

# *Voices from Medicine*

## OUR COMMON ENEMY: COMBATTING THE WORLD'S DEADLIEST VIRUSES TO ENSURE EQUITY HEALTH CARE IN DEVELOPING NATIONS

*by John J. Carvalho IV*

*Abstract.* In a previous issue of *Zygon* (Carvalho 2007), I explored the role of scientists—especially those engaging the science-religion dialogue—within the arena of global equity health, world poverty, and human rights. I contended that experimental biologists, who might have reduced agency because of their professional workload or lack of individual resources, can still unite into collective forces with other scientists as well as human rights organizations, medical doctors, and political and civic leaders to foster progressive change in our world. In this article, I present some recent findings from research on three emerging viruses—HIV, dengue, and rotavirus—to explore the factors that lead to the geographical expansion of these viruses and the increase in frequency of the infectious diseases they cause. I show how these viruses are generating problems for geopolitical stability, human rights, and equity health care for developing nations that are already experiencing a growing poverty crisis. I suggest some avenues of future research for the scientific community for the movement toward resolution of these problems and indicate where the science-religion field can be of additional aid.

*Keywords:* dengue virus; equity health care; geopolitical stability; global warming; HIV/AIDS; human rights; infectious diseases; rotavirus; science-religion; world health; world poverty

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## THE IMPACT OF THE SPREAD OF KEY VIRUSES ON GEOPOLITICAL STABILITY, HUMAN RIGHTS, AND EQUITY HEALTH CARE

The beginning of the twenty-first century has witnessed economic instability in war-torn areas such as the Middle East, the advent of more advanced terrorist activity, and global warming. Within this new era, the emergence of viruses and the infectious diseases they cause is becoming a worldwide threat of the utmost importance. Indeed, unlike the migration of peoples, which can be curbed by national and continental boundaries, viruses have no boundaries that constrict their spread. They are free to expand their geographical habitats irrespective of governmental restrictions, economic factors, or other forces that normally affect the movements of populations. As a result, many developing countries are experiencing larger outbreaks of viral diseases, including diseases such as polio thought to be eradicable by vaccine programs. And not only the developing nations are suffering from emerging viruses. Even in developed countries such as the United States, certain viruses have expanded their geographical range and become more frequent in first-world hospitals.

Of the emerging viruses, five have particular importance for what scientists and world leaders can learn concerning their impact on geopolitical stability, human rights, and equity health care for the underprivileged in both developed and developing nations. They are (1) human immunodeficiency virus (HIV), the causative agent of Acquired Immune Deficiency Syndrome (AIDS), (2) dengue virus, the causative agent of dengue fever and dengue shock syndrome, (3) rotavirus, the causative agent of viral-induced gastroenteritis, (4) influenza virus, and, surprisingly, (5) the coronavirus that causes Severe Acute Respiratory Syndrome (SARS). This last one is included not because of the number of illnesses it has caused but rather because of the economic impact and societal panic it has been responsible for recently (Gostin, Bayer, and Fairchild 2003; Zhong and Zeng 2006)—manifestations that can tell us much about what could transpire if more deadly viruses or deadlier versions of the SARS coronavirus surfaced. For the sake of this synopsis, I focus on HIV, dengue, and rotavirus.

*HIV/AIDS.* By far, the greatest emerging threat internationally is HIV because developing nations, especially those in Africa, are experiencing the enormous influence of this virus. Since its discovery in 1981, HIV has confounded scientists with its enigmatic biology and, consequently, has caused a worldwide pandemic. Globally, estimates of HIV infections range from 40 to 65 million, with 22.5 million infections in sub-Saharan Africa alone (White and Fenner 1994; Flint et al. 2000; Fauci 2007; Kuritzkes and Walker 2007). To make matters worse, the distress caused by HIV/AIDS is somewhat of an underestimate, because persons presently infected will eventually die if a cure is not discovered—creating further

instability at the geopolitical, economic, and social levels and reversing progress in many societies for decades while simultaneously contributing to the geographical expansion of the virus (see below). Some estimates suggest that the workforce in fifteen countries will be 24 million fewer by 2020 and that some nations, including South Africa, will experience a 17 percent lower GDP by the beginning of the next decade because of the impact of HIV (Piot et al. 2001).

