



Perspective

Policy

Addressing challenge of zoonotic diseases through One Health approach

COVID-19 pandemic has reiterated the need for urgent, systematic, concrete and multisectoral actions to prevent, control and mitigate impact of infections that have been, and shall continue to arise from animals. Human-animal interaction is essential for survival and cannot be eliminated in foreseeable future thus facilitating zoonoses. In developing countries, especially the rural population has a greater, co-habitation of humans with the animals. Higher prevalence of zoonoses in these countries is a testimony to this inextricable relationship.

The ever-increasing proximity to wildlife due to land use changes, illegal trade in wildlife and other economic activities makes it conducive for pathogens circulating in wildlife to come closer to peri-domestic areas and infect animals and humans in these settings¹. Such animal-human interface poses the potential to cause outbreaks due to novel pathogens. Unless detected and contained during early phase, a small outbreak can progress into an epidemic or even public health emergency of international concern (PHEIC), finally culminating into a pandemic². Global impact of these PHEICs has been severely felt³ during the current millennium (Figure) thus not only halting but reversing the gains made in human development and alleviation of poverty.

The Figure shows that since 2001 almost every third year a major public health event has occurred, six of these were declared by the World Health Organization (WHO) as the PHEIC³ in accordance with the International Health Regulations (2005)¹. Most of these events were caused by the pathogens that originated from animals. It is obvious that these events will continue to occur frequently in the future and the causative agents will arise from animals. Wildlife shall be a perpetual source of microorganisms for which humanity is immunologically naive. It is estimated that more than 850,000 viruses are lurking in the wildlife, of which 20,000 are coronaviruses¹⁵.

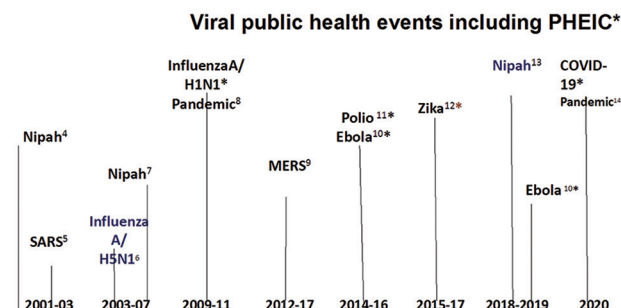


Figure. Major public health events including PHEIC and pandemics during current millennium. Superscript numerals represent reference numbers. SARS: Severe Acute Respiratory Syndrome; MERS: Middle East Respiratory Syndrome, COVID-19: Coronavirus Disease of 2019. *Declared as Public Health emergencies of International Concern by WHO³.

The diseases of animal origin are multidimensional. Zoonoses are endemic (leptospirosis, rabies, hydatidosis, taeniasis, KFD) and epidemic-prone (Japanese encephalitis, plague, Nipah, avian flu, MERS). Food-borne pathogens (*Salmonella*, *Staphylococcus aureus*, *Campylobacter*, *E. coli*), PHEIC and pandemics (influenza, SARS, COVID-19, Zika) and their causative agents can also be used to deliberately harm the human health (agents for bioterrorism or biowarfare e.g., *Yersinia pestis*, *Bacillus anthracis*, etc).

Pandemics and PHEIC are the visible faces of zoonoses. There are numerous other zoonotic diseases that are widely prevalent, constitute major chunk of human infectious diseases and have a wider canvas. The humans are known to be infected with 1407 pathogens¹⁶. Of these, 61 per cent have originated from animals and among these, more than 40 per cent are viruses. Seventy five per cent emerging infectious diseases have an animal origin; five new human diseases appear every year, of which three are of animal origin and 80 per cent of agents with potential bioterrorism use are zoonotic pathogens¹⁷. These numbers are bound to increase and pose associated risks because of more

qualitative and quantitative contact of humans with animals. It is estimated that in India, number of animals match with the human population¹⁸ and any increase in human population results in a corresponding increase in the number of animals. High consumption of food of animal origin is associated with high incidence of food-borne illnesses. This group of zoonotic diseases is mainly caused by bacterial pathogens unlike the PHEIC which are mostly of viral aetiology. Unlike PHEIC, which are primarily caused by viruses, the food-borne zoonotic infections are mainly bacterial in aetiology. Thirty one bacterial genera have been incriminated as causing food-borne illnesses¹⁹. The food-borne zoonoses are responsible for substantial mortality, morbidity, and economic losses across the world every year²⁰.

