NEGLECTED ZOONOTIC DISEASES: IMPACTS AND SOLUTIONS

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ABSTRACT

Zoonotic diseases, which can only be passed between mammals and humans naturally, present a significant public health threat in developing nations. The WHO has acknowledged eight neglected zoonotic diseases (NZDs), such as anthrax, rabies, leishmaniasis, brucellosis, bovine tuberculosis, cysticercosis, sleeping sickness and hydatid disease, that impact poor populations to a greater extent. These types of illnesses are often linked to animals that carry diseases, insects that transmit them, and contamination of food and water, causing significant economic and social repercussions. In Africa, Asia, and Latin America, Neglected Zoonotic Diseases (NZDs) continue to be a significant reason for illness and death, impacting around 1 billion individuals and necessitating preventive and/or therapeutic actions for 1.6 billion people. The high economic costs of NZDs include negative impacts on animal production, human health, and economic benefits. Furthermore, lack of knowledge, inadequate diagnostic resources, and limited healthcare accessibility all play a role in exacerbating this problem. A multi-sectoral approach involving animal health, public health messaging, and community programs is needed to reduce NZDs. At the same time, a dual benefit strategy can be utilized by eradicating NZDs through animal reservoirs, which will not only help human health but also animal health, and enhance livelihoods by increasing animal productivity. This summary highlights the importance of increased awareness, funding, and collaboration in addressing NZDs and improving the health and well-being of marginalized populations.

Keywords: Neglected zoonotic diseases, Poverty, Economic impact, Anthrax, Rabies, Sleeping sickness, Tuberculosis, Brucellosis, Leishmaniasis, *T. solium*

I. INTRODUCTION

The World Health Organization (WHO) has defined Zoonotic diseases (ZD), as those diseases and infections, which are naturally transmissible between vertebrate animals and man. This transmission can occur either directly or indirectly via vectors, food, water, or soil. Over the past decade, approximately 75% of new human cases have involved pathogens originating from animals or animal-derived products. Various factors that significantly impact the prevalence of zoonoses include ecological changes in human environments that promote the growth and development of certain infectious vectors, the handling of animal by-products and wastes (which pose occupational risks), increased human mobility (such as urbanization and deforestation leading to wildlife contact), a rise in trade of animal products, higher densities of animal populations, and socio-cultural practices like hunting, tourism, and pilgrimage.

Neglected tropical diseases (NTDs) are a broad category of illnesses that are linked to severe physical, social, and economic repercussions and are brought on by a range of pathogens, including bacteria, viruses, parasites, fungi, and toxins. NTDs are primarily found in tropical disadvantaged populations, while some are found in considerably wider geographic areas. According to estimates, about 1 billion people

are impacted by NTDs, and 1.6 billion people need NTD therapies, both preventive and therapeutic. Environmental factors are frequently linked to the complicated epidemiology of NTDs. Numerous of them are linked to intricate life cycles, have animal reservoirs, and are vector-borne. Because of all these variables, their public health regulation is difficult. The neglected tropical diseases are found in developing and backward areas of the world. The neglected zoonotic diseases (NZDs) are a subset of these neglected tropical diseases. The WHO has recognized a subset of eight endemic or "neglected zoonotic diseases" : Human African trypanosomiasis, rabies, leishmaniasis, brucellosis, anthrax, bovine tuberculosis, *T. solium* cysticercosis, and cystic echinococcosis (hydatidosis). Poverty, dependence on livestock or wildlife for social and economic capital, a lack of resilience, and the close proximity of people and their animals all contribute to the prevalence of these diseases

III. ZOONOSES AND POVERTY

The burden of sickness is disproportionately borne by the poor in all societies, but it is especially high in emerging nations. Beyond the common explanations of vulnerability, price, and accessibility, there are several other factors that contribute to the disproportionate burden of zoonoses on the impoverished. Reasons for this high burden includes:

