epiTRENDS

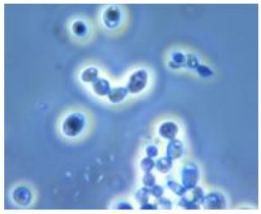
A Monthly Bulletin on Epidemiology and Public Health Practice in Washington

June 2020 Volume 25, Number 6

Microbiology and Public Health

The recognition and study of the microscopic causes of human illnesses has occurred only in the past two centuries. Other explanations for disease sometimes led to successful public health actions, but targeted interventions were limited until until a full understanding of microbiology developed.

Development of Microbiology



Brewer's yeast (CDC)

Humans were able to make use of certain microorganisms with no awareness of their existence. Yeast fermented foods such as wine and cheese, as well as yogurt and bread, millennia before the agents and processes involved were known.

Disease classification also lagged in the absence of scientific interpretation. An unusual disease such as rabies was clearly recognized long before its viral nature was understood and specifically linked with animal bites. Other less unusual diseases were lumped by major symptoms, described simply as a fever or rash. Some such as leprosy were attributed to the individual person being sinful or evil and led to rejection of affected persons. During times of bubonic plague the blame might be laid on outsiders or marginalized populations.

In the past, many diseases seemed to occur more commonly in areas with unpleasant smells or vapors, resulting in the miasma theory which connected swamps and polluted rivers to areas with higher rates of certain diseases, including conditions now known as malaria and enteric infections. Draining swamps and cleaning contaminated areas, along with providing access to safer drinking water and hygiene facilities, did reduce disease levels; the burning of pungent material to chase away miasmatic smells was ineffectual. John Snow determined that an outbreak of cholera in London in 1854 was associated with a particular public water pump, but the causative agent for cholera remained unknown.

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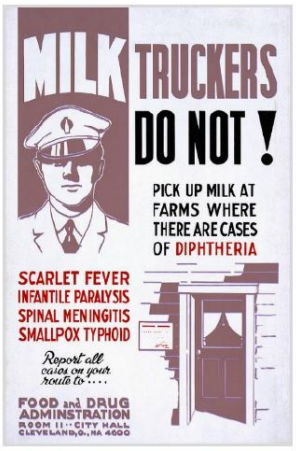
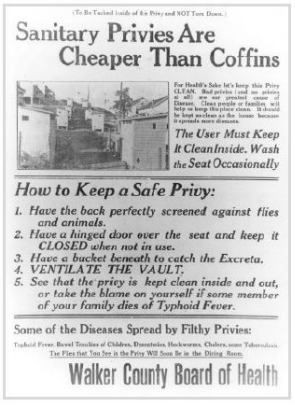
The first documentation of microscopic life is