Animals contract numerous diseases because of poor sanitation around their habitation. In developing world, it is not uncommon to observe co-habitation of humans and animals in an infection-friendly rural environment deprived of appropriate cleanliness, hygiene and sanitation. Instead of addressing these challenges, antimicrobial agents are used as the quick alternative to prevent infections and promote growth of the animals. This has resulted into an enormous increase in use of antibiotics in the animal health sector. It is projected that between 2013 and 2030, use of these agents shall double in India, and in a few other countries²¹. It is also estimated that in most of the countries, about 70 per cent of all antibiotics are consumed in the animal health sector²². The excessive use of antibiotics is recognized as one of the greatest drivers of antimicrobial resistance (AMR). It facilitates selection of resistant strains which, through the food chain find their way to human beings and cause difficult-to-treat infections. But abuse of antibiotics is not limited to animals. There is an increase in the use of antibiotics in humans also which has dangerous consequences. AMR is now considered as the greatest challenge to mankind's efforts in containing infectious diseases. In spite of strong advocacy, there seems to be little action. The inaction is going to cost heavily. AMR has already assumed serious proportions²³ to the extent that we are heading towards a "post-antibiotic era".

In the absence of any concrete and swift actions, by 2050, resistant pathogens will cause death of more than 10 million people every year which shall be more than the number of people dying of cancers and road-side accidents put together, 7.5 per cent reduction in livestock production thus impacting food

security, US \$ 100 trillion loss with 3.5 per cent dip in the global Gross Domestic Product (GDP), pushing 28 million people into poverty apart from many other adverse impacts²³. AMR will increase healthcare costs and push millions of people into poverty. It will also negate health benefits of modern technologies and complex surgeries^{23, 24}. Because of changed land use, deforestation, and illegal trade in wildlife and products, new viruses shall continue to originate from wild animals through "spill over". These spill overs may not remain localized to a defined geographical area or population. Rapid transport shall dramatically reduce the time for international spread of zoonotic viruses and drug resistant bacteria. With thousands of flights everyday carrying 3.5 billion passengers every year²⁵ the world can be traversed in less than 24 hours.

The internecine nature of zoonoses calls for establishment of a collaborative and collective response. This response is recognized as a One Health approach which calls upon convergence of efforts of all stakeholders to protect human and animal health²⁶. One Health recognizes inter-connectivity between people, animals, plants, and their shared environment. It calls for a collaborative, multisectoral, and transdisciplinary approach working at the local, regional, national, and global levels with the goal of achieving optimal health outcomes²⁶. One Health in nutshell is working together.

In spite of advocacy by several leading agencies including the WHO, the Food and Agriculture Organization of the United Nations (FAO), the World Organization for Animal Health (OIE) and United Nations Programme for Environment (UNEP), there has been an inertia in implementing activities under the One Health approach. A tripartite agreement between FAO-OIE-WHO has been in operation for advocacy and as a replicable model at the local, regional and national levels²⁷. This model calls for coordinated action by different stakeholders to contain, prevent, detect and respond to zoonoses including AMR and food-borne illnesses.

One Health should not be construed as a stand-alone or new programme that has to be built *de novo*. This endeavour utilizes existing expertise and infrastructure in various sectors with emphasis on inter-sectoral coordination, collaboration and communication. Essence of One Health is to provide a formal platform to people to plan and work together to achieve shared objectives of mitigating morbidity, mortality, economic loss and social chaos.

One Health does not imply creating a new or a vertical programme. It calls for enhancing capacity of each of the existing sectors to fight infectious diseases and more importantly breaking silos to ensure a collective fight to understand, predict, prevent, detect and respond to infectious diseases through collaboration, communication, cooperation, coordination and commitment between various sectors for efficient use of resources and collective expertise^{28,29}. One Health synergizes the strength of all major stakeholders and at the same time enhances the respective capacity of these sectors to address the present and future challenges by complex and hitherto unknown infectious diseases.

A large number of zoonoses that have till date not infected livestock and humans makes the whole world vulnerable to their invasion and consequent devastation. It has been exemplified by the ongoing pandemic of COVID-19 caused by SARS-CoV-2 virus. There is an urgent need to complement the activities being undertaken by the Global Virome Project¹⁵ by using sophisticated latest virological techniques, geospatial mapping processes, big data analytics and artificial intelligence for the identification of the hotspots for such viruses across the world, detecting, isolating and characterizing the novel viruses for prior development of diagnostic and therapeutic agents including development of the prototype vaccines. In addition, collective efforts by human health and animal health sectors can accelerate early diagnosis and joint containment activities.

