Caveat Payor: Antimicrobial Resistance

WHITE PAPER

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Executive Summary

Since the discovery of penicillin in 1928, antibiotics have saved countless lives and increased the global standard of living. However, the usage (appropriate or otherwise) of antimicrobials applies selective pressures on resistant strains of the pathogen, inevitably reducing the drug's effectiveness in curing infectious disease. Therefore, tackling antimicrobial resistance (AMR) requires a balance between the positive effects and the reciprocal negative impact of resistance, and recognition that AMR is not eradicable but must be managed. The consequences of AMR are wide ranging and can have catastrophic impacts on human health, medical costs, and economic activity. This White Paper targets actors that assume the financial risk associated with illness, or the payers of health services, which includes insurance companies, governments, and individuals.

Two broad trends have caused a sharp rise in AMR rates around the world:

1. **Overuse and Misuse of Antimicrobials**
   Due to the resultant selective pressure on resistant microbial strains, use of antimicrobials must be judicious. However, common practices in medicine and in agriculture have led to excess use of antimicrobials around the world. Studies show that antibiotics are routinely prescribed inappropriately and in response to common infections which are not cured by antibiotics. In addition, lack of regulation in the sale of pharmaceuticals and underdeveloped health care systems in developing countries have led to alarming levels of AMR in some of the most densely populated regions of the world. Lastly, uncontrolled use of antibiotics in animal husbandry and disease prevention in livestock contributes greatly to excess selective pressures, leading to resistant infections in humans.

2. **Decline in New Classes of Antimicrobials**
   Although signs of resistance to penicillin, the first class of antimicrobials, surfaced only 2 years after its introduction in medicine, patients were protected by the active pipeline of new classes of antimicrobials. Unfortunately, this R&D pipeline has dried up due to (1) the heavy costs and riskiness of developing a new antimicrobial, and (2) declining profitability of antimicrobials compared to drugs targeting chronic diseases. As such, doctors are stuck prescribing the same set of antimicrobials over time, fostering the growth of resistant pathogens.

From the perspective of a payer of health services, AMR should raise many concerns. Increasing rates of resistance in the absence of novel classes of antimicrobials means that people are collectively at greater risk of becoming ill and subsequently seeking care. **While the potential for an endemic superbug looms, the real risk of AMR is in rendering futile the use of antimicrobials during and after inpatient procedures to prevent nosocomial (hospital-acquired) infection**. This threatens many facets of modern medicine, including surgery, cancer therapy, organ transplantation, neonatal care, and more.

The RAND Corporation conducted a landmark study to model the future of AMR based on varying levels of resistance. The mortality of these alternative futures ranged from 11 million to 444 million. The global economic costs due to AMR ranged from US$5.8 trillion to US$125.5 trillion, double the annual global GDP.[1]

Based on this study, we have outlined four scenarios of antimicrobial resistance:

[1] Taylor, Jirka, and Marco Hafner. 2014. "Estimating the Economic Costs of Antimicrobial Resistance." RAND Corporation, Santa Monica, CA.

Low Risk	Baseline	Emergency Action	High Risk
Resistance Rate = 5%	Resistance Rate = 40%	Resistance Rate = n/a	Resistance Rate = 100%
Effective monitoring and prescription, resistance controlled geographically.	Status quo; already observed in several countries worldwide.	As in Ebola and SARS epidemics, governments and private sector intervene at critical mass	Inception of post-antibiotic era due to AMR apocalypse.

For payers of health services, the greatest risks arising out of antimicrobial resistance are:

- Increased risk of deadly nosocomial (hospital-acquired) infections.
- Increased length and severity of common infectious diseases.