Many scholarly journals consider the effect of geopolitical stability on public health, but rarely do they consider the effects of public health on geopolitical stability. Consequently, the contribution of HIV/AIDS to such stability is underappreciated. Increase in HIV/AIDS cases is linked to the breakdown of country boundaries, a rise in the number of ill refugees migrating across borders and to different areas within their host countries, an increase in military personnel or world peacekeepers becoming infected with the virus, and the deterioration of national infrastructures. UNAIDS estimates that HIV rates among armed forces in some developing nations is higher than that of the general population and that HIV is responsible for causing a 50 percent mortality in some militaries, to say nothing of the financial burden these militaries must face to combat the virus (Feldbaum, Lee, and Patel 2006). Furthermore, the impact of the virus on some civilian populations such as in sub-Saharan Africa raises the alarming possibility of a “state meltdown” (Feldbaum, Lee, and Patel 2006). That HIV is causing problems in certain strategically important nations such as Russia, China, and India is of much concern given that estimates suggest these regions could witness 193–259 million HIV cases by 2025 (Eberstadt 2002). The effect of HIV on the geopolitical order of these strategic nations, as well as developing nations that require robust militaries or the presence of peacekeeping forces in order to maintain national stability, has great importance for world peace (Feldbaum, Lee, and Patel 2006). Furthermore, in many of these hardest hit nations HIV/AIDS is disproportionately affecting younger people, so that the coming decades may reveal a population inversion, with individuals in their 60s and 70s outnumbering those in their 40s and 50s (Piot et al. 2001).

The expansion of HIV/AIDS is not just an economic and geopolitical crisis; it is also a human-rights problem. In a previous article in *Zygon* I mentioned that the United Nations’ *Universal Declaration on Human Rights* affirms that all persons should have the right to adequate medical care and social services in order for the war on global poverty to be successful (Carvalho 2007, 292). Unfortunately, as the HIV/AIDS pandemic spreads, it is largely the “poorest of the poor” who suffer from inadequate health care and lack of equity social services (reviewed extensively in Farmer 2005). Indeed, HIV/AIDS exacerbates and prolongs poverty in every respect. It has a devastating impact on the stability of households in developing nations. In Africa, 13.2 million children have been orphaned because of AIDS,

and this phenomenon is causing serious strain on national health infrastructures and human relief agencies (Piot et al. 2001). Similarly, education—a primary means of breaking the poverty cycle—in many nations is being detrimentally affected because sick teachers are dying, children are dropping out of schools because of personal illness or the illness of parents or guardians, and families cannot pay for school supplies because of the economic burden of HIV/AIDS on household incomes (Piot et al. 2001). HIV/AIDS also contributes to problems in the agricultural industries of these nations as manpower dwindles because people become sick with the virus and livestock need to be sold off to handle family funeral expenses (Piot et al. 2001). The impact on food supply further exacerbates the poverty—and therefore human rights—crisis already exhibited in these regions. Furthermore, the progression from infection to full-blown AIDS appears to occur faster in patients living in lower-income countries because of malnutrition and the lack of equity health care (Pinching 1988; Piot et al. 2001; Farmer 2005; Sanchez and Swaminathan 2005; Wanke 2005; Cohen 2006).

In summary, the HIV/AIDS pandemic has emerged into an economic, geopolitical, and human-rights crisis that feeds off poverty and the lack of equity health care in developing nations while further intensifying poverty and the lack of equity health care. These factors lead to the inability to control HIV and thus promote the geographical expansion of the virus. Arguably, HIV/AIDS is a model case by which to measure how viruses can expand their presence in the world by collaborating with and strengthening the factors that allow them to perpetuate in the human population.

*Dengue.* Although HIV/AIDS is considered the most pressing worldwide concern for scientists, dengue virus is also alarming. Dengue is a member of the *Flaviviridae* family of viruses, which includes yellow fever, Japanese encephalitis, and West Nile viruses, among others (reviewed in Gubler, Kuno, and Markoff 2007; Lindenbach, Thiel, and Rice 2007). It is the causative agent of two major diseases, dengue hemorrhagic fever and dengue shock syndrome (Deen et al. 2006). Early epidemics of dengue were documented in Jakarta, Cairo, and Philadelphia in the late 1700s (Mairuhu et al. 2004). Since that time, epidemics have occurred on all continents every ten to thirty years, but the disease was relatively benign, showing just fever and severe bone and back pain in patients (Mairuhu et al. 2004). After 1945 the disease became more fatal, displaying signs of hemorrhage in subjects from the Philippines in 1953 and shock in those from Southeast Asia (Mairuhu et al. 2004). During the 1980s dengue spread into India, Pakistan, China, Sri Lanka, and the Maldives. It has since become a significant health problem in South and Central America and the Caribbean, where a recent outbreak was documented in Puerto Rico (Mairuhu et al. 2004; Torres and Castro 2007; Morens and Fauci 2008;

