

Infectious Diseases, Past, Present and Future

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Introduction

To keep this essay brief yet relevant, I will concentrate on infectious diseases in Australia, going global only for the period since World War II. First, however, we need to consider when causes and cures of infectious diseases were discovered.

Important Discoveries: the Causes of Infectious Diseases

For most of recorded history the cause of infectious diseases was a mystery. It was not until the ground-breaking discoveries of Louis Pasteur and Robert Koch in the 1860s that it was realized that many infectious diseases were caused by bacteria. Thirty years later, use of Pasteur-Chamberland filters, which held back bacteria, demonstrated that other infections were caused by much smaller objects, later called viruses. Other infectious agents included rickettsias, fungi, protozoa, and nematodes; several species in each of these groups cause disease in humans.

Important Discoveries: Prevention and Treatment of Infectious Diseases

In 1854, when cholera was still attributed to a miasma, John Snow founded the science of epidemiology by demonstrating that "the cholera poison" was distributed widely by the Broad Street pump, which drew sewage-polluted water from the River Thames. Then, a hundred years after Edward Jenner had, in 1798, demonstrated that inoculation with cowpox virus provided protection against smallpox, vaccines were developed against typhoid fever, cholera and plague, followed in the early twentieth century by vaccines against yellow fever, pertussis, influenza and typhus. Several other vaccines have been developed since, an enormous effort is being made to produce vaccines against malaria and HIV.

Effective treatment of compound fractures and other localized infections was initiated by Joseph Lister in 1864 by the use of carbolic acid as an antiseptic. However, it was not until the 1940s that Howard Florey converted the serendipitous discovery of the antibacterial properties of penicillin into practical reality that the antibiotic era was initiated, with control of many bacterial diseases.

Infectious Diseases in Hunter-Gatherer Societies

It is impossible to say, with any certainty, what infectious diseases occurred amongst hunter-gatherers before contact with humans who had experienced the agricultural revolution. The best information, and it is largely guesswork, comes from a consideration of infectious diseases amongst Australian Aboriginals before 1788. One can say, with confidence, that hunter-gatherers would have been infected from time to time with whatever arboviruses that cause disease in humans occurred in the areas where they lived. Some 75 arboviruses have been isolated in Australia. Only half a dozen of these cause human disease, the most important being Murray Valley encephalitis virus, Ross River virus and Kunjin virus. Since malaria has long been present in New Guinea, which was connected by land with northern Australia when Aboriginals arrived some 50,000 years ago, it was also very likely to have been brought to northern Australia, where vector *Anopheles* mosquitoes have long been present. Other vector-transmitted diseases that occurred amongst Aboriginals, most commonly in northern Australia, include three different rickettsial diseases (North Queensland tick typhus, scrub typhus and Q fever), and a nematode transmitted by mosquitoes, filariasis.

However, because the population numbers in different tribes were so small, none of the infectious diseases common in Europe in the eighteenth century; diphtheria, measles,

scarlet fever, whooping cough, smallpox, tuberculosis and probably chickenpox, were endemic among the Aboriginals, although smallpox was introduced several times into northern Australia by Macassan trepang fishermen between about 1720 to 1860. Evidence from bones suggests that two treponemal diseases were present before 1788, yaws in the humid north and 'irkinjtja' (treponarid), a non-venereal disease, in the southern part of Northern Territory. One interesting finding in the 1960s was the widespread occurrence of hepatitis B virus, which is spread by intimate postnatal contact between mother and child and can persist for life and be maintained in very small populations, causing hepatitis in adult life in some of those affected.

Trachoma has long been common among Aboriginals; the early English explorer, William Dampier, mentioned seeing Aboriginals on the north-west coast in 1688—89 who "had such bad eyes that they could not see us till we came close to them".

Infectious Diseases after the Industrial Revolution in the Nineteenth Century

Apart from nutritional problems, infectious diseases were by far the commonest diseases of humans in the industrialized countries in nineteenth and early twentieth centuries, as they are now among the poor in developing countries. They covered the full range of infectious diseases except those limited to tropical countries. To get an idea how Australia was developing then, as a number of British colonies, Sydney was established in 1788, within the colony of New South Wales, Hobart, in Van Diemensland, in 1803, Perth, in Western Australia, in 1829, Adelaide, in South Australia, in 1836 and Brisbane and Melbourne, still within the colony of New South Wales, in 1824 and 1835 respectively. Because of the relatively small numbers of children and the length of the voyages from Britain, none of the common infectious diseases of childhood occurred in the colonies until many years after the arrival of the First Fleet.

Among specific diseases, the first death from diphtheria, which had been unusually common and severe in England in 1858, was reported in Melbourne in October 1858 and it was the cause of death of 280 children there in 1859 and 636 in 1860. It appears to have been imported into Tasmania in 1859 and Western Australia in 1864, but whether from England or another Australian colony is impossible to say. The first definite case of scarlet fever was reported in Tasmania in 1833, with cases in Victoria and New South Wales in 1841, Queensland in 1858 and South Australia in 1859. Whooping cough was introduced into Sydney in 1828, and was very prevalent in Tasmania in 1833, whence it was transferred by a military detachment to Perth and was common there in 1848. Measles was introduced into Victoria in 1850, and spread to New South Wales the same year and to Tasmania in 1854. Influenza was recorded in Sydney for the first time in 1820, when a virulent epidemic attacked both Europeans and Aboriginals. Thereafter there were epidemics in Sydney in 1826 and 1836, and in Sydney, Melbourne and Hobart in 1847, coinciding with years of world prevalence of the disease.

As clean water, the proper handling of sewage, antisepsis, and the use of vaccines and antibiotics became available over the next century, they were immediately applied to the control of infectious diseases in Australia, with the result that by the mid-1950s such diseases were of minor importance to the white population of Australia, although not amongst Aboriginals.