These risks serve to increase chances of community-acquired resistant infections and increase subsequent costs associated with hospitalization. In other words, not only is there an uptick in baseline actuarial risk, this risk is more volatile as well. Overall exposure to AMR is positively correlated with resistance rates; it is in the payer's interest that resistance rates remain manageable. In the US, the cost of AMR on the health care system is estimated to be US$20 billion annually.[2]

The primary concern assessment of this risk is rooted in superficial public perception. The risk is substantial and global in nature, yet there is minimal mainstream attention paid to it. There are parallels in the current public opinion to vaccines that apply to AMR. Experts and the public weigh risks differently, which impact overall risk tolerance. Responding to different resistance levels on a limited budget and capacity cause the issue to be politicized. Rates of resistance occur in hotspots around the world, and the effective response depends on the power structures of world leaders. Furthermore, a debate on the validity of the science is occurring within the agricultural industry on the transmission of resistant bacteria from antimicrobial usage in livestock to humans. There is a gap in understanding how the scientific knowledge translates into policy. Currently, there is no systematic international surveillance of AMR or systematic data collection on antibiotic use in healthcare and agriculture. This means that there is inadequate risk governance infrastructure for the management of AMR in contemporary systems of global governance.

If antibiotics lose their effectiveness, routine critical medical procedures could become too risky to perform, with most of the AMR impact falling on low and middle-income countries. Tackling antimicrobial resistance is central to the long-term development of the global economy and requires a critical mass of global support. As payers of health services, insurance companies are highly exposed to AMR and play a pivotal role in the private sector response to addressing the issue. They have a vested interest in the outcomes of this emerging risk, control vast amounts of capital and clout, are well-integrated into health systems, yet remain largely untapped as a force for rectifying antimicrobial resistance. The antimicrobial industry is in dire need of innovation, and insurance companies just might be what the doctor ordered.

[2] Lee Ventola, C. (2015). "The antibiotic resistance crisis." Pharmacy and Therapeutics, 4(40), 277-283.

Risk Pre-Assessment

Antimicrobials are essential in the prevention and cure of bacterial, parasitic, viral, and fungal infections. Since the discovery of penicillin in 1928, antimicrobials have saved countless lives and increased the global standard of living. However, the inescapable reality of using antimicrobials to treat infectious diseases is that infectious agents naturally develop resistance to the drugs through various biological mechanisms. In recent decades, the phenomenon of antimicrobial resistance (AMR) has gained global importance due to the confluence of two trends:

1. Exasperation of resistance due to overuse and misuse of antimicrobials;
2. Declining commercialization of new antimicrobials and withdrawal of major pharmaceutical companies from the antimicrobial market.

The consequences of AMR are wide ranging and can have catastrophic impacts on human health, medical costs, and loss of economic activity. This issue involves many diverse stakeholders, including doctors, patients, hospitals, policymakers, government agencies, pharmaceutical companies, insurance companies, the agriculture industry, and civil society advocacy groups. Among all those affected by AMR, this White Paper will target the payers of health services, which includes insurance companies, governments, and individuals.

The Science Behind AMR

In general, the use of antimicrobial agents creates a selective pressure for the emergence of resistant strains that applies to both broad-spectrum and narrow-spectrum antimicrobials. Infectious microbes may either be intrinsically resistant to certain classes of antimicrobials or may acquire resistance by random genetic mutation or via the acquisition of resistance genes from other microorganisms.[3] In any case, resistance genes render antimicrobial drugs ineffective by increasing the microbe's defenses or modifying the structure or internal processes of the microbe.

These mechanisms spell out the importance of effective prescription and consumption of antimicrobials. A systematic review of antibiotic prescribing in primary care revealed that patients who presented with respiratory or urinary tract infections and prescribed first line antibiotics developed bacterial resistance to that drug within the first month. This effect not only increases the population carriage of organisms resistant to first-line antibiotics but also creates the conditions for increased use of second and third line antibiotics in the community. These are more expensive and may have greater side effects.[4] Eventually, certain strains of infectious microbes can become resistant to even the last resort medications. For example, gonorrhea resistant to third-generation cephalosporin antibiotics and colistin-resistant Enterobacteriaceae have been found in tens of countries across Europe, Asia, and North America, making infections caused by such bacteria untreatable.[5] With the status quo already posing such dangers, fears of an AMR epidemic have fueled studies on the modeling of its possible spread and impact across the globe, as outlined in the Risk Appraisal.

