future patient’s rights. Cost effectiveness analysis and the Georgetown Mantra of Bioethics;
- Cost effectiveness analysis accords much preference to the present as compared to the future patient. However, the concern on patient autonomy is not well addressed;
- While the principle of autonomy should ad vocally be respected and enforced, it presents a major conundrum especially if its applicability affects many other people;
- In the four principles of bioethics, non-maleficence and justice seeks to protect the rights of future patients. However, the implementation model that can balance the spirit of the four principles is lacking;
- Writing guidelines or developing a decision support system to help clinicians make balanced decisions regarding antibiotic prescription seems inevitable. However, it may be a bit difficult to address and implement the provisions of autonomy as a principle. Cost effectiveness analysis where benefits and losses are allotted rationally comes in handy;
- Rawl’s “veil of ignorance” construct is advocated. Future as well as unaffected present patients are not given consideration. Decisions based on doctor and present patients are given pre-eminence and;
- A model of ensure patient autonomy while maximizing their safety is currently lacking. However, it may only be possible to mitigate but not completely eradicate breach of the provisions of the principle.

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**Ethics, Antibiotics, and Public Policy**

- The use of antibiotics constitutes a key tenet in the effectiveness of the practice of medicine. However, the more they are used both in agriculture & humans, the less effective they become;
- Increased use of antibiotics especially among children, heightens chances of development of autoimmune diseases due to unwarranted and invisible destruction of microbiota;
- The human body hosts in excess of 39 trillion bacteria especially in the gut. While most of them are commensals, others are mutualistic and parasitic. Antibiotics are wired for destruction of parasitic bacteria;
- Antibiotic resistance is arguably, a moral event. The choices humans make regarding use of antibiotics have not just significant but also potentially catastrophic cumulative outcomes on other humans;
- If not addressed successfully, the economic cost of antibiotic resistance may grow to 100 trillion dollars (USD) by 2050;
- The current choices on the use of antibiotics both in humans and agriculture have sizeable consequences on the welfare of future generations;
- The benefits of using antibiotics are often internal (cure the infection) while the actual costs are social (occurrence of resistance). As such, patients and farmers overuse antibiotics while veterinarians and medical practitioners overprescribe them;
- Resistance to antibiotics is one of the major challenges humanity faces. Factually, occurrence of antibiotic resistance has outpaced development of new drug agents. As such, quick and effective interventions must be coined;
- Consumption of antibiotic agents should be limited and cautiously regulated;
- Alternative interventions to limit occurrence of infections that require the use of antibiotics should be beefed up;
- Relevant government agencies should work to ensure that antibiotics are accessible only by prescription. This is because their use has major impact on the welfare and well-being of other people;
- While some countries especially in the developing continents have punitive laws on the use of recreational drugs, they are unfortunately not as strict when it comes to purchase and misuse antibiotics. Humans have a right of autonomy but; definitely not to use their bodies as biological weapons. Knowingly or otherwise;
- In agriculture, antibiotics should only be used for treatment and not for growth promotion;
- Production of antibiotics used in agriculture should relatively be highly taxed. This will deter unnecessary and inefficient use. Proceeds accrued from the taxes can be used to compensate for the negative effects of misuse;
- Increasing antibiotic user fees may most likely prohibit quick decisions to purchase the agents. While this may sound effecti
- Financing information campaigns regarding rational and informed ways of use of antibiotics. This applies to patients, veterinarians, clinicians and all players involved in the antibiotic use continuum and;
- Supporting basic science research financed by antibiotic user fees. This may have an impact on production of most effective treatments and laboratory diagnostics.

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**Tackling antimicrobial resistance: ethical framework for rational antibiotic use**

- Advocating for rational use of antibiotics has potential to trigger conflict between patients’ therapeutic interests and prevention of antibiotic resistance;
- Occurrence of antibiotic resistance may pose negative effects on; patient management, public health, agricultural activities, economic stability and national security;
- Overprescribing and overconsumption are key drivers of antibiotics. Intervention mechanisms should not just target production but also the former and the latter;
- Rational use of antibiotics is key to reduction of AMR. It may involve delaying or not prescribing antibiotic intervention at all in order to scale down on use;
- However, rational use of antibiotics has enormous ethical connotations. Major benefit entails reduction in wasteful use of agents which may commensurately reduce development of resistance. While this intervention is crucial, it has potential to deny or delay patients’ therapeutic interventions which can save lives or reduce pain. Restricting/minimizing prescription represents a patient mortality risk of up to 1%. Principles of autonomy, non-malefice are reasonably compromised;
- A dilemma between comprising the wellness of the current patient while promoting viability of antibiotics for the welfare of a future patient is quite prominent and;
- When can clinicians prescribe antibiotics for the welfare of the current patient? When do they not prescribe for the welfare of the future patient? At present, guidelines regarding these questions are either lacking or not explicit.
V. DISCUSSION