*USA Today* 2007; *MSNBC* 2007). The disease is presently confined to tropical and subtropical regions and is transmitted to humans by the bite of infected female mosquitoes of the genus *Aedes* (*Aedes aegypti*, *Aedes albopictus*, and *Aedes polynesiensis*) (Gubler, Kuno, and Markoff 2007). According to the World Health Organization, nearly half the world's population is now living in dengue endemic areas, and it is estimated that annually there are 50–100 million dengue fever cases, 500,000 of them the dengue hemorrhagic fever variety (Deen et al. 2006; Gubler, Kuno, and Markoff 2007, 1172). Given the possibility for severe disease in infected individuals and the ease by which dengue is transmitted by mosquitoes, the spread of dengue virus could be considered one of the most dangerous emerging threats facing the world.

A number of factors of human origin contribute to the geographical expansion of dengue virus and increased incidence of severe disease. These factors exacerbate one other to amplify both the spread of the virus and the negative impact of each factor on suffering human populations. For example, the failure to control the spread of *Aedes* mosquito populations is critical because these mosquitoes are the vectors that carry the virus. Mosquito programs have met with repeated failure in certain countries and have been linked to a resurgence of the virus in the Americas in the 1970s (Gubler 1989). Much of this failure came from insecticide resistance and reduction in program support in poorer nations (Mairuhu et al. 2004). In addition, as resolutions to control global warming were neglected by governments over the past few decades, climate changes have resulted in large areas of standing water following major monsoons that have acted as ideal breeding grounds for mosquitoes (Torres and Castro 2007). Concurrently, haphazard deforestation has compounded the emergence of vector-borne diseases like dengue (Torres and Castro 2007).

The above factors are coupled with unprecedented population growth and uncontrolled urbanization, both of which have greatly expanded the geographical range of the mosquitoes and the viruses they harbor—in essence providing hyperendemic areas where multiple serotypes of dengue virus can circulate in human and *Aedes* populations simultaneously. For example, in Latin America, population growth and uncontrolled migration from the countryside to the cities have resulted in poor housing conditions, inappropriate disposal of waste, and lack of adequate food, clean water and health care—all of which are concurrent with an increase in infected mosquitoes carrying different versions of dengue virus (Torres and Castro 2007). The biology of the virus itself compounds the problem, with new, more pathogenic dengue serotypes emerging that cause the more severe hemorrhagic and shock forms of the disease, such as in Cuba in 1981 when 344,000 infections were reported (Mairuhu et al. 2004; Guzman 2005). The multiple circulating serotypes can contribute to more severe forms of disease upon secondary infections (Mairuhu et al. 2004). One

immunological theory postulates that some dengue-specific antibodies from prior infections can cross-react with viruses from secondary infections without neutralizing the virus but acting as a mediator for increased uptake of the virus into target immune cells (such as monocytes and macrophages) where the virus can replicate and then be secreted from these cells (Clyde, Kyle, and Harris 2006).

As indicated, these factors feed off each other. By far, social inequalities that stem from poverty are the biggest concern. Educational scarcity on dengue virus and the diseases it causes, poor sanitation, lack of quality public health surveillance, and delayed clinical diagnosis are dominantly seen in more underprivileged areas (Morse 1995; Ligon 2004; Torres and Castro 2007; Khun and Manderson 2007; 2008). Spread of the virus in these areas further aggravates the lack of equity health care—a human rights issue—to the most disadvantaged. Much of this is a result of the economic impact of dengue on poor nations. Estimates of total costs from epidemics in Puerto Rico, Cuba, and Nicaragua are as high as \$15.6 million, \$103 million, and \$2.7 million, respectively (Torres and Castro 2007). Endemic dengue contributes even more to the economic burden (Torres and Castro 2007). Because most families in endemic areas such as Latin America and the Caribbean earn US \$10,000/year, the economic load of dengue is harshest for the poorest families in society, where even a brief hospital stay takes a significant toll on household income. In turn, the missing workdays by sick patients results in reduced revenue for the already cash-strapped governments these citizens belong to. Essentially, lack of financial resources contributes to the deterioration of the established public health infrastructure, a breakdown that in turn jeopardizes the maintaining of mosquito-control, entomological-surveillance, and prevention programs and reduces the likelihood of rapid diagnoses in hospitals and clinics because of poorly trained staff or lack of medical resources including available doctors.