Zoonoses continue to have endemic and epidemic-potential and every few years will strike as PHEIC or pandemic. Next pandemic due to the zoonotic virus is imminent. Zoonoses cause huge morbidity, mortality, economic loss and social chaos and the most efficient way forward to address this challenge is an urgent application of One Health approach that harnesses global and national resources to mount efficient and effective response to zoonoses including food-borne illnesses and AMR^{30,31}. One must not forget that economic losses due to pandemics and AMR shall not halt but reverse human development as has been shown by the COVID-19 pandemic. The need for launching a coordinated multisectoral global response with active engagement of human health, animal health and environment sectors in an One Health approach was never felt more till date^{32,33}.

Conflicts of Interest: None.

Rajesh Bhatia

Former Director, Communicable Diseases, World Health Organization South-East Asia Regional Office, New Delhi 110 002, India
Drrajesh.bhatia1953@gmail.com

Received February 4, 2021

References

- Gibb R, Redding DW, Chin KQ, Donnelly CA, Blackburn TM, Newbold T, *et al.* Zoonotic host diversity increases in human-dominated ecosystems. *Nature* 2020; 584 : 398-402.
- World Health Organization. IHR procedures concerning public health emergencies of international concern (PHEIC). Available from: <https://www.who.int/ihr/procedures/pheic/en/>, accessed on February 4, 2021.
- Mullen L, Potter C, Gostin LO, Cicero A, Nuzzo JB. An analysis of International Health Regulations Emergency Committees and Public Health Emergency of International Concern Designations. *BMJ Glob Health* 2020; 5 : e002502.
- Chadha MS, Comer JA, Lowe L, Rota PA, Rollin PE, Bellini WJ, *et al.* Nipah virus-associated encephalitis outbreak, Siliguri, India. *Emerg Infect Dis* 2006; 12 : 235-40.
- Anderson RM, Fraser C, Ghani AC, Donnelly CA, Riley S, Ferguson NM, *et al.* Epidemiology, transmission dynamics and control of SARS: the 2002-2003 epidemic. *Philos Trans R Soc Lond B Biol Sci* 2004; 359 : 1091-105.
- Webster RG, Guan Y, Poon L, Krauss S, Webby R, Govorkovai E, *et al.* The spread of the H5N1 bird flu epidemic in Asia in 2004. *Arch Virol Suppl* 2005; 19 : 117-29.
- Nikolay B, Salje H, Hossain MJ, Dawlat Khan AKM, Sazzad HMS, Rahman M, *et al.* Transmission of Nipah virus - 14 years of investigations in Bangladesh. *N Engl J Med* 2019; 380 : 1804-14.
- Boëlle PY, Ansart S, Cori A, Valleron AJ. Transmission parameters of the A/H1N1 (2009) influenza virus pandemic: a review. *Influenza Other Respir Viruses* 2011; 5 : 306-16.
- World Health Organization. Middle East Respiratory Syndrome Coronavirus (MERS-CoV). Available from: https://www.who.int/health-topics/middle-east-respiratory-syndrome-coronavirus-mers#tab=tab_1, accessed on February 7, 2021.
- Malvy D, McElroy AK, de Clerck H, Günther S, van Griensven J. Ebola virus disease. *Lancet* 2019; 393 : 936-48.
- Soghaier MA, Saeed KMI, Zaman KK. Public Health Emergency of International Concern (PHEIC) has Declared Twice in 2014; Polio and Ebola at the Top. *AIMS Public Health* 2015; 2 : 218-22.
- Heymann DL, Hodgson A, Sall AA, Freedman DO, Staples JE, Althabe F, *et al.* Zika virus and microcephaly: why is this situation a PHEIC? *Lancet* 2016; 387 : 719-72.