It is undeniable that the war on AMR is far from being won. Genetic credentials for microbial agents constantly metamorphose facilitating their vulnerability to development of resistance. Human moral inclinations bordering on ethical principles of biomedicine have continued to play a fundamental role in this arena. From autonomy to justice, beneficence to non-maleficence; applicability of each of these principles in respect to equitable distribution of benefits and harms represents a substantial conundrum. According to [18], effective management of AMR should be done within the jurisdiction of ethical requirements. However, absolute implementation of provisions of each of the principles, may in some instances, present weighty and negative collateral connotations. For instance, enforcing a ban on use of antibiotics for growth promotion among agricultural players may negatively affect the food production continuum. Limiting prescription of adequate antibiotic agents to the current patient with a view to protect the welfare of a future unknown patient, borders on neglect of non-maleficence. Further, differences in patient socio-economic demographics require that implementation of guidelines for use of antibiotics is equitable. Obviously, this becomes a direct breach of the principle of justice. Balancing between benefits to the human body and protection of the environment presents another major challenge. Because they operate in isolation and have comparatively limited access to a range of antibiotic agents, community-based prescribers (CBP) are highly implicated in over and defensive prescribing. They also have substantial regard to patient demands and therefore autonomy. This exacerbates occurrence of resistance and negates non-maleficence as well as beneficence. As such, targeted educational programs should be considered in order to hone and help clinicians understand how to better handle dynamic situations.

According to [19], AMR is a consequence of socioeconomic, behavioral, environmental and biological challenges. The core bottleneck is achieving a balance between controlling excessive use of antibiotics in some regions while increasing access in other regions. This is especially bolstered by the uneven distribution of infectious diseases around the world. The need for concerted efforts to scale down the prevalence of infectious diseases in some regions, fairly limit access to antibiotics and upregulate respect to the principle of justice cannot be over-emphasized. Considering that AMR has no respect for geographical demarcations, developed economies may consider conducting extensive research and rapid development of drugs to make up for what LMICs are short at. On the other hand, LMICs are challenged to strengthen their expert base as well as upscale quality assurance for drugs. Further, management of waste during the process of drug development is a major concern. Negation of quality processes that apply to waste management betrays the principle of non-maleficence.

Report by [20] associated empirical prescription of antibiotics with increased mortality rate. A situation where clinicians prescribe antibiotics without due knowledge of subject microbe faculties including their susceptibility profiles should only suffice during emergencies. Key principles that are featured by Leonard et al. and somewhat compromised are autonomy and non-maleficence. The eminent dilemma is attaining optimal and effective treatment of current patients while protecting the welfare of the future ones. Two intervention models are proposed: the cost-effective analysis and Georgetown Mantra of Bioethics. The former roots for exhaustive treatment of current patients without regard to the welfare of unknown patients while; the latter advocates for implementation of the four ethical principles of biomedicine. Unfortunately, a model that ensures a safe balance of the principles is currently lacking. Interventions including development of custom guidelines and decision support systems would be effective except that they may still be deficient of a model to help achieve the required balance. To this end, the Rawl’s “veil of ignorance” construct where the clinicians’ decision on current and known patients is accorded preeminence. It may therefore not be possible to completely implement provisions of the Georgetown Mantra of Bioethics without entertaining a breach on some of the principles.

Study by [21] reckons that increased use of antibiotic agents poses a commensurate or even higher risk of resistance. That occurrence of resistance is technically a moral event which can otherwise, be avoided. Anomaly reminisces that if not addressed urgently, deliberately, and aggressively, AMR would cost the world up to 100 trillion dollars by 2050. Other than the unimaginable mortality estimates, such costs would be economically and socially catastrophic to say the least. Several intervention representations are advocated for. They include: scaling down prevalence of infections that require use of antibiotics, limiting access to antibiotics without a valid prescription, banning use of antibiotics for promotion of growth, increasing user fees on the use of agriculture related antibiotics and funding research to help downregulate empirical prescription. While these are potentially effective interventions, they represent reasonable repudiation of the provisions of autonomy and justice.

Moreover, [19] roots for rational use of antibiotics. This would entail, limiting unnecessary use in order to suppress chances of development of resistance. They implicate over prescription and irrational consumption of antibiotic agents as central drivers of resistance. Interestingly, Littman et al. documented a 1% mortality risk due to limiting of use of antibiotics. It is therefore debatable as to whether one would consider implementing a model that still puts lives of patients at risk. Worse still, while scaling down access to antibiotic agents would be a viable intervention, it heightens the risk of death among current patients while compromising non-maleficence, justice, and autonomy.

VI. CONCLUSION(S)

i. Balancing provisions of the four ethical principles of biomedicine remains a challenge for clinicians and other players;
  ii. Clinicians, Agriculturalists, Pharmacists, patients and other stakeholders are relatively lacking in knowledge regarding risks and available mechanisms to curb the occurrence and spread of

DOI: http://dx.doi.org/10.24018/ejmed.2022.4.2.1240
AMR and;

iii. There is paucity of data to inform effective policy formulation as well as effective decision making.

VII. EXPERT OPINION(S)

i. A prescription model that considers a balance of provisions of the four ethical principles of biomedicine should be developed and implemented;

ii. Simplified and targeted trainings and fact sheets should be developed and rapidly disseminated and;

iii. Collaboration opportunities and funding of both basic and ground breaking research should be considered and increased.

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CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

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