Why is this happening?

With such immense possible impacts, it is important to understand the many reasons for the development of AMR. These implicate many actors, from physicians and patients around the world to pharmaceutical manufacturers and agricultural companies. The factors leading up to accelerated AMR can generally be attributed to misaligned incentives or lack of knowledge.

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[3] Tenover, F. C. 2006. "Mechanisms of Antimicrobial Resistance in Bacteria." American Journal of Medicine, 119, 6, S3 -S10.
[4] Costelloe, C., Metcalfe, C., Lovering, A., Mant, D., and Hay, A. D. 2010. "Effect of antibiotic prescribing in primary care on antimicrobial resistance in individual patients: systematic review and meta-analysis." British Journal of Medicine, 340, c2096.
[5] World Health Organization. 2016. "Antimicrobial Resistance." World Health Organization Fact Sheet. September. http://www.who.int/mediacentre/factsheets/fs194/en/.

First and foremost, there is a problem of economic incentives. Since 1987, there has been no discovery of a new class of antibiotics that is available for treatment of systemic bacterial infections. With an average required investment of US$800 million over ten years, bringing an antimicrobial drug to market is a costly and risky endeavor.[6] Furthermore, antimicrobials are formulated into courses spanning a short timeframe, while drugs targeting non-communicable diseases, such as hypertension, are administered over long periods of time, offering better long term revenue potential. This presents distinct incentives towards consolidating efforts on developing drugs for chronic diseases, rather than antimicrobials which cure illness quickly. Thus, while resistance to penicillin was detected just two years after its discovery in 1928, a steady pipeline of new classes of antimicrobials meant there was always a new line of defense against drug-resistant bugs. With no new classes of antimicrobials in the last few decades, AMR is quickly taking hold.

The acceleration of AMR has not been without human error and negligence on the part of both patients and providers. For example, despite clear evidence that antibiotics should not be used to treat acute bronchitis (characterized by a wheezing and deep cough), about 70% of bronchitis patients received prescriptions for antibiotics between 1996 – 2010.[7] Worse yet in developing countries, reckless use, over the counter sale of drugs, self-medication, and lack of regulation have led to some of the highest rates of resistance in the world. In India, *Klebsiella pneumonia* has resistance rates of at least 60% to all available antibiotics, and *E. Coli* resistance is at 80%.[8] The combination of high population density, unsanitary conditions, and globalization of goods and people should ring alarms all over the globe amidst such high resistance rates.

Agricultural companies have also emerged as actors in this issue, using antimicrobials as a preventive measure to keep livestock healthy and productive. The use of small, routine doses of antimicrobials fosters resistance in food animals, whose meats can be a vector for human infection. While the use of antimicrobials in livestock is banned in Europe, about 80% of all antimicrobials sold in the US are for livestock.[9] This has led to multiple outbreaks of Salmonella in humans and leads to US$365 million per year in medical costs in the US.[10] Resistant strains of the bacteria are even more costly and virulent, sometimes leading to life-threatening infections. Critically, there can be no discussion on mitigating the risk of AMR without addressing its use in agriculture.

Thus far, efforts aimed at decreasing risk of antimicrobial resistance have focused on addressing over-prescription and promoting proper administration of antimicrobials, which tends to homogenize the approach to AMR and does not address all sources of drug-resistant infection. Strategies to prevent the development and spread of antimicrobial resistance depend on the pathogens. For bacterial respiratory tract pathogens (e.g., Streptococcus pneumoniae), controlling outpatient antimicrobial use is crucial; for some enteric pathogens (e.g., Salmonella), limiting antimicrobial use in food animals is essential. For pathogens that cause nosocomial infections (e.g., Staphylococcus aureus), improving inpatient antimicrobial utilization and infection control practices is critical. Currently, the disparate strategies to tackling AMR do not consider this holistic perspective.