As with the HIV pandemic, it is the poorest of the poor who suffer from the inadequate health care in dengue endemic regions, such as Latin America and Cambodia (Torres and Castro 2007; Khun and Manderson 2007; 2008). And when poor families do not have access to health care, there is the further possibility of infected individuals not seeking treatment, which in turn leads to underreporting of disease cases, which further hampers governmental effort on resource allocation to combat the disease (Torres and Castro 2007; Khun and Manderson 2007; 2008). The lack of equity health care in endemic areas becomes a human rights issue rather than just a medical one—an issue that has great importance for the medical community's attempts to stop the geographical expansion of dengue virus.

*Rotavirus.* Rotavirus, a member of the *Reoviridae* family of viruses, is the major causative agent of viral-induced gastroenteritis (reviewed in Estes and Kapikian 2007). There are approximately 2.1 million rotavirus

infections and 660,000 rotavirus-induced deaths per year, affecting mostly children in developing nations, with 80 percent of deaths occurring in South Asia and sub-Saharan Africa (Bresee et al. 2005; Parashar et al. 2006; Estes and Kapikian 2007). Rotavirus is spread by fecal-oral contamination and via airborne viruses or contaminated respiratory droplets (Estes and Kapikian 2007). New rotavirus strains can emerge from nucleic acid “reassortment,” whereby simultaneous or asynchronous infection of organisms with human and animal rotaviruses leads to new, more pathogenic viruses being produced with mixed genetic material from both humans and animals (Cook et al. 2004).

The geographical expansion of rotavirus, like HIV and dengue, is caused by a variety of factors: the ability of the virus to infect many different types of organisms, contaminated water supplies, poor hygiene and inadequate sanitation, lack of education, lack of prevention/treatment strategies and the supplies needed to carry out prevention/treatment, and the cycle of poverty in rotavirus endemic regions (Levine et al. 1986; Cook et al. 2004; Estes and Kapikian 2007). As with HIV and dengue, poverty and rotavirus infections feed off each other. Viral infections add to the economic burden on suffering nations. Sick children and adults may be absent from school or work, impeding GDP (Gray et al. 2008). Rotavirus outbreaks may deter travelers willing to visit exotic countries, which leads to loss of the tourism dollars that may be the foundation of the economies for such countries (Diemert 2006).

Medical costs for treatment of infected individuals can be enormous. Studies of eight Latin American and Caribbean countries (Argentina, Brazil, Chile, Dominican Republic, Honduras, Mexico, Panama, and Venezuela) reveal that for every 1,000 children born in 2003, US \$7,971 was expended in direct medical costs during their first five years of life (Rheingans et al. 2007). Indirect costs likely increase these numbers, further indicating that rotavirus gastroenteritis results in substantial economic burden for poorer families in these nations. In Poland, each nosocomial infection can cost as much as US \$2,500 for treatment, with yearly impact amounting to US \$4.5 million (Chandran et al. 2006). Overall, the cost of treatment in the United States is around \$1 billion, due partly to increased hospital visits from rotavirus infections (Estes and Kapikian 2007). The economic burden of rotavirus exacerbates difficulties in providing equity health care, with poorer populations suffering the most during epidemics.

The data in the literature on the effects of rotavirus on geopolitical instability are underappreciated. Nevertheless, if the HIV pandemic teaches us anything, it is that it is highly likely that the lack of proper health care and economic difficulty in the poorest rotavirus endemic regions contribute to problems in geopolitical stability and that the continued geographical expansion of rotavirus will likely intensify these problems in the future. To make matters more worrisome, the zoonotic potential of rotavirus can

have a detrimental impact on agricultural safety, with poorer nations lacking adequate protections. Global warming has been a cause of increased monsoons, with greater potential for contaminated cattle excreta to run off into fresh water supplies such as rivers and lakes (Cook et al. 2004). Contaminated water supplies can further contaminate crops. Already, outbreaks of rotavirus infections from contaminated food have been seen around the world (Cook et al. 2004). The zoonotic potential of rotavirus becomes further important because more dangerous viruses could emerge and because rotavirus can be repeatedly introduced into the human population from a variety of sources (Cook et al. 2004).

