Health Education and Public Health
2025; 8(2): 598-600. doi: 10.31488/HEPH.194

Review

Viral and Bacterial Pathogens as Infectious Agents

Uwe Ernsberger*[1,2]

1. Alumnus Max Planck Institut für Hirnforschung, Frankfurt am Main, Germany

2. Alumnus interdisziplinäres Zentrum für Neurowissenschaften, Heidelberg, Germany

Corresponding author: Dr. Uwe Ernsberg, Polizeimeister-Kaspar-Straße 44, 60320 Frankfurt/Main, Germany

Received: March 20, 2025; Accepted: April 14, 2025; Published: April 24, 2025

Abstract

Influenza and Corona virus-caused pandemics early in the 20th and 21st century claimed enormous numbers of human lives. The threat in healthcare by RNA viruses is aggrevated by an increasing number of antibiotics-resistant bacterial strains. The One Health concept'' for stewardship in prescription and use of antibiotics, the guide to the "5 moments of hand hygiene'', and an orchestrated attempt to avoid nosocomial infections attempt to meet this challenges. Preventing the spread of pathogens from aerosols, body excretions, surface and skin-associated pathogene reservoirs into aseptic working and nursing environments will become key to a successful care system, as well as individual and public care

Keywords: pathogen, nosocomial, One Health, 5 moments of hand hygiene, pandemics

Introduction

Eye-opening research in the field of bacterial infections and the understanding of epidemics such as tuberculosis and cholera [1] has left other devastating common diseases like smallpox, measles and influenza puzzling. The basic differences in the dimensions, structure and biology of the disease-causing agents will only become resolved starting in the 1930s. The Spanish flu in 1918/1919 has initially remained unresolved [2] and put the already exhausted healthcare at the end of the First World War under biggest challenges. Losses in medical and health care staff are largely unaccounted for and were considered „Victims of faithful fulfillment of duty" [3].

The dimensions of the Influenza pathogene became resolved in the 1930s. Throat lavage at the onset of a seasonal influenza yielded a pathogen able to infect ferrets with a transmittable flu-like disease [4]. Even after a filtration to remove bacteria, the material remained infectious, demonstrating the new quality of the disease-causing agent. This work laid the ground for the classification of the influenza pathogen as a virus, demonstrated its human origin, and opened the field for a systematic analysis of this group of disease-causing agents. In a fascinating chapter of medical history including work on swine influenza and on vaccine development, structural and evolutionary principles of this group of pathogens emerged and effective vaccination regimes were developed [5].

Reccuring influenza pandemics throughout the 20. century point to an enormous thread potential [6]. Influenza viruses display mechanisms to reorganize genetic material between virus strains infecting respiratory tissue of different mammalian and avian species. The Asian flu in 1957/1958 and the Hongkong flu in 1968/1969 were characterized by newly arranged elements found in successor strains of the Spanish flu virus 1918/1919 and avian flu virus strains [7].

The Age of Antibiotics and the Ways of Bacterial Adaption

The first line of success in the battle against infectious diseases became apparent in the 1930s. The discovery of Penicillin by Alexander Fleming, and the production of Penicillin G on an industrial scale in the 2nt World war, made a dramatic success in the figth against infections caused by Gram-negative bacteria [8]. However, already in 1940, bacterial strains with enzymatic activity to degrade Penicillin showed up [9]. Genes for lactamases - the black sheep among the enzyme proteins responsible for the inactivation of antibiotics like Penicillin - spread in bacterial genomes. Initially during 2nd World war and then in the 1970s, they surfaced in different bacterial species. At the onset of the

21st century, the picture of a global thread due to pan-resistant bacterial strains emerges, resilient torwards all antibiotics available [10].

The 21st Century in the Shadowes of Highly Infectious RNA Viruses

In 1931, a new respiratory disease has been reported, spreading through north-american chicken farms and killing between 40 % and 90 % of the animals. In 2019, the SARS-CoV-2 RNA virus, member of the same virus group, marks the third epidemic massively affecting the human population in the young century [11]. After 2 epidemic waves with the related viruses, the corona virus SARS-CoV-1 (2002/2003) and MERS (2012), the pandemy caused by SARS-CoV-2 results in close to 7 million human deaths.

