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Exploring the Causes and Effects of Infection on Human Health

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ABSTRACT
Efforts made to comprehend the essence of disease and its causes have shaped the history of medicine. Yet, unless one invokes some kind of supernatural causes, it is often impossible to answer the question of why a particular individual suffers from this or that malady. Nevertheless, one interesting exception to this rather unsatisfactory situation was always seen in the instance of infectious diseases. Here it is possible to discern a relatively simple cause and effect chain, which in turn offers the practionable perspectives of their successful prophylaxis and cure. The discovery that anthrax was caused by a bacillus was an important turning point in medical history. Previous to this seminal event, so called 'black death' and other plagues were considered as the manifestation of God's curse. Appropriate preventive and therapeutic measures were hence seen in terms of piety and futile penance rather than crude pathogenetic mechanisms. Since the mid 19th Century, and in no small part due to advances from bacterial theory and histological techniques, experimental infections were subjected to rational and systematic scrutiny. Soon, the battle against long dreaded scourges like smallpox, cholera and plague appeared to have been won. There was hence an almost universal belief, that in the foreseeable future microbes would be tamed, and that the age of infectious diseases was almost past

Keywords: practionable, prophylaxis, turning, Century

1. INTRODUCTION

Efforts made to comprehend the essence of disease and its causes have shaped the history of medicine. Yet, unless one invokes some kind of supernatural causes, it is often impossible to answer the question of why a particular individual suffers from this or that malady. Nevertheless, one interesting exception to this rather unsatisfactory situation was always seen in the instance of infectious diseases. Here it is possible to discern a relatively simple cause and effect chain, which in turn offers the practionable perspectives of their successful prophylaxis and cure. The discovery that anthrax was caused by a bacillus was an important turning point in medical history. Previous to this seminal event, so called 'black death' and other plagues were considered as the manifestation of God's curse. Appropriate preventive and therapeutic measures were hence seen in terms of piety and futile penance rather than crude pathogenetic mechanisms. Since the mid 19th Century, and in no small part due to advances from bacterial theory and histological techniques, experimental infections were subjected to rational and systematic scrutiny. Soon, the battle against long dreaded scourges like smallpox, cholera and plague appeared to have been won. There was hence an almost universal belief, that in the foreseeable future microbes would be tamed, and that the age of infectious diseases was almost past

Methods

A prospective, observational mixed-methods study is proposed - embedding a study of novel anti-microbial treatment strategies utilising bacteriophages into MACROFLAME, an observational, experimental study of the causes and effects of infections in acute care. Infections are frequent amongst patients admitted to hospital and

are a leading cause of admission. However, the causative pathogen is not identified in over half of hospitalised patients with infection. Thus, there is an emphasis on empirical use of broad-spectrum antibiotics. Inappropriate antibiotic use promotes the selection of multi-drug resistant organisms, with 25% of hospitals reporting organisms showing resistance to all tested antimicrobials (Quarton et al., 2024).

Conclusion

These are challenging times for those seeking to maintain health and cure disease. Technological advances have led to the investigation of ever more pathological processes that further complicate our understanding. By studying them in an isolated fashion, it can be fashionable to lose sight of the complex interaction of all the parties. Indeed, until the beginning of the 19(th) century anatomists were still debating how blood was conducted through empty tubules. The efforts made to comprehend the essence of disease and its causes have shaped the history of medicine. However, it is seen over and over again that once a cornerstone is found, much that had been difficult to understand suddenly falls into place. An exception in this unsatisfactory situation is infectious disease. Here one can discern a cause and effect chain, which, starting with the pathogen, passes through its mode of transmission to termination in the body's defence or breaking down of its resistance. This simple view offers the practicable perspectives of prophylaxis and therapy (X. Lackner, 2007). Up until the time when an unassuming country physician named Robert Koch discovered that anthrax was caused by a bacterium, raging epidemics were something that were accepted with uneasy resignation as an expression of the whim of the Lord. God obviously had little fondness for the town of Rattenberg in Bavaria. In 1634, for the second time in a mere 18 months, its population was struck down by the pestilential distemper, as the chronicles describe it. Within 12 weeks more than 1,000 people died in a town of 586 houses. This time the rich and respected were as much the victims as the poor and the weaver. The extent of the disaster can be surmised from the fact that the plague panick-stricken other cities closed their gates to the carters who delivered the blossoms of the silk factories, and set up a black-red barrier surrounding Rattenberg. This barrier did not prevent the import of the disease, but served to maintain the people of Rattenberg cut off from the outside world and dying unmolested. At such times, when the roads were closed and the situation was truly desperate, the unlucky people of Rattenberg would gather around their parish church, from which the miraculous Lourdes Madonna had been paraded in procession since 1440. The screening terrors of death in town and country would lie on their knees before it, holding candles, and imploring the intercession of the blessed virgin with a fervor that could move even the stone deaf ear of the heavens. And then one day the epidemic would suddenly dissipate from Rattenberg to reappear with ferocity four years later.

