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Emerging and re-emerging diseases as a constraint for poultry development and management

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Abstract
Poultry production is one of the fastest-growing agricultural market segments globally. The sector significantly guarantees food security for the continually expanding human population on a global scale. Poultry immunity, health, and production are several factors that challenge the future growth of the poultry industry. The emergence and re-emergence of pathogens have an influence on the industry's profitability and competitiveness, and this is one of the main problems it faces. An abundance of infectious diseases has emerged and re-emerged around the world as a result of multiple factors such as climate change, rapid movement of men and material due to trade and tourism, deforestation due to urbanisation, pressures of unmanageable population explosions, predispositions of polluted environment, and so on. Different measures have been taken up by the government for the management of various bacterial, and viral diseases like Marek's disease, Avian influenza etc. Thus, the present paper reviews various emerging and re-emerging poultry diseases and their constraint on poultry development in India and around the world.

Keywords: Bacterial diseases, biosecurity, emerging diseases, re-emerging diseases, viral diseases

1. Introduction
Poultry meat is a fairly wholesome and effective source of protein for humans which is why poultry production is one of the fastest-growing agricultural market segments globally (Panda *et al*., 2021) [18]. The sector significantly guarantees food security for the continually expanding human population on a global scale. The emergence and re-emergence of pathogens, which continue to have an influence on the industry's profitability and competitiveness, is one of the main problems it faces. Widespread morbidity and death, decrease body mass gain, decrease egg production, increase medication costs, problems with animal welfare, hazards to the public's health and food security, and significant economic losses are all consequences of these diseases (Bera *et al*., 2010) [3].

1.1. Definitions
The World Health Organization defines an emerging pathogen as a specific microbe that can be ascertained to be the cause of a disease that:
- That has not previously been recognised in the population.
- That has been previously recognised but the cause has remained unknown.
- There is a new disease syndrome that has not been observed.

1.2. Re-emerging diseases: Diseases that reappear, which were previously known after a period of disappearance or decline in incidence or appear in a new geographical area can be considered as re-emerging (Chugh, 2008) [4].

1.3. Emerging diseases and the poultry industry: Raising poultry increases the danger of developing novel infectious diseases. It is currently the population's primary source of animal protein, and the sector is quickly transforming (FAOSTAT, 2019) [6]. The global spread of the highly virulent strain of avian influenza (AI) caused by the H5N1 subtype of influenza A, following its initial emergence in China in 1996, serves as an example of the relationship between the expansion of the poultry industry and the appearance of pathogens (Guan and Smith, 2013) [8]. The most sensitive bird species (such as chicken, turkey, and quail) have severe symptoms of Highly Pathogenic Avian Influenza (HPAI), with broiler flock fatality

rates as high as 100% observed (OIE, 2018) [17].

2. Present Scenario of Exotic and Emerging Disease in India: Vision 2050: ICAR-National Institute of High-Security Animal Diseases

A plethora of infectious diseases have emerged and re-emerged around the world as a result of multiple factors such as climate change, rapid movement of men and material due to trade and tourism, deforestation due to urbanisation, pressures of unmanageable population explosions, predispositions of polluted environment, and so on (Islam, 2015) [11]. Because India is bordered by countries with weak animal health systems, such as Bangladesh, Nepal, and Bhutan, it is particularly vulnerable to exotic and transboundary diseases (Yadav *et al*., 2020) [25]. Since the first epidemic in 2006, India has had multiple outbreaks of avian influenza, with the introduction of novel clades of the H_5N_1 virus on a regular basis (Nagarajan *et al*., 2012) [16].

2.1. Emerging and Re-emerging Bacterial Diseases (Hafez, 2003) [9]

- Amyloid Arthropathy
- Erysipelas
- Necrotic Enteritis (NE)
- Ornithobacterium rhinotracheale (ORT)
- Avian mycoplasmosis

2.2. Emerging and Re-emerging Viral Diseases (Bayry, 2017) [2]

- Highly pathogenic avian influenza
- Avian leukosis (subgroup-1) virus
- New-castle disease
- Astroviruses Causing Fatal Gout in Goslings
- Chicken circovirus
- Infectious Laryngotracheitis Virus
- Infectious Bronchitis Virus
- Fowl Adenovirus
- Avian Hepatitis E.

2.3. Mechanisms of the emergence of poultry pathogens:

2.3.1. Genetic change/Mutation: In a pathogen, this might happen as a result of accumulating point mutations in the genome or even recombination and reassortment of gene sequences. These alterations can occasionally result in a disease that is able to replicate more efficiently in the environment (Domingo, 2010) [5]. The pathogen's mutant strain grows, adapts to the host, and spreads within flocks. e.g. Avian leukosis (subgroup-J) virus emerged by genetic recombination in the field between two avian retroviruses (Gao *et al*., 2012) [7].