- Zoonoses are more likely to infect those in poverty. Living near animals, which are known to be disease reservoirs, is strongly linked to poverty. Risk factors are particularly evident for some diseases, such as brucellosis, anthrax, and bovine tuberculosis, which are mostly occupational diseases that affect livestock keepers and, in the case of anthrax, people who prepare animal products, such tanners. Once more, the poor are at a disproportionate risk for diseases that impact cattle product users. The lowest consumers purchase or consume meat from dying animals killed in backyards or close to farms, unpasteurized milk sold in unsanitary conditions, and pork that cannot be marketed due to cysts.
- The poor are least likely to receive appropriate treatment once infected. Once more, this is especially true for zoonotic diseases for several reasons. The majority deal with the difficulty of getting a proper diagnosis, which is a result of both the dearth of diagnostic resources and affordable, reliable tests as well as the fact that zoonoses are typically contracted by isolated rural populations for whom frequent visits to health centers for diagnosis or treatment eventually become unaffordable. In Uganda, for instance, people who were successfully diagnosed with zoonotic trypanosomiasis had, on average, visited a medical facility three times before.
- The impact of disease is greatest in poor households, since it affects both people and animals. Some zoonotic diseases, such as sleeping sickness, tend to be diagnosed in active adults, as well as diseases like anthrax, tuberculosis, and brucellosis, which are linked to livestock-keeping occupations. The death or illness of a breadwinner has a devastating impact on rural households. Other zoonoses are most likely to affect children, who are the most likely to be bitten by a rabid dog.

IV. THE EIGHT MAJORS NEGLECTED ZOONOSES: ECONOMIC AND HEALTH IMPACT

ANTHRAX

Though all warm-blooded animals are somewhat vulnerable, anthrax primarily affects herbivores. *Bacillus anthracis*, a spore-forming bacterium, is the cause. Soil that has been contaminated by spores recently or even decades ago are the disease's "reservoir." Anthrax is typically contracted by humans through occupational exposure to tainted animal products or direct or indirect contact

with infected animals. The illness almost always kills animals quickly. There are three types of the disease in humans.

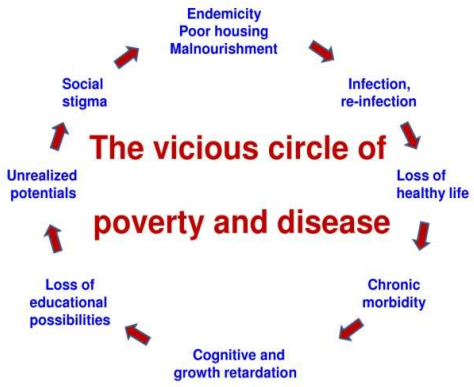

Fig. 1: The vicious cycle of poverty and diseases (Bergquist and Whittaker, 2012)

The cutaneous form of anthrax, which makes up over 95% of cases reported in developing nations, is contracted through skin lesions; gastro-intestinal anthrax is contracted by consuming infected meat from an animal that died of the disease; and inhalation anthrax is an occupational disease that is only known to occur in industrialized nations and is contracted by breathing in spores. The mortality of infected and post-vaccination animals, the decrease in animal products, the total destruction of carcasses and byproducts, and the closure of slaughterhouses are all causes of economic losses. Different animal species have different anthrax death rates. Pigs typically recover from this illness, but horses and ruminants typically die from a clinical infection. According to an estimate every anthrax-infected cow in Africa can give rise up to 10 human cases. In humans, the respiratory form has a case fatality rate of 90-100%, about 10% in cutaneous form and 25-40% in gastrointestinal form. The financial consequence of a bioterrorist attack of anthrax is $26.2 billion per 100,000 individuals.

BOVINE TUBERCULOSIS

Most cases of tuberculosis in humans are primarily attributed to *Mycobacterium tuberculosis*. Nonetheless, tuberculosis can be attributed to various other types of bacteria, with *Mycobacterium bovis*, responsible for 'bovine tuberculosis,' being one of the most common and having the broadest range of hosts among all TB bacteria. Tuberculosis caused by *M. bovis* can frequently affect areas other than the lungs (extra-pulmonary) and often presents with symptoms similar to M. tuberculosis infection. Nevertheless, individuals infected with *M. bovis* frequently do not react positively to the usual TB medications, which can lead to a lethal result. More costly medications are frequently required, which adds to the strain on health services. In cattle, the illness leads to decreased productivity, but rarely results in death. Similar to brucellosis, bovine TB has mostly been eliminated from herds in the developed world through a program of testing and slaughtering. The combined direct and indirect annual economic loss from BTB was calculated to be NGN 703,980,070 (EUR 1,725,441.4)