Unfortunately, the temporally distant nature of AMR means that few consider it a local threat. In recent years, the

[6] Theuretzbacher, U. 2015. "Recent FDA Antibiotic Approvals: Good News and Bad News." Center for Disease Dynamics, Economics, & Policy. http://cddep.org/blog/posts/recent_fda_antibiotic_approvals_good_news_and_bad_news#sthash.uGkuGRSo.dpbs
[7] Damle, S. G. 2015. "The good, the bad and the ugly!! – Antibiotics." Contemporary Clinical Dentistry, 6, S139-S140.
[8] Ibid.
[9] United States Food and Drug Administration. 2012. "Drug Use Review." https://www.fda.gov/downloads/drugs/drugsafety/informationbydrugclass/ucm319435.pdf
[10] Centers for Disease Control and Prevention. 2013. "Antibiotic Resistance Threats in the United States." U.S. Department of Health and Human Services. https://www.cdc.gov/drugresistance/pdf/ar-threats-2013-508.pdf

emergence and response to acute epidemics such as the Ebola crisis and Zika virus have dominated global public health discussions. Furthermore, hyperbolic discounting at the patient level means that individuals ignore the long-term risks of taking antibiotics (even if taken appropriately) if it means short term gains in health today. This is especially true given that the state of illness can be interpreted as being in the domain of losses. Prospect theory predicts individuals are more risk-seeking in this circumstance.

What does this mean?

From the perspective of a payer of health services, AMR should raise many concerns. Increasing rates of resistance in the absence of novel classes of antimicrobials means that people are collectively at greater risk of becoming ill and subsequently seeking care. While the potential for an endemic superbug looms, the real risk of AMR is in rendering futile the use of antimicrobials during and after inpatient procedures to prevent infection from occurring. Without effective antimicrobials, diverse fields of medicine will be severely threatened, including surgery, the care of premature infants, cancer chemotherapy, care of the critically ill, and transplantation medicine, all of which are feasible only in the context of effective antibiotic therapy.[11]

Furthermore, strategies to mitigate this risk through higher insurance premiums are impractical due to the difficulty of assessing the actuarial risk of antimicrobial resistant infections, as well as associated reputational costs. Similarly, governments insuring their populations through nationalized health care (as in Canada) will find little recourse but to take on the extra burden of risk and associated costs at the expense of other budgetary priorities. Furthermore, if more people are sicker for longer, losses to economic productivity will accrue. The Review on Antimicrobial Resistance, chaired by Lord Jim O’Neill, predicts that the cumulative cost to the global economy could reach $100 trillion by 2050.[12]

Risk Appraisal

Scenario planning on the sophisticated risk of antimicrobial resistance can be mathematically modeled through available data. The net economic impact of AMR is equated to treatment cost divided by prevention cost. It is a balance of the cost of full AMR eradication as it grows exponentially as AMR reaches zero.

$$Net\ Economic\ Impact\ AMR\ = \frac{cost\ of\ treatment\ due\ to\ resistant\ microbia}{cost\ of\ preventing\ resistant\ infections}$$

The impact of AMR will have far-reaching costs across society, and its modeling has emerged as a valuable tool for scientists and policymakers. The insurance industry closely follows the health of the financial sector and is directly impacted by the macroeconomic movements. Economic growth spurs insurance activities, and a slowdown in the economy creates critical problems for the insurance industry, including collecting premiums and adjusting plans. Whether it is due to less demand, fewer investments, or less claims, a reduction in economic development can have far-reaching implications on the health of the insurance industry. In the 2015 study led by Lord Jim O’Neill, research suggests 700,000 people die each year from infection by drug-resistant pathogens and parasites. If it continues to be business as usual, the figure will rise to 10 million by 2050, knocking off 2% - 3.5% of global GDP.[13]

[11] Infectious Disease Society of America (IDSA). 2011. “Combating antimicrobial resistance: Policy recommendations to save lives.” Clinical Infectious Diseases, 52 (suppl 5), S397-S428.
[12] Review on Antimicrobial Resistance. 2014. “Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations.” https://amr-review.org/sites/default/files/AMR%20Review%20Paper%20-%20Tackling%20a%20crisis%20for%20the%20health%20and%20wealth%20of%20nations_1.pdf
[13] O'Neill, Jim. 2016. "Tackling Drug-Resistant Infections Globally." Wellcome Trust.