13. Sharma V, Kaushik S, Kumar R, Yadav JP, Kaushik S. Emerging trends of Nipah virus: A review. *Rev Med Virol* 2019; 29 : e2010.
14. Umakanthan S, Sahu P, Ranade AV, Bukelo MM, Rao JS, Abrahao-Machado LF, *et al.* Origin, transmission, diagnosis and management of coronavirus disease 2019 (COVID-19). *Postgrad Med J* 2020; 96 : 753-8.
15. Daszak P, Carroll D, Wolfe N, Mazet J. The global virome project. *Science* 2018; 359 : 872-4.
16. Woolhouse ME, Gowtage-Sequeria S. Host range and emerging and reemerging pathogens. *Emerg Infect Dis* 2005; 11 : 1842-7.
17. Centers for Diseases Control and Prevention. *Zoonotic diseases*. Available from: <https://www.cdc.gov/onehealth/basics/zoonotic-diseases.html>, accessed on February 3, 2021.
18. Ministry of Fisheries, Animal Husbandry & Dairying. *Department of animal husbandry & dairying releases 20th livestock census; total livestock population increases 4.6% over census-2012, increases to 535.78 million*. Available from: [https://pib.gov.in/PressReleasePage.aspx?PRID=1588304#:~:text=Total%20Bovine%20population%20\(Cattle%2C%20Buffalo,of%200.8%20%25%20over%20previous%20Census](https://pib.gov.in/PressReleasePage.aspx?PRID=1588304#:~:text=Total%20Bovine%20population%20(Cattle%2C%20Buffalo,of%200.8%20%25%20over%20previous%20Census), accessed on January 31, 2021.
19. Bintsis T. Foodborne pathogens. *AIMS Microbiol* 2017; 3 : 529-63.
20. World Health Organization. WHO estimates of the global burden of foodborne. Available from: https://apps.who.int/iris/bitstream/handle/10665/199350/9789241565165_eng.pdf;jsessionid=726E59975724BEA5DFFC37CB4178DFA4?sequence=1, accessed on February 4, 2021.
21. Van Boeckela TP, Brower C, Gilbert M, Grenfell BT, Levin SA, Robinson TP, *et al.* Global trends in antimicrobial use in food animals. *PNAS* 2015; 112 : 5649-54.
22. Center for Infectious Diseases Research and Policy. FDA: Antibiotic use in food animals continues to rise. Available from: <https://www.cidrap.umn.edu/news-perspective/2016/12/fda-antibiotic-use-food-animals-continues-rise#:~:text=Approximately%2070%25%20of%20all%20medically,96%25%20from%202009%20to%202015>, accessed on January 30, 2021.
23. Review on Antimicrobial Resistance. *Tackling drug-resistant infections globally: Final report and recommendations*. Available from: https://amr-review.org/sites/default/files/160525_Final%20paper_with%20cover.pdf, accessed on January 30, 2021.
24. Bhatia R. Antimicrobial resistance in developing Asian countries: burgeoning challenge to global health security demanding local approaches. *Global Biosecurity* 2019; 1 : 50-4.
25. International Civil Aviation Organization. *Continuing traffic growth and record airline profits highlight 2015 air transport results*. Available from: <https://www.icao.int/Newsroom/Pages/Continuing-Traffic-Growth-and-Record-Airline-Profits-Highlight-2015-Air-Transport-Results.aspx>, accessed on February 2, 2021.
26. El Zowalaty ME, Järhult J. From SARS to COVID-19: a previously unknown SARS-related coronavirus (SARS-CoV-2) of pandemic potential infecting humans – call for a One Health approach. *One Health* 2020; 9 : 100124.
27. World Health Organization. *Zoonoses: FAO/OIE/WHO Collaboration (Tripartite)*. Available from: <https://www.who.int/zoonoses/concept-note/en/>, accessed on February 1, 2021.
28. Food and Agriculture Organization. *One Health*. Available from: <http://www.fao.org/one-health/en/>, accessed on February 1, 2021.
29. Bhatia R. Implementation framework for One Health approach. *Indian J Med Res*, 2019; 149: 329-31.
30. Bhatia R. Feasibility of combating antimicrobial resistance using One Health approach. Available from: <file:///C:/Users/ICMR/Desktop/Downloads/241124-Article%20Text-828833-1-10-20200415.pdf>, accessed on February 1, 2021.
31. Bloom DE, Cadarette D. Infectious disease threats in the twenty-first century: Strengthening the global response. *Front Immunol* 2019; 10 : 549.
32. Ellwanger JH, Veiga ABG, Kaminski VL, Valverde-Villegas JM, Freitas AWQ, Chies JAB. Control and prevention of infectious diseases from a One Health perspective. *Genet Mol Biol* 2021;44 (1 Suppl 1) : e20200256.
33. Osterhaus ADME, Vanlangendonck C, Barbeschi M, Brusckhe CJM, Christensen R, Daszak P, *et al.* Make science evolve into a One Health approach to improve health and security: a white paper. *One Health Outlook* 2020; 2. doi:10.1186/s42522-019-0009-7.