2. Understanding the Basics of Infections

There is no doubt that, for all higher animals and man, infections are one of the prime threats to health and survival. Nevertheless, regarding the nature of infections, there are many misunderstandings with laymen and this is also widespread with professionals other than microbiologists and infectious diseases specialists. This may have at least two important consequences unfavourable to patient health: ignorance or neglect of key diagnostic procedures, and, as a consequence, suboptimal or even wrong treatment of the patient. Furthermore, there exists a widespread incorrect opinion that, with the advent of antibiotics and other potent drugs in the field of antimicrobial chemotherapy, the problems related to infections has more or less been solved. Microorganisms are a mixed blessing; they sustain life on Earth, yet they cause most infectious diseases. Although equipped with a repertory of defenses, our susceptibility to infection looms large, being influenced by lifestyle fosters many infectious diseases; they run a protracted, insidious course that befalls us late in life; most micro-organisms cannot be exterminated due to intrinsic resistances; antibiotics target a narrow spectrum of bacteria; the microbial genome may host unanticipated genes conferring antibiotic resistance. Pursuing survival, pathogens have devised an impressive array of stratagems, and we, as hosts, have met this by developing an equally sophisticated set of immune defenses. Yet, where the fight takes place within the confines of individual cells, the resources the host can muster often prove inadequate, and the pathogens avert lethal confrontation, emerging instead as silent, lifelong companions. This fragile equilibrium may be disrupted, however, as borne out by the virulence of certain infections, and the frequent encounters with micro-organisms to which we have not yet been exposed, are immune suppressed, or are weakened by age.

2.1. Definition and Types of Infections

Infection is the presence of an organism in an ordinarily sterile body site or an organism other than normal flora for that location on a body surface. An infection may or may not cause illness of the patient. Infection that does not cause illness is called subclinical (Walker, 2014). Diseases cause symptoms, which are the clinical manifestations that the patient describes such as pain, nausea, loss of appetite, or fatigue, and signs, which are objective observations such as fever, rash, paralysis, seizure, coma, or rapid breathing. The duration of infection may be acute (days or weeks) or chronic (months or years). If the pathogen is not cleared by the immune response, the infection is described as persistent. If an infectious agent persists without replicating for any length

of time, the infection is called latent. A latent infection can reactivate; the agent can replicate and cause illness if the immune system fails to keep it under control. The term persistent is used for infections that are chronic, slow, and insidious.

Infection results from the complex battles between pathogens and the host. Pathogens have evolved many different strategies to evade the host defence mechanisms to cause disease. The human body has a range of physical and immunological barriers that prevent the establishment of infection. The predominant mechanisms of host defence are pH, temperature, and specific cell types that physically remove or destroy pathogens. When pathogens breach these defences, they can cause infection by a number of mechanisms. There are four main categories of infection: extracellular bacteria; toxins; intracellular bacteria, fungi, and viruses; and parasites.

2.2. Modes of Transmission

Infectious agents are transferred between hosts by various modes of transmission. Theoretical studies have modeled the evolution of different transmission modes by assuming contacts between randomly contacting hosts. On the other hand, genetic distance between pathogens might correlate with the frequency of the various transmission modes. If there is a strong spatial pattern in host-specific pathogen genetic distance but there is little association between the genetic distance and the degree of relatedness of hosts, then horizontal transmission (either directly via contacts or indirectly via the environment) should be the dominant mode. Contact tracing data on naturally acquired infections from cows and humans were used. In the case of cows, 60 contacts of 11 transmitted infections led to estimates of different transmission routes; 73% of infections were transmitted between calves. Surveys of chicken movements combined with experimentally determined transmission routes have suggested direct contacts are the main transmission routes.

In the case deviating from this pattern, human contact tracing data were re-analyzed. Data on 53 index cases with well-defined exposure routes and their 300 known or suspected contacts had been used to determine the transmission modes. The empirical analysis did not find a correlation between the mode of transmission and the spatial distribution of host-specific pathogen genetic distance. Thus, the nature of co-evolution might be coupled to other variables, or the pattern effect may be not so straightforward as to manifest as a simple correlation.