The first discoveries of world-wide significance made by Australian scientists were the discovery of the adult worm of *Filaria bancrofti* by Joseph Bancroft in 1876 and the demonstration of its development in mosquitoes by his son, Thomas Bancroft, who also suggested, for the first time, that *Aedes aegypti* was the probable vector of dengue. Then,

around the turn of the century, bubonic plague broke out in Sydney and Brisbane, and Frank Tidswell, Ashburton Thompson and Burnett Ham made some astute observations on the role of fleas in its epidemiology. In 1918 J.B. Cleland, later Professor of Pathology in the University of Adelaide, isolated the virus of "X disease", an arbovirus later known as Murray Valley encephalitis virus, from the brains of fatal cases obtained after an outbreak in New South Wales.

In the latter half of the nineteenth century bacterial intestinal diseases in Australia had the same patterns of morbidity and mortality now seen on Third World countries. Deaths from typhoid fever were in excess of 50 per 100,000 per annum, cholera cases were not infrequent and few people escaped the unpleasant, sometimes life-threatening consequences of bacillary dysentery and salmonella gastroenteritis. Between 1900 and 1950 the incidence of these diseases declined dramatically, due primarily to better education and increasing affluence which led to clean water supplies, effective sewage and waste disposal and improved housing, together with an increasing awareness of the importance of personal hygiene and the value of community-funded health facilities.

In 1915 a donation from Walter Hall, who had made a fortune from gold mining at Mount Morgan, was used to set up the Walter and Eliza Hall Institute, which rapidly became, and continues to be, 90 years later, the outstanding medical research institute in Australia. It really did not get going until Charles Kellaway became Director in 1923 and in 1928 appointed F.M. Burnet, who was to become the most innovative and brilliant biological research worker in Australia, as a full-time research worker. Initially he worked on bacterial viruses, then on animal virology and eventually on immunology.

The 1930s saw the development of effective microbiology laboratories in most large hospitals and the expansion of Departments of Microbiology in the universities. Initially building on discoveries made in the northern hemisphere, these led to greatly improved diagnosis and later to real advances in the understanding of bacterial and later viral diseases. In 1941 Norman McAlister Gregg, an ophthalmologist, discovered the teratogenic potential of rubella virus, a discovery described by Burnet as "the most important contribution to medicine ever made in Australia."

The Second Half of the Twentieth Century

With accelerating pace, this period saw unprecedented advances in science and technology, great increases in wealth in the 'Western' industrialized countries, great increases in air traffic all over the world and the advent of globalization. Although deaths from infectious diseases, particularly of children, remained and remains high in the developing countries, the global population continued to expand, from 360 million in 1900 to 2.5 billion in 1959, 6.2 billion in 2000 and an expected 8 to 9 billion in 2100. Industrialization, air pollution and greenhouse gases continue to expand, with dire warnings about global warming and gross overuse of resources. Especially in Africa and Asia, there is ever-increasing pressure of expanding populations on remnant forest areas, leading to increasing contacts between humans and other animals, with the appearance of what are called "emerging" diseases. A great advance in curative medicine for bacterial diseases was initiated with the development of penicillin in the early 1940s, but now we are seeing, increasingly, a "re-emergence" of various bacterial diseases due to antibiotic resistance. The classical emerging viral disease is HIV-AIDS, first impacting on public consciousness as a disease of homosexual men in the United States in the mid- to late-1970s. It is now the most common and widespread lethal infectious disease in the world, although control in Australia has been remarkably good.

The term "emerging viruses" became widely used after a conference with this name organized in Washington by Joshua Lederberg in 1989. It is estimated that some 35 viral diseases of humans discovered during the last twenty years fall into this category. In 1995 the Center for Disease Control and Prevention (CDC) initiated the production of a peer-reviewed journal, *Emerging Infectious Diseases*, initially (1995—98) quarterly, then every two months (1999—2001) and since 2002 monthly. This is free on the web and paper copies are distributed free to interested scientists world-wide.

The Future

During the last decade or so it has come to be accepted that human health world-wide cannot be separated from the health of the rest of the biosphere, or indeed from the "health" of the inanimate environment. With the reality of global warming, resource destruction and growing population, contact between wild animals and humans is going to increase. Every domestic animal that has been adequately studied is host to viruses of between 10 and 28 different genera (and some of these containing at least that number of antigenically different species). There is no reason to think that wild animals are any different, and with ever-increasing contacts between human and wild animal populations more emerging viral infections are inevitable.

With bacterial diseases we are becoming aware of the myriad of ways by which resistance genes can be transferred from one microorganism to another, for example with MRSA and *Escherichia coli* O57, to know that this is what the future has in store for us. The other feature of the modern world, and the future, unless shortage of fuel interferes with air transport, is the fact that any disease transferred from one person to another via the respiratory tract can spread around the world in a matter of days. Influenza is a bird virus with a genome consisting of eight pieces of RNA; its infectivity depends on one of the surface proteins, the haemagglutinin. RNA viruses undergo much more frequent mutations than DNA viruses, and in addition, the eight genome fragments can re-assort, the phenomenon that caused pandemics in 1957 and 1968. So far, of the 15 different haemagglutinins found in wild birds only three (H1, H2 and H3) are able to pass from one human to another via the respiratory tract. Currently there is great concern that a strain of influenza virus that is unusually virulent for a wide range of different birds, and occasionally infects children, may acquire the ability to spread readily from one person to another via the respiratory tract, either by continuing mutation of its haemagglutinin (H5) or by reassortment. With the enormous increase in intercontinental air travel such a virus would cause a severe pandemic.

Further Reading

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