Innovation in the Fight Against Infectious Diseases

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The discovery of antibiotics in 1928 led the world to believe that the fight against infectious diseases was one to be won within a few years. Nowadays, nearly 90 years following the discovery of penicillin, infectious diseases remain one of the main causes of mortality worldwide, with lower respiratory tract infections, diarrhoeal diseases, and tuberculosis ranking among the top 10 causes of death according to the World Health Organization (WHO) [1]. In recent years, the advent of antibiotic resistance, the anti-vaccination movement, and humanitarian crises have seen a rise in infectious diseases that were once thought to be nearly eradicated, such as polio, tuberculosis and measles.

Reducing the burden of infectious diseases by 2030 is one of the targets stated in the Sustainable Development Goals (SDGs), with SDG3 focusing on ending the epidemics of the Acquired Immune Deficiency Syndrome (AIDS), tuberculosis, malaria and neglected tropical diseases, as well as combating hepatitis, water-borne diseases and other communicable diseases [2]. Innovation in the field of Science and Technology has allowed for better surveillance, diagnosis, and treatment options, as well as contributing to the development and implementation of strategic policies.

Surveillance

Formal reports of suspected outbreaks are usually received by the WHO from ministries of health, national institutes of public health, WHO regional offices, and civil society. Traditional surveillance methods rely on routine reporting of pre-determined information by healthcare facilities. This often results in delayed notifications, making outbreak prediction difficult and leading to slow or less-than-adequate responses.

Technological advances, mainly in the field of digital transformation, have enabled the development of digital surveillance reporting systems and monitoring networks, providing a more rapid response to epidemic threats. These systems collect and analyse information obtained from diverse sources, including social media, news reports, and web-based searches, with the aim of detecting events with epidemic potential prior to official notifications [3].

As part of the Global Outbreak Alert and Response Network (GOARN), the Global Public Health Intelligence Network (GPHIN) was developed by Health Canada in collaboration with the WHO as a tool for event-based surveillance. This system is a secure internet-based multi-lingual early-warning system that continuously searches global media sources to identify information regarding disease outbreaks and other relevant events of potential international public health concern. Reports obtained in this way require verification to ensure cases meet a specific case definition. The importance of GPHIN was highlighted in 2003 during the Severe Acute Respiratory Syndrome (SARS) outbreak in China, issuing the first alert of unusual respiratory illness in

Guangdong Province to WHO and GOARN.

Diagnosis

Advances in the field of genetics and biotechnology have enabled rapid diagnosis of infectious agents. New technologies allow the identification of unculturable bacteria thanks to DNA sequencing, and whole genome sequencing (WGS) can be used not only to diagnose an infectious agent but also to identify epidemic strains and transmission events. The most commonly used genetic tool in clinical microbiology is the real-time polymerase chain reaction (PCR), which amplifies genetic material for enhanced detection of pathogens, and is characterized by high sensitivity and specificity, low contamination risk, and high speed [4].

A notable example of the role of innovation in diagnostics, in the context of infectious diseases, is the case of tuberculosis (TB). The bacterium that causes TB takes approximately 21 days to grow in solid culture. Therefore, diagnosis using classical microbiology is typically slow, during which time the infected patient is contagious and can transmit the disease to anyone in close proximity, given the airborne nature of TB. In addition to genetic techniques as a method of identification, the invention of mycobacterial growth indicator tubes (MGIT) has been revolutionary, allowing identification of positive cultures as soon as 1 hour after inoculation. Rapid diagnosis leads to better treatment outcomes and reduces transmission — a key factor in eradication.

Moreover, innovation in the field of diagnostics has not been limited to speed, but also to comfort. Many infectious diseases can only be diagnosed through a blood sample, requiring patients to attend healthcare centres and have their blood drawn. Advances in the field of HIV/AIDS diagnostics have resulted in the invention of HIV home-tests, allowing people to test for HIV in the comfort and privacy of their homes.

Treatment

The treatment of infectious diseases consists of drugs aimed at killing or limiting the growth of the infectious agent, but, due to the intense regulatory pathways in drug development and the high increased risk of failure of clinical trials, pharmaceutical companies do not invest greatly in drug candidates for infectious diseases since the return on investment is generally quite low. However, antibiotic resistance is globally recognised as an emerging public health threat, and policy initiatives are underway to provide solutions for overcoming important obstacles in the fight against antibiotic resistance. These include strategies to incentivise the development of novel antibiotics, including the development of new economic models and policies for sustainable antibiotic use [5].

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One of the main causes of antibiotic resistance is non-compliance with the prescribed treatment due to the length of treatment, the amount of daily pills taken, or the adverse side effects associated with the drug. These problems also arise in treating chronic non-bacterial infectious diseases, such as HIV. Research from the Massachusetts Institute of Technology, as well as the Brigham and Women's Hospital, into new delivery options for currently available drugs has led to the development of an ingestible capsule that can slowly release 1 week's worth of antiretroviral drugs [6]. Although its application is currently only being researched for HIV, this technology

could be used in the delivery of a number of drugs.

Policy and its Role in Eradicating Infectious Diseases

Policies on infectious diseases are difficult to establish due to the range of competencies involved and the different socio-economic and cultural settings in which they are implemented. Scientific advances have played an important role in eradicating many infectious diseases in the developed world, however, many hard-to-reach areas in low- and middle-income countries may not reap the benefits of such advances due to high levels of poverty. Moreover, poverty creates conditions that favour the spread of infectious diseases and prevents affected populations from obtaining proper access to prevention and care. Therefore, policies to reduce poverty and inequalities play important roles in eradicating diseases.

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Daniela is a PhD candidate at the Molecular Immunity Unit of the Department of Medicine, studying Mycobacterium abscessus infection in the context of Cystic Fibrosis. She completed her undergraduate degree in Biology at Universidad Complutense de Madrid (Spain) and obtained her Master's degree in Medical Microbiology from the London School of Hygiene and Tropical Medicine. Daniela is very interested in the role and contribution of Science and Policy in the fight against infectious diseases. She is currently doing an internship at the Department of Strategic Policy at UNAIDS in Geneva, Switzerland.