#### SUGGESTIONS FOR FURTHER BIOLOGICAL RESEARCH AND PUBLIC POLICY CONSTRUCTION

Scholars have written on the link between human rights, world poverty, and the epidemiology of disease (Sen 1999; Farmer 2005). I myself have suggested how the theoretical discussions in the science-religion dialogue could contribute to concerns for equity health care in the developing world (Carvalho 2007) and how such discussions can expand the science-religion audience (Carvalho 2008). I and others also have suggested that scientists and science-religion scholars—who understand the impact of technology, philosophy, religion, and culture on societies—should engage the wider political and social realm to tackle present, practical problems (Carvalho 2007; 2008; Deane-Drummond 2007; Polkinghorne 2007; Wildman 2007). Continuing with these themes, it is clear that the geographical expansion of three viruses (HIV, dengue, and rotavirus), the increase in frequency of the infectious diseases they cause, and the relationship between these viruses and geopolitical stability, human rights, and equity health care for developing nations are problems of great concern promoted not only by biological and technological factors but also by social, religious, and cultural ones. Consequently, the issues must be tackled from many different angles: clinical intervention, biomedical research, philosophical analysis of social/cultural/religious issues, and public policy.

In my view, scholars in the biomedical research and public policy arenas have a number of avenues to pursue to combat the geographical expansion of HIV, dengue, and rotavirus and the increase in the infectious diseases they cause. For example, unlike with HIV, most of the data on the economic and societal impact for dengue and rotavirus are derived from epidemic as opposed to endemic cases. This lack of sufficient data is relevant for how governments will allocate resources for research, prevention, and more aggressive control activities. This is an area for immediate attention by the scholarly community. Similarly, better epidemiological and entomological surveillance must be established, and the *sources* of the vectors for the viruses—such as water reservoirs that act as breeding grounds for dengue-infected mosquitoes—must be reduced, partly through curbing



global warming. There should be additional research on the control of the zoonotic potential of rotaviruses given the large number of animals able to be infected with these viruses and the recurrent infection of the human population. Better and more rapid clinical diagnosis of patients, especially underprivileged individuals, is a must. Delays in diagnosis in poorer communities continue to contribute to the geographical expansion of HIV, dengue, and rotavirus. In order to achieve this end, the health funding structures in developing nations need to be evaluated. Indeed, the creation of appropriate funding mechanisms (such as the availability of equity health insurance) is crucial to ensure access to health care for poorer families. Otherwise sick individuals who do not have insurance and who cannot present cash for clinical care will not seek treatment, which invariably leads to delayed diagnosis and inappropriate surveillance and, additionally, detrimentally influences how funds are allocated to combat the viruses. At the public policy level, there needs to be enforcement of international human rights standards to protect the most underprivileged, such as refugees who may be infected with HIV (see UNHCR 2006).

In terms of the science-religion dialogue, I would argue that public policies should contain insights from science-religion scholars or biologists who maintain a human rights perspective, because human rights and equity health care are inherently linked to the epidemiology of HIV, dengue, and rotavirus. Science-religion scholars could act as resources for education on the moral dimension of viral infections. HIV, for example, has become a major epidemic in certain developing nations—such as those in Latin America and the Caribbean—because people in these regions possess an erroneous theological view that HIV infection is a “moral curse” that is a “punishment” for unethical behavior. (We have even seen this position in the United States.) Societies in these areas therefore impose a great stigma on HIV-infected patients that leads to widespread discrimination in all forms, including unwillingness from physicians to even treat the disease (Ramirez 2008). Such discrimination promotes the lack of equity health care for the neediest individuals and can be witnessed in dengue and rotavirus cases as well. Given that science-religion scholars are likely to promote more correct theological insights into morality while simultaneously possessing a quality understanding of science, they could be powerful proponents in educating societies that viral diseases result largely from causes that are not based on incorrect presuppositions about morality or social taboos. Educational campaigns dealing with HIV/AIDS could have benefited greatly in the earlier years of the epidemics if erroneous theology had been corrected by insights from the science-religion field. This can be seen especially with the early epidemics in the United States and Mexico (Cohen 2006). Such insights could prevent future mistakes in handling disease epidemics. It cannot go unnoticed that activism from religious organizations that accept advice from science-religion scholars or the human

rights field could be pivotal in curbing the geographical expansion of viruses in certain underprivileged communities. Cases in point are Mexico and Honduras (Cohen 2006).