BRUCELLOSIS

Brucellosis is a highly prevalent zoonotic disease around the globe. Resulting from different types of bacteria from the Brucella genus that target cattle, sheep, goats, pigs, and other animals, it causes abortion, long-term reduced fertility, and consistently lower milk production in affected animals. It can be transmitted to individuals through direct contact with livestock or by consuming unpasteurized milk from an infected animal. The primary indication in individuals is repeated episodes of elevated body temperature, leading to its alternative moniker 'undulant fever' - often mistaken for drug-resistant malaria in tropical regions. It results in significant financial losses for livestock producers in areas or groups of animals where it is widespread. In the majority of developed nations, test-and-slaughter efforts, combined with farmer compensation and incentives for disease-free herds, have largely eradicated brucellosis in animals, resulting in few human infections. The financial consequences of a

bioterrorist strike is $477.7 million for every 100,000 individuals affected in the brucellosis situation.

CYSTICERCOSIS

Cysticercosis is increasingly becoming a significant issue in numerous developing countries across Africa, Asia, and Latin America, affecting public health and agriculture. *Taenia solium* tapeworms are obtained by humans when they consume raw or undercooked pork meat that is infected with cysticerci, the tapeworm's larval stage that grows in the human intestine and matures into adult tapeworms that can reach a length exceeding three meters. These mature worms release eggs in human feces which have the potential to infect either the same or different humans as well as pigs through either direct contact with tapeworm carriers or through the indirect contamination of water or food. The illness is closely linked to keeping pigs in unclean environments. Consuming eggs leads to larval worms that travel to various areas of the human and pig's body and develop into cysts (cysticercosis). Pigs are able to carry numerous cysts, leading to the meat from these animals being deemed inedible and often leading to the complete rejection of the pig's body. The central nervous system is a main place where migration occurs in humans. Neurocysticercosis in humans is the result of cysts forming in the brain. It is known as the primary parasitic infection of the human nervous system and the leading preventable cause of epilepsy in developing countries. WHO believes that cysticercosis impacts approximately 50 million individuals globally and results in around 50,000 fatalities in areas where it is prevalent. Approximately 2.5 million individuals carry T. solium, with 50,000 deaths reported each year from neurocysticercosis. An estimated 400,000 cases of symptomatic cysticercosis in Latin America's endemic zone were found among a population of 75 million people.

CYSTIC ECHINOCOCCOSIS (CE/HYDATIDOSIS)

CE or hydatid disease is a result of the larval stage of the tapeworm Echinococcus granulosus. It is a typical process involves existing as a cyst within sheep and as a tapeworm within dogs. Dogs consume meat from sheep that are infected, and then excrete eggs in their feces that are eaten by sheep. Humans can get infected by consuming food or water that has been contaminated with fecal matter containing tapeworm eggs from infected carnivores, or by coming into contact with infected dogs. Cysts, commonly found in the abdominal region, gradually increase in size and may grow to a substantial extent. Surgery is typically the treatment for the cure. Hydatid disease can be found worldwide in regions where sheep and dogs are raised in close proximity to each other. It is commonly found in numerous developing nations, particularly in impoverished areas. In humans, the prevalence of surgical cases varies from 0.1 to 45 cases per 100,000 and the actual prevalence ranges from 0.22% to 24% in endemic regions. Control involves deworming dogs and ensuring they don't consume undercooked sheep meat, especially organs, along with monitoring abattoirs and providing health education. It results in significant human pain and major decreases in agricultural and human efficiency. The transmission is made easier due to the population at risk lacking awareness of how transmission occurs and how to prevent it, the high number of stray dogs, inadequate meat inspection at slaughterhouses, improper disposal of animal waste, and home slaughtering methods. The economic outcomes are frequently unclear, leading to subsequent disregard in decision-making. The losses due to the economic impact of organ condemnation, livestock losses—mostly in nations with functional meat hygiene systems—amounted to US$2.19 billion, while human-associated annual economic losses (including medical expenses, wage losses, and postoperative deaths) were estimated to be US$1.9 billion worldwide.