2.3.2. The evolution of viral pathogens in conjunction with vaccinations and treatments: Poultry pathogens, like all other species, change and evolve. Genetic control causes antigenic alteration, which can be increased under immunological stress. Antibody production and T-cell activation against pathogen-specific protein structures, which are the most likely to alter over time (Kim and Lillehoj, 2019) [13]. Antibacterial and anticoccidial medications have similar long-term effects. The use of the same antimicrobial or anticoccidial medications to treat coccidiosis or bacteria, especially at subtherapeutic levels, tends to encourage the formation of resistance to those treatments (Snyder, 2021) [23].

Case study: Impact of avian influenza on the Indian poultry industry

Early in 2006, the "avian influenza" or "bird flu" danger in India cost the country's poultry business more than INR 2200 crores in damages. India’s first outbreak of avian flu was confirmed on 19 February 2006 with the death of 200,000 birds in Navapur in Maharashtra’s Nandurbar district (Mohan *et al.,* 2009) [15].

2.4. Measures taken by the Government of India: The Department of Animal Husbandry runs a website to closely monitor the situation by providing weekly updates, information to the media, and coordination with authorities of all states on action plans. A native vaccination against the fatal illness has just been created by the Indian Council of Agricultural Research (ICAR). In April 2006, the Reserve Bank released instructions for relief measures by commercial banks and urban commercial banks as part of efforts to preserve the domestic poultry business from any damage resulting from avian flu (Mohan, 2006) [14].

Case study- Marek’s disease: time to review the emerging threat in Indian poultry

One of the re-emerging diseases in Indian poultry is Marek's disease (MD). Despite vaccination, MD outbreaks were recorded in several regions of the country, resulting in significant financial losses (Kannaki and Gowthaman, 2020) [12]. Flock mortality of 10–40% has still been observed in vaccinated flocks during outbreaks, but MD is thought to be successfully managed with vaccination. MD outbreaks in vaccinated Indian poultry flocks cause annual losses of approximately 40 million Indian rupees. It should be a top priority to conduct nationwide monitoring, report MD outbreaks, and better characterise the Indian field isolate. Along with improved biosecurity measures, management practices, and more effective control of immunosuppressive diseases, it is equally important to review the current vaccination strategy and examine the need for the introduction of more effective vaccines that provide better protection against more virulent strains (Kannaki & Vasudevan, 2020) [12].

3. Challenges: Vision 2050: ICAR-National Institute of High-Security Animal Diseases

3.1. The emergence of novel and unknown pathogens in the country poses a danger to the growth of the poultry industry and puts trade restrictions on the export of chicken and poultry products: The evolution of already-existing infections into more virulent ones, enhanced pathogen resistance to treatment options, and adaptability to new host ranges and geographic regions are just a few of the many variables that contribute to the formation of an emerging pathogen. Unknown diseases are emerging as a result of altered environmental circumstances, greater human-animal contact, urbanisation, deforestation, the growth of transportation networks, and intensified poultry production and trade (Yadav *et al*., 2020) [25]. Landscapes and ecosystems noticeably shift as a result of climate change, variations in seasonal temperature, and changes in rainfall patterns. These, in turn, are causing the microbial flora to alter rapidly.

3.2. A paradigm change in poultry rearing techniques results in altered host-pathogen interactions is changing the profile of poultry diseases - One of the main causes of shifting disease dynamics is the population of chickens. It is fuelled by the demand-driven rise in chicken meat and egg consumption in a rapidly developing nation like India (Pandey and Upadhyay, 2022) [19]. As small-scale farming has been abandoned in favour of more lucrative income-generating endeavours, there has been a tendency toward scaling up to large commercial chicken production and increasing intensification. This would cause a rise in illnesses linked to animal overcrowding and environmental degradation while gradually decreasing those endemic and epidemic diseases that are simpler to control in intensive systems.

3.3. Rise in risk of zoonotic infections with increasing number of animal pathogens adopting human beings by crossing species barriers with greater ease due to ecological changes and greater contact between humans and poultry. (Zoonotic infections) — In the past two decades a large number of new viral infections with severe life-threatening and economic consequences have emerged. At present, of all the microbial pathogens, 60% are zoonotic with 13% species regarded as emerging or re-emerging. Among emerging infectious diseases, 75% are zoonotic (Parvez and Parveen, 2017) [20].