Additionally, the burden caused by these viruses to underprivileged families—financial, psychological, social, religious, and cultural—needs to be better defined, as does how this burden relates to human rights and equity health care. Science-religion scholars are more likely to understand the complicated dimensions of many societies, so once again they would be helpful in educating the scholarly community on the religious and cultural parameters of viral epidemics. For example, during the HIV/AIDS epidemic in Africa some ritual practices involving blood may have resulted in HIV infections. Similarly, male circumcision has been suggested to reduce HIV infections (Morris 2007), but circumcision practices that reuse unsterilized objects in certain communities could be problematical (see UNAIDS 2006). Cultural insights from science-religion scholars on the religious traditions in these communities could have resulted in an educational campaign to modify cultural and religious ceremonies to make them safer. To illustrate with another case, it greatly surprised the medical community when polio vaccine distribution in the Muslim world met fierce resistance due to mistrust of Western medicine (Roberts 2004). Knowing this is important for vaccine distribution for other viruses like rotavirus. Again, an educational campaign with religious and cultural insights from science-religion experts on Islam could be helpful in future public policy and procedures for vaccine distribution in Muslim communities.

Apart from these concerns, the issue of equity needs to be further explored and the problems resolved. Lack of equity health care is not the only crisis exacerbated by viruses; equity in education (such as access to educational materials and scientific data in developing nations) is also a problem. For example, a proper theological perspective on the dignity and rights of the human person could have thwarted epidemics within certain communities, such as the Mayan community in Guatemala, where individuals are treated as second-class citizens and are not afforded access to health care or even educational materials on HIV (Cohen 2006). Scholars within the science-religion field have suggested that addressing the health crisis in poorer areas of the world could help eliminate superstitious beliefs (Budenholzer 2003, 143–45). I would claim that some of these beliefs clearly have a negative impact on equity.

I have argued that biologists should address global health in numerous ways (Carvalho 2007). I also have articulated that professional societies should devote sections of their journals to philosophical analysis and public policy suggestions that attempt to resolve world health issues (Carvalho 2007). Interdisciplinary collaboration has been successful in other cases, and it is my expectation that continued interdisciplinary collaboration should keep biomedical research focused and relevant. Science-religion

scholars could provide a “moral compass,” encouraging the biomedical community to focus not only on discovering drugs helpful to already developed nations (and therefore profitable to drug companies) but also on research into antiviral medications that would have a greater impact on developing countries and therefore be more likely to slow the geographical expansion of viruses from their niches into first-world communities.

In addition, science-religion scholars with expertise in bioethics and/or human rights could be helpful as interdisciplinary collaborators for public policy initiatives such as the implementation of new medicines or vaccines. Research on vaccines is always ongoing in the biomedical community, but it is important to determine proper cost/benefit information whenever a new vaccine is made, and such cost/benefit information needs to take into account the wider impact of vaccine distribution. For example, the removal of one rotavirus vaccine from the international market in 1999 because of a side effect that occurred in very few cases and that could have been resolved by a simple medical procedure may have thwarted an additional 5 million rotavirus-induced deaths in the developing world (Strauss and Strauss 2008, 203–5). Cost/benefit analysis is based on financial feasibility and the goal of causing no harm in any patient. Much of this analysis presently is based on the effects that could occur to already developed nations. Science-religion scholars could have provided additional bioethical insights into cost/benefit analysis for such vaccine distribution in developing nations. By educating public health agencies and governments on the burdens (financial, social, cultural) of rotavirus epidemics in these poorer countries, science-religion scholars could have presented a better case for how the vaccine would have slowed the geographical expansion of rotavirus in the hardest hit endemic areas and how it would have aided poorer communities at many levels beyond just the medical. It is doubtful that previous cost/benefit analysis took into consideration how the additional rotavirus deaths would have also impacted family structure and family relationships to the wider community, or the added economic burdens and burdens on national health infrastructure resulting from the new deaths because of lack of an adequate vaccine.

In conclusion, the battle against infectious diseases must involve a multifaceted approach that takes into account the social, religious, and cultural dimensions of disease epidemics. The interdisciplinary background of scholars within the science-religion dialogue could be extremely valuable in identifying what these dimensions are and how they can be approached for resolution.

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