RABIES

Rabies is likely the most recognized zoonotic disease. A virus, usually transmitted through a bite or skin injury, is responsible for the infection as it travels to the brain. Its severe symptoms in both animals and humans, along with the fatal result for those who do not receive treatment following a painful illness, have caused it to be the most dreaded zoonosis. In terms of public health, the best way to prevent it is still through dog vaccination, even though there is some risk to dogs and people from infected wild animals. Individuals who have been bitten by an animal believed to be infected should begin by cleansing the wound and then promptly seek post-bite treatment. Different kinds of after-exposure care are present; however, they are frequently not accessible in remote rural regions or too costly for governments or individuals to pay for. On average, between 30% and 50% of human rabies cases, and therefore rabies-related deaths, happen in children under the age of 15, based on incidence rates divided by age. Significant livestock losses, particularly among cattle, have been documented in several regions. In the developing world, over 99% of human rabies deaths are caused by domestic dogs. Dog transmission of rabies causes more than 1.8 million DALYs (disability adjusted life years) to be lost annually, resulting in economic costs of 5.5 billion per year due to expenses related to prevention and treatment. These viral illnesses lead to approximately 24,000 to 60,000 fatalities globally every year. Over 95% of rabies-related human deaths happen in Africa and Asia. For example, Ethiopia has thousands of rabies infections, resulting in around 2,700 annual deaths, one of the highest rates globally.

HUMAN AFRICAN TRYPANOSOMIASIS (HAT)

HAT, also known as sleeping sickness, is only present in Africa where the tsetse fly transmits the disease. There are two types of African trypanosomiasis. The chronic gambiense form is present in Central and West Africa and while an animal can become infected, the disease is perpetuated through transmission between the insect vector and humans. Nevertheless, the animal reservoir plays a significant role in the acute rhodesiense form discovered in Eastern and Southern Africa. *Trypanosoma brucei rhodesiense*, the causative agent, infects humans, wild animals, and domestic livestock, spreading infection between epidemics. It coexists with a group of pathogenic trypanosomes (*T. congolense, T. vivax, and T. brucei*) in animals, causing a significant issue for livestock owners in Africa. If not treated, the illness will result in death for humans every time, with extremely harmful outbreaks happening in the past century. Treating the disease can be costly, typically costing between US$150 and US$800 per person, with a 5% mortality rate during treatment in advanced stages. In Uganda 92% of death due to sleeping sickness is under reported.

LEISHMANIASIS

This parasitic disease, transmitted by vectors and caused by protozoa, ranks as the third most significant vector-borne disease worldwide. Around 350 million individuals in 88 countries are vulnerable, with 12 million cases and roughly 50,000 deaths annually. Transmission primarily occurs through animals like dogs and small rodents, but the illness can also be transmitted among humans. Cutaneous leishmaniasis, the most prevalent type, does not result in death, yet it can lead to significant skin ulceration, which can result in severe facial deformity and social stigma. Visceral leishmaniasis is a long-lasting, widespread illness that impacts the internal organs and can result in death if not treated. According to WHO data, leishmaniasis are estimated to cause 2.4 million DALYs, yet existing methods of measuring disease impact do not consider differences in how the disease presents clinically, leading to a need for intense medical interventions in specific areas. There is a lack of reliable information regarding the frequency, length, and effects of the different syndromes linked to leishmaniasis.

V. PREVENTION & CONTROL STRATERGIES

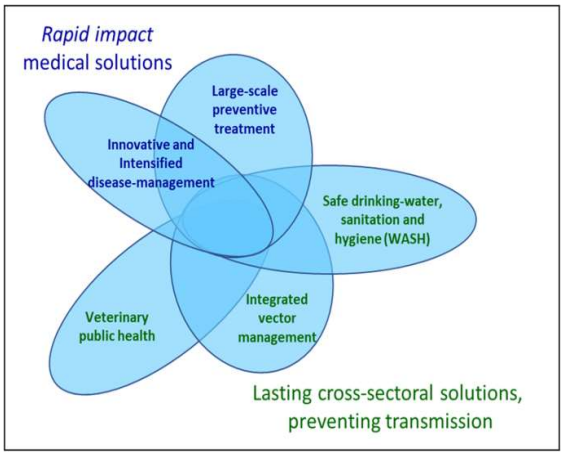

Fig. 2: The five public health interventions recommended by WHO to overcome the impact of NTDs (Engels and Zhou, 2020)