During the Ebola epidemy 2014-2016 [12], an RNA virus of high mortality was spreading through several westafrican states, provoking the question of how western european states could handle such an outbreak [13]. The situation during the COVID-19 pandemy 2020-2023 gives a multi-coloured picture. The number of infection outbreaks remained high in nursing homes [14] until vaccines became available. Thus, not all sectors of our health care systems are robust enough to handle such an event.

Hygiene Competence and Clean Hands

The foundation for our understanding of hygiene in healthcare were laid during the second-half of the 19th century [1]. Dramatic decreases in mortality among wounded soldiers due to a basic cleanliness in their surroundings and at their bedside, disinfecting washing of the hands in maternity wards, as well as disinfection of surgical equipment and the surgeons hands, went in line with the germ theory of infection. With advances in diverse domains, disinfection protocols based on temperature and chemicals, the removal of pathogenic germs from textils and hands by appropriate washing techniques and detergents, and single-use gloves propelled infection prevention. 150 years after Florence Nightingale, Ignatz Semmelweis, Joseph Lister, Louis Pasteur, and Robert Koch, the leading national institutes consider hand washing the moseffective single means to prevent nosocomial infections [15,16].

The progress towards alcohol based skin and hand compatible disinfectants, and the resultant time savings, fostered an increase in compliance with the recommendations for hand hygiene, a reduction in care-associated infections, and antibiotics-resistant pathogenes [17]. Still, the recommendations for hand hygiene and the change of gloves are not followed often enough [18] and contaminated single-use gloves are a serious reason for care-associated infections [19].

Education, Knowledge and Compliance are Essential

in 2020, healthcare systems were challenged to and beyond their limits. Different building blocks attempt to face and meet the challenge by RNA viruses and antibiotics-resistant bacteria. The One Health-concept [20] targets towards an appropriate reduction in the use of antibiotics in healthcare, agriculture, and environment, to cut down the evolutionary adaptation of bacterial metabolic processes. A further building block lies in an improved infection prevention in healthcare [21]. The spread of pathogens from the hospital to nursing home, home care and into the healthy population points at the importance of education and knowledge to develop working routines suitable for infection prevention. Together with basic hygiene in the personal environment, these routines fulfill major protective functions in clinical as well as in home care. Compliance with the recommendations for hand hygiene and protective masks for face and respiratory tract [22,23] are of essence.

The potential spread of viral and bacterial pathogens from aerosols and body excretions, from skin and textiles, as well as a range of surfaces in the patients environment, requires a precise adaptation of the workflow to prevent touching unclean surfaces during a routine that needs to be kept aseptic. This task goes well beyond simple hand washing [24] and aims at the reduction of nosocomial infections, the suffering of patients concerned, and treatment costs as well [17].

Acknowledgements

Early discussions with the late P. Zieba at the start of the corona pandemic initialized this work. M. and L. Sieber provided Technical Support for speech recognition. U. Wagner provided essential personal help.

Disclosure

This work was originally published as „Viren und Bakterien als Infektionsauslöser“, in PflegeZeitschrift (76) 3, 34-35, Springer Heidelberg/Germany