3. The Immune Response to Infections

Our immune system plays active role in protecting us in varieties. With the presence of a large number of cells and a variety of molecules, it is a very adaptive system. The immune system objects not only the outside pathogenic agent but also recognizes body's own components. In normal condition the immune system knows self and non-self very nicely; nonetheless in certain defects of the immune system it loses the discrimination between self and non-self. Subsequently immune responses are raised against self-antigens, which lead to autoimmune diseases (Gupta et al., 2016). So the immune system is very significant for us; this was understood primarily by the early work of scientists. These scientists were the first to recognize the ability of the normal immune response to work against various potential pathogenic agents, laying the foundation of immunology. Due to the continuous evolution of new strains, microbes are always of health risk to human kind. Cross resistance to all classes of antibiotics is emerging with every kind of microbes. Hence it has severe clinical consequences. Reemergence of diseases which were thought to be eradicated like tuberculosis and cholera, which were highly communicable, and rheumatic fever diseases which occur most prominently in economically backward countries. The reemergence and new pathogenic agents of these diseases and newer diseases are probably based on some changes in the environmental or genomic mutations in these agents, which were not previously recognized, either singly or in combination. The immune response occurs after the pathogen gains entry into the host body. The immune system recognizes the pathogen and responds accordingly. Thus, the sequence is infection, recognition, response, and elimination. After entry, the pathogen interacts with various components including nutrients, temperature, and pH. Finally it establishes itself inside and then the immune system of the host recognizes it. Subsequently, the effector response against the pathogen is given. This response eliminates the growth of the pathogen. There are two kinds of immune responses: innate immune response and adaptive immune response. The self-/non-self-recognition is the hallmark of the immune response. The innate immune system recognizes and responds to the pathogen in a non-specific way. However, the adaptive immune system recognizes specifically, and the response against the pathogen is mediated by some specialized responses, so that the immune system remembers the pathogen for the second exposure. This is where the immune responses are generated against the new antigen(s). In the study of immunology, attention is given to the immune system responses against a variety of pathogenic agents. Medical microbiology is the comprehension of mild and extreme infectious agents. These agents comprise the bacteria, fungi, parasites, viruses, and prions, and the diseases that are created by these agents are infected surgically. Pathogens pertain to those organisms that are obligate parasites and essentially do not have a significant impact on the destructor host. The impact of the pathogen on the host is frequently addressed to the pathogenesis. There are broad categories of pathogenesis. Opportunistic interactions are the kind that arise in response to defects in the process host immunity. Some organisms are usually very non-pathogenic under healthy terms, but if the immune system

of the host is weakened, these very similar agents create infections. Subsequently there are a range of bad strains of a particular organism and maintain it burdocks. Resent war of these things intensively in the host and lead to clinical consequence.

4. Common Infectious Agents and Diseases

Infection is the invasion of a host organism's bodily tissues by disease-causing agents. Infections can cause diseases, symptoms, carriers of diseases, nonhuman carriers, and immune or vaccinated carriers. Infection can be caused by a variety of infectious agents, which may also be called pathogens. Infections are caused by infectious agents including viral, viroid, bacterial, nematode, arthropod, protozoan, and prion agents. Pathogenicity is the potential disease-causing capacity of pathogens. The first colonists of the body when a new host is encountered often cause infections, as they are inadequate to protect the body against infection.

There are a number of common infectious agents in our environment that can cause very severe diseases. These include Influenza caused by an RNA virus. Methicillin-resistant Staphylococcus aureus is a bacterium that causes skin infections, enterocolitis, and osteomyelitis. The severe human disease called dengue, or "breakbone fever", is caused by the dengue virus, of which there are four types; the disease is spread by mosquitoes and is the most important arboviral disease in humans. Recently there has been the rare fatal disease, Creutzfeldt–Jakob disease, which causes brain damage due to an infectious protein called a prion. Bounds with the disease-associated form of the prion are able to convert normal proteins into the misfolded cell-killing form of transmissible spongiform encephalopathies. (Soni et al., 2023)(Dehghani and Kassiri2021)(Marinho et al.2022)

5. Impact of Infections on Human Health

Infections are a self-replicating parasite which can cause damage at cellular level, hence tissue, organ and organism level. A family of virus, bacteria and fungi cause infection in the human body. Some infections can be suppressed by blocking the activity of enzymes or genetic information replication. Parasites are eukaryotic pathogenic agents invade into the body by forming cysts or spores, becoming encysted or thick wall sacs. This spore-forming bacterium cause severe headache, vomiting and fainting in a healthy person. The prevalence of parasitic diseases is usually dependent on eating poor hygiene food. Infections that go untreated become acute and spread quickly where the host body producing antibodies to fight the invader. The leukocytes, WBCs (White Blood Cells), elevates to kill the infectious agents, mentioning disease to cure and keep away from contagious patients (M. Morens et al., 2004). Some infections can create serious illness which produces toxins in the host body. R.N.A virus can impair the genetic information of the host body. Anti-Viral drugs are used to inhibit the repeating process of infection in the host body. Drug allergies are caused in the host body due to the chemicals present inside the antibiotics, antipyretics or analgesics. “Motility is the property of an organism to move itself or its parts”. Infectious agent has the property of motility to move from the host body to outside environment and new environment to host body. The pathogenic agent can enter or invade the host body through wounds, cuts, bruises, bite wounds, puncture wounds, etc. A large number of compounds are chemotactic for many different groups of bacteria at lower concentration; addition of a chemo-repellent to a preexisting chemo-attractant gradient can either temporarily or permanently cause bacteria to reverse direction. At larger dose, they inhibit chemotaxis; while most chemorepellents interfere in the detection or processing of stimuli controlling chemotaxis. Chemo-attractant such as maltose or aspartate is bound by periplasmic binding proteins, which then hinders association of the chemoreceptors with the CheA protein. The seven-transmembrane-helix protein Tsr, one of the aspartate receptors in bacteria, generated a version of Tsr that was truncated a single residue from the C terminus and constitutively active. Silent mutations, those changing a nucleotide without impeding the amino acid sequence, effectively "tune" the receptor protein so that it is able to form stable complexes even when the usual signals are absent; as a result, the response regulator and flagellar motors are frequently at the basal, low-energy state.

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