3.4. Rise in antimicrobial drug resistance due to indiscriminate use of antibiotics in animals leading to the emergence of superbugs unresponsive to treatments of modern medicine (Drug resistance) - Multi-drug resistance strains have emerged as a result of decades of indiscriminate antibiotic usage in poultry. Since antibiotics are selectors of bacterial strains, they are already developing and are often referred to as "superbugs," which are too harmful to be handled in open laboratories. These bacteria are resistant to all known kinds of antibiotics. We are seeing the development and adaptability of bacteria to the use of antibiotics as medicinal agents, which is testing our comprehension. To reduce the dangers of newly developing drug-resistant strains, readiness is required at the animal-human interface (Pontes *et al*., 2018) [21].

3.5. Increasing possibilities of use of animal pathogens as biological warfare agents to disturb the economy of the country (Bio-terrorism) - Poultry pathogens may be used as bio-weapons or in bio-terror because they have a high impact, are cheap, easy to acquire and propagate, and can be readily smuggled through border checks undetected (Hamilton and Smith, 2006) [10].

4. Management of emerging and re-emerging diseases: (Bagust, 2013) [1]

4.1. Biosecurity: The main factor in controlling and preventing poultry illnesses in commercial settings is biosecurity. Avian pathogens, which comprise disease-causing bacteria, viruses and protozoan parasites, do not recognize national boundaries, only production sites and their disease control circumstances. The most important measure for sustainable and profitable production on a poultry site is therefore to have forward defences in place – i.e., a biosecurity programme (Bagust, 2013) [1].

- Keep poultry in a completely enclosed space with a single point of physical entrance to prevent unauthorised access. Only a footbath with disinfectant should be used to access this location. A poultry production site should generally deter casual visits. All visits should be recorded.
- Prevent contact with wild birds and vermin by physically excluding them from the site.
- The equipment used for keeping poultry in must be maintained clean and should undergo periodic disinfection.
- Between batches of poultry, cleaning and disinfection are important. The efficacy of cleaning and disinfection is considerably increased in chicken production facilities using concrete flooring as opposed to dirt flooring.
- It is not suitable to share equipment among poultry locations. Equipment must be completely cleaned and disinfected before and after entering any poultry production location if sharing is absolutely essential.
- Food and water contamination by faeces should be rigorously avoided. The feed should be kept in safe, closed containers, and the water source should be cleaned, maybe with a simple chlorination process.
- Birds should be sourced from a breeder whose bird health status is known to be good, and should be of healthy appearance on arrival at the site.

4.2. Quarentine: Currently, genetically based disease resistance is rarely of practical use in the field. This means that isolation is the only option (Sharma, 2010) [22]. This is the oldest of the approaches, and dates back to Roman times.

4.3. Hygiene and disinfection: When flocks are being isolated from the entry of microbes, hygiene and cleaning are the first measures used. These must result in the removal of organic material from the surfaces to be decontaminated, for example, in poultry houses or the hatchery, if antimicrobial disinfection treatment is to be effective.

4.4. Vaccination: It is probably the easiest and most economical group of methodologies used for the control and prevention of poultry diseases in poultry production. However, it should not be used as the sole measure on a flock.

4.5. Eradication: For just a few specific poultry pathogens, this is a practical strategy for disease control. The two main requirements that must be satisfied are typically that the main route of infection transmission is through the egg and that generally reliable and affordable laboratory tests have previously been devised. Even though a successful eradication campaign necessitates large resource inputs, business can eventually reap enormous rewards.

4.6. Immunogenetic resistance: Although disease resistance is not yet complete, it may do so soon, as the virus that causes Marek's disease shows. If a commercial demand puts pressure on this, genetic selection might be used to improve disease resistance, which may put the answer in the hands of commercial primary breeding businesses. In contrast to other growth and production characteristics, this is currently not seen to be a major priority. Additionally, there aren't enough efficient methods for identifying particular resistance to a variety of serious re-emerging diseases that affect poultry.

4.7. Network building: Building long-lasting systems to control poultry's emerging and re-emerging diseases that can integrate their professional resources for poultry health are the major challenge for developing nations. There may not be much genuine progress made in terms of improving the general health of poultry due to resource fragmentation, redundancy, and conflicts over which (and how) areas of weakness should be reinforced. Regular information interchange between industry veterinarians, public health services (laboratory and field), and frequently local universities is a defining trait of poultry health services in developed countries. Such collaboration and communication are commonplace since it is understood that speaking out about issues relating to poultry outbreaks helps both parties and outweighs the harms caused by being silent. Experiences gained in developed poultry industries worldwide have demonstrated that investing State resources in a central poultry health facility/unit with designated functions can provide avian health-in-production services. Interaction between government and industry representatives is therefore essential for successful design and planning.

5. Conclusion

The poultry industry has long been concerned about bacterial and viral infectious illnesses that are emerging and re-emerging. Many outbreaks have occurred in the world's poultry population in recent years. As it has resulted in significant economic damage throughout the nation and globe, fundamental approaches for managing the relevant diseases must focus on preventing and limiting the spread of these diseases.

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