Conflict of Interest

The author declares no conflict of interest

References

1. Ernsberger U. Keine Gesundheit ohne Hygiene. Pflege Z. 2023;76(1-2):36-37.
2. Salzberger B, et al. The pandemic influenza 1918. Dtsch Med Wochenschr. 2018;143(25):1858-1863. doi:10.1055/a-0666-1962
3. Braunschweig S. Opfer treuer Pflichterfüllung. Basler Z Gesch Altertumkd. 2019;114:143-165. Krankenpflege. 2019;2:26-29.
4. Smith W, Andrewes CH, Laidlaw PP. A virus obtained from influenza patients. Lancet. 1933;222:66-68.
5. Barberis I, et al. History and evolution of influenza control through vaccination. J Prev Med Hyg. 2016;57(3):E115-E120.
6. Kilbourne ED. Influenza pandemics of the 20th century. Emerg Infect Dis. 2006;12(1):9-14. doi:10.3201/eid1201.051254
7. Taubenberger JK, et al. Integrating historical, clinical and molecular genetic data in order to explain the origin and virulence of the 1918 Spanish influenza virus. Philos Trans R Soc Lond B Biol Sci. 2001;356(1416):1829-1839. doi:10.1098/rstb.2001.1020
8. Chain E. Thirty years of penicillin therapy. J R Coll Physicians Lond. 1972;6(2):103-131.
9. Abraham EP, Chain E. An enzyme from bacteria able to destroy penicillin. 1940. Rev Infect Dis. 1988;10(4):677-678.
10. Jean SS, et al. Global threat of carbapenem resistant gram-negative bacteria. Front Cell Infect Microbiol. 2022;12:823684. doi:10.3389/fcimb.2022.823684
11. V'kovski P, et al. Coronavirus biology and replication: implications for SARS-CoV-2. Nat Rev Microbiol. 2021;19(3):155-170. doi:10.1038/s41579-020-00468-6
12. Kamorudeen RT, et al. Ebola outbreak in West Africa, 2014–2016. J Infect Public Health. 2020;13(7):956-962. doi:10.1016/j.

jiph.2020.03.014

13. Grünewald T. Ebola – wie Deutschland vorbereitet ist. Dtsch Ärztebl. 2014;111(33-34):A1418-B1222.
14. Mbalayen F, Dutheillet-de-Lamothe V, Letty A, et al. The COVID-19 pandemic and responses in nursing homes: a cross-sectional study in four European countries. Int J Environ Res Public Health. 2022;19(22):15290. doi:10.3390/ijerph192215290
15. KRINKO. Händehygiene in Einrichtungen des Gesundheitswesens – Empfehlung der Kommission für Krankenhaushygiene und Infektionsprävention (KRINKO) beim Robert Koch-Institut (RKI). Bundesgesundheitsbl. 2016;59:1189–1220. doi:10.1007/s00103-016-2416-6
16. Simmons BP. CDC guidelines for the prevention and control of nosocomial infections. Guideline for hospital environmental control. Am J Infect Control. 1983;11(3):97-120. doi:10.1016/0196-6553(83)90122-0
17. Vermeil T, et al. Hand hygiene in hospitals: anatomy of a revolution. J Hosp Infect. 2019;101(4):383–392. doi:10.1016/j.jhin.2018.09.003
18. Imhof R, Chaberny IF, Schock B. Gloves use and possible barriers-an observational study with concluding questionnaire. GMS Hyg Infect Control. 2021;16:Doc8. doi:10.3205/dgkh000379
19. Lindberg M, Skytt B, Lindberg M. Continued wearing of gloves: a risk behaviour in patient care. Infect Prev Pract. 2020;2(4):100091. doi:10.1016/j.infpip.2020.100091
20. Niedrig M, Eckmanns T, Wieler LH. One Health-Konzept: Eine Antwort auf resistente Bakterien? Dtsch Ärztebl. 2017;17:8-10. doi:10.3238/PersInfek.2017.04.28.02
21. Schwerdtner NL, Graf E. Infektionsprävention schnittstellenübergreifend. Pflege Z. 2021;74(8):24-27. doi:10.1007/s41906-021-1076-9
22. Hill B, Lamichhane G, Wamburu A. Infection prevention and control: critical strategies for nursing practice. Br J Nurs. 2024;33(17):804-811. doi:10.12968/bjon.2024.0286
23. Ferguson ON, Flynn MR, Mitchell RA, et al. Sex differences in the physiological and perceptual responses to face masks during exercise. J Appl Physiol (1985). 2025;138(4):926-938. doi:10.1152/japplphysiol.00679.2024
24. Gartmeier M, et al. Why hand hygiene is not sufficient. GMS J Med Educ. 2019;36(4):Doc39. doi:10.3205/zma001247

To cite this article: Ernsberger U. Viral and Bacterial Pathogens as Infectious Agents. Health Education and Public Health. 2025; 8(2): 595-600. doi: 10.31488/HEPH.194.