As part of the 2015 Lord O'Neill study, the RAND Corporation was commissioned to model and analyze the economic costs of antimicrobial resistance through different scenarios until 2050. The scenario planning was developed through a general equilibrium model, "which calculated the extent of losses to the world economy caused by decreases in the supply of labor resulting from resistant hospital acquired infections and selected major infectious diseases (HIV, TB, malaria)."[14] The seven scenarios, outlined below incorporated varying levels of future resistance, availability of second-line therapy, and time of onset of increases in resistance.

The results offer an emerging picture of the future of AMR. The cumulative costs of the worst-case scenario based on current mortality rates are $49.9 trillion USD, roughly the equivalent of three-quarters of the annual global GDP. The worst absolute AMR rate (100%) projects a cumulative cost of $125 trillion USD, almost double the annual global GDP. The business-as-usual scenario estimates a cumulative global cost of 5.8 trillion USD[15].

Through this mathematical modeling of the economic costs of antimicrobial resistance, we have produced three possible scenarios and common risks associated with AMR:

The **low-risk scenario** is a resistance rate of 5%. Resistant bugs are constrained and controlled geographically, limiting the spread of infection through effective monitoring and prescription. The discovery of new antibiotic classes, along with innovative new approaches to fighting diseases manage AMR at a low, natural rate of 5 percent.

The **status quo scenario** is the medium-level scenario, with a resistance rate of 40%. The medium rate of 40% has already been observed, in a small number of cases in a limited number of countries. The discovery of new antibiotic classes is infrequent but slows down the overall rate of resistance. This allows for the somewhat effective management of AMR. Health care costs will rise in pockets where resistance is prevalent.

The **Emergency Action scenario** is a response where monitoring of antimicrobial resistance reaches a critical mass and garners sufficient attention to elicit global action. Much like past epidemics, such as the Ebola and SARS crises, governments and the private sector worldwide will intervene by issuing a public health emergency and allocating extensive funds to combat the epidemic resistant bugs. This may see a short-term spike in health care costs, moderating out in the long term.

The **high-risk scenario** is an AMR apocalypse with an antimicrobial resistance rate of 100%. We continue the current trend of no discovery of new antibiotic classes. Continued mismanagement by patients and physicians allows for the natural progression of resistance to completely reduce the effectiveness of antibiotics. This scenario is conceptually clear in that it corresponds to a health care system without effective first-line antimicrobial drugs. Essentially, this is a return to the pre-antibiotic era. As overall costs to the healthcare system increase due to the usage of second and third line antimicrobials, it will affect insurance premiums and subsequently the availability of health insurance.

Intolerable Risks of Antimicrobial Resistance

On the surface, payers of health services seem to be rather removed from the system of moving parts involved in this issue. Though they are not directly participating in the transaction of health services, they assume the financial burden associated with the risk of people becoming ill. As such, given the trends described in the Pre-assessment, some high-profile threats emerge that payers of health care services are exposed to. From the perspective of an insurer of health

[14] ibid.
[15] ibid.

services, those second-order effects of antimicrobial resistance which necessarily increase the baseline actuarial risk in the entire risk pool will most significantly impact payers of health services and are therefore intolerable. Naturally, scenarios which entail higher rates of antimicrobial resistance pose more acute and severe risks to the bottom line.

Perhaps the most intolerable risk arising out of AMR is the risk of **increased deadly nosocomial (hospital-acquired) infections**. As mentioned, many branches of modern medicine are dependent on the effectiveness of antimicrobials. Hospital settings are, counterintuitively, a breeding ground for resistant microbes due to the clustering of vulnerable patients and frequent use of antibiotics. In the context of heightened resistance, a surgery patient has greater chance of infection during recovery, which will require additional courses of stronger, more expensive antimicrobials, longer hospitalization, more resources spent, and overall higher expenditures per patient. The root cause of this AMR risk is the decline of new classes of antibiotics, as the set of drugs available to treat one patient after another does not change, applying selective pressure on resistant strains of bacteria. From a population-level perspective, the vulnerability of health insurers to this risk is rather low, as nosocomial infections are limited to hospital settings. However, given that the people at risk of this kind of infection are those that are already generating the greatest costs within the system (surgery patients, chemotherapy patients, transplant patients, etc.), the potential impact of this risk is high. In one year, two common types of resistant infections, sepsis and pneumonia, were responsible for 50,000 deaths in the US and costed payers of the American health care system (which includes insurance companies and the US government) a total of $8 billion.[16]