- The Rose Bengal test could be used in conjunction with bovine TB skin testing to combine screening for brucellosis and bovine TB. The Rose Bengal test is an agglutination test that is inexpensive, easy to use, and highly sensitive. After 48 hours, when the brucellosis test results are also available, the intradermal bovine TB skin test is read, and farmers and communities can be notified of both.
- Although a variety of wildlife can serve as HAT reservoirs, domestic cattle are the main source of infection in Uganda. Although it has long been known, the animal reservoir plays a crucial role in preventing Rhodesian sleeping sickness. The SRA gene is a molecular marker used to identify human infectious parasites in livestock. An injection of a cheap (US$0.5) trypanocidal medication is necessary to eradicate all trypanosomes from cattle. Long-lasting synthetic pyrethroid formulations can be used to treat animals and prevent re-infection with human and animal infectious trypanosomes. Poor farmers in Africa can now control trypanosomiasis because insecticides are only applied to the legs and belly of the bovine host, which is where the majority of tsetse flies feed. Additionally, only 20% of a cattle population needs to be treated with insecticides in order to control both animal trypanosomes and HAT.
- *Targeting dogs can help combat the three* NZDs*:* rabies, leishmaniasis, and hydatid disease. *Rabies vaccination has a high cost/benefit ratio and* is a tried and tested intervention. *Campaigns for community* rabies vaccination could be *enhanced by combining them with* leishmaniasis *or hydatidosis treatments*. *Just raising awareness of the disease's cause and prevention measures could lower* the *incidence* of *canine rabies in underdeveloped areas where it is still very endemic.*
- Dog collars impregnated with deltamethrin have shown promise in controlling the spread of *Leishmania* from dogs to humans through the sand fly. Although the impact of collaring depends on collar coverage and collar loss rate, modeling has shown that community-wide use of treated dog collars may be more effective than a dog-culling strategy, particularly in areas with high transmission rates.
- Deworming dogs, controlling the number of stray dogs, and preventing dogs from consuming the viscera of infected livestock can all help stop the spread of *E. granulosus* (CE). Several low-cost methods could be employed to control CE, such as prohibiting dogs from consuming publicly discarded cysts in government slaughterhouses and during backyard slaughter.
- Pigs and humans are caught in a vicious cycle of *Taenia solium* cysticercosis/taeniasis in areas where open defecation is common. Providing clean water and sanitation along with veterinary sanitary measures, like inspecting meat and treating infected animals, is the most sustainable way to prevent the spread of *T. solium* from humans to pigs. In China and

Latin America, mass treatment programs have used repeated mass drug administration (MDA) of antihelminthic medications, such as praziquantel, niclosamide, and albendazole, to human *T. solium* carriers.

- Vaccination of animals against anthrax, especially development of oral/nasal/ocular vaccines for nomadic pastoralist in backward areas with proper disposal of dead carcass suspected for anthrax has a pivotal role in anthrax prevention.

VI. CONCLUSIONS

Neglected zoonotic diseases (NZDs) have become almost nonexistent in wealthier nations, but they continue to be significant contributors to illness and death in Africa, Asia, and Latin America. This oversight is partly due to underreporting, leading to an under appraisal of their global impact, which diminishes their significance to policymakers and funding organizations. Raising awareness about the origins of NZDs and their prevention could mitigate the occurrence of various endemic zoonoses. By addressing NZDs through the animal reservoir, a dual benefit can be achieved, as better animal health lowers the risk of human infection and enhances livelihoods through increased animal productivity. The expenses associated with NZD intervention may appear significant when viewed solely in terms of public health advantages, but these expenses are readily justified when a comprehensive cross-sector evaluation is conducted, taking into consideration both monetary and non-monetary gains—especially concerning the livestock industry. Recent public-private partnerships have supported the control of human diseases, and they could similarly be successful in tackling endemic zoonoses by utilizing social impact investments.

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