In the same vein, a related, yet separate intolerable risk is that of **increased length and severity of common infectious diseases**. Its root causes are unregulated use of antibiotics in modern animal husbandry in North America, as well as the unregulated, often uninformed misuse of antimicrobials in the developing world. These causes serve to make common bacteria more resistant to antibiotics. Thus, this risk operates at the population level, granting it a high level of vulnerability. Indeed, outbreaks of community-acquired methicillin-resistant staphylococcus aureus infections have increased rapidly among the general population.[17] These infections require second- and third-line antibiotics which are more toxic to patients and costly to the system. As such, the potential impact of this risk is rated medium.

Estimates regarding the medical cost per patient with an antibiotic-resistant infection range from US$18,588 to US$29,069. With this in mind, the additional costs due to AMR depend on the probability of acquiring an antimicrobial resistant infection. In the US, this burden is estimated to be as high as US$20 billion.[18] In reality, the total cost is directly correlated with rates of resistance, and with a baseline scenario of 40% resistance, overall exposure to these two risks pose significant additional costs in the future to foot the bill, and as such, they are intolerable. Resistance rates in excess of the baseline point towards increased costs up until the inception of a post-antibiotic era, after which a new, lower equilibrium human population will ensue.

There are other risks that arise due to antimicrobial resistance, such as loss of wages and diminished economic productivity. However, from an insurance company's perspective, these are tolerable because they do not directly feed into higher healthcare costs and therefore increased insurance claims. This changes if the insurer happens to be a government or an individual paying out-of-pocket, as loss of wages or economic productivity means less fiscal space to allocate for health care. In any case, these risks do not directly impact the risk of a person becoming ill or requiring greater health services and are tertiary effects distal to AMR.

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[16] Lee Ventola, C. (2015). "The antibiotic resistance crisis." Pharmacy and Therapeutics, 4(40), 277-283.
[17] Centres for Disease Control and Prevention. (2013) Antibiotic Resistance Threats in the United States, 2013. https://www.cdc.gov/drugresistance/threat-report-2013/
[18] Lee Ventola, C. (2015). "The antibiotic resistance crisis." Pharmacy and Therapeutics, 4(40), 277-283.

Concern Assessment

Solutions to the antimicrobial resistance cannot be solved with science alone. Global surveillance and cooperation must be realized, which is inherently political. Many studies have called for public awareness as the backbone to all antimicrobial resistance campaigns, but questions arise about funding and power dynamics. In 2014, former President Obama doubled the budget for AMR to US$1.2 billion over five years[19]. Furthermore, deciding which pathogen to target resistance reduction efforts on is inherently deciding on the cure of one disease over another. If the developed countries lead the charge against AMR, the beneficiaries will be entirely different than if the focus were on diseases most often found in developing countries. For example, in India and Pakistan, up to 95% of adults carry bacteria resistant to β-lactam antibiotics, which are considered last-resort antibiotics. In contrast, only 10 percent of adults in Queens, New York carry such resistant bacteria[20]. With limited funds and competing interests, political factors could certainly influence the handling of antimicrobial resistance.

Traditionally, responses to public health risks are reactive in nature. When the Ebola and the SARS crises hit critical mass, the systems of global governance stepped in and devoted immense resources to the fight against the global epidemic. In the case of Ebola, the disease has seen 24 outbreaks since 1976, but wasn't at the forefront of public perception until the 2013 outbreak. The overall public opinion on AMR is still severely superficial, both by the general masses and medical professionals. In a study of AMR knowledge in doctors and nurses in Ethiopia, 65 percent of physicians and 98 percent of nurses indicated that they need training on antimicrobial stewardship[21]. This is worrisome but also emblematic of the broader public. The public concern to AMR occurs within a domain of loss. People are more likely to take risks to get better, even if they know the risks of AMR in the future. Antibiotics are a reactive measure to infections, so future concerns are heavily discounted.

Public perception on vaccines could offer evidence towards public opinion on antimicrobial resistance. Experts' perceptions of vaccines regard quantitative analytical frameworks, including rate of herd immunity, the risks of death from preventable diseases, and the risks of adverse events following immunization. In contrast, parents and vaccinees are more concerned with the possibility of themselves or their child being the "one-in-the-million" who could develop fatal adverse effects to certain vaccines. AMR public perception follows a similar thought process. Experts view antimicrobial resistance regarding mortality rates, complications and impact on the health system. Antibiotic consumers are more concerned about whether they can get healthier, rather than what taking an antibiotic could do for future resistance.

Historically, antibiotics in agriculture have allowed for veterinary treatment to improve the health of animals. As industrial agriculture systems of chemically intensive food developed in response to the skyrocketing world population featuring large single-crop farms and animal production facilities, farmers began using antibiotics to reach economies of scale and meet the unprecedented demand for animal protein. Different groups have politicized this agriculture narrative for and against the industrial agriculture system. Reliable, concrete data on human resistance due to similar antibiotic use in agriculture has yet to be fully defined and still requires further study. This has led to the cherry-picking of studies and science to back up both claims. Regulatory schemes also differ; current antimicrobial use policy for animals and agriculture in the US differs from policy enacted in the European Union, which has banned

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[19] The White House. 2015. "FACT SHEET: Obama Administration Releases National Action Plan to Combat Antibiotic-Resistant Bacteria." Briefing Room. March 27. https://obamawhitehouse.archives.gov/the-press-office/2015/03/27/fact-sheet-obama-administration-releases-national-action-plan-combat-ant.

[20] Reardon, Sara. 2014. "Antibiotic resistance sweeping developing world." Nature. May 06. http://www.nature.com/news/antibiotic-resistance-sweeping-developing-world-1.15171.

[21] Abera, Bayeh, Mulugeta Kibret, and Mulu Wondemagegn. 2014. "Knowledge and beliefs on antimicrobial resistance among physicians and nurses in hospitals in Amhara Region, Ethiopia." BMC Pharmacology and Toxicology.

the use of certain antimicrobials for growth promotion. Both sides make arguments for political gain, but a better understanding of the consequences in agricultural AMR is needed to assess the potential effects on animal and human health.

Conclusion

The coalescence of various social and economic phenomena has bolstered the risk of antimicrobial resistance around the world. Modeling the complex nature of the risk allows for the most efficient hedging against a global threat that UK's Chief Medical Officer, Dame Sally Davies, describes as big a risk as terrorism.[22] The risk has reached a level of severity where even the status quo is problematic. If antibiotics lose their effectiveness, routine critical medical procedures could become too risky to perform, with most of the AMR impact falling on low and middle-income countries. Tackling antimicrobial resistance is central to the long-term development of the global economy and requires a critical mass of global support.

Insurance companies are highly exposed to AMR and play a pivotal role in private sector involvement in the issue. They are a unique player in this arena, as they have control of vast resources and have a distinct vested interest in the outcomes of this emerging risk. Indeed, insurance is the kind of industry that can go under very quickly in a context where baseline risk and potential losses accumulate. If convinced of this, insurance companies can be driven to mobilize their capital and clout in order to work with the different parts of the problem, including pharmaceutical companies, physicians, and governments. They are well integrated into the health care network, yet remain largely untapped as a force for rectifying antimicrobial resistance.

[22] Walsh, Fergus. 2013. "Antibiotics resistance 'as big a risk as terrorism' - medical chief." BBC News. March 11. http://www.bbc.com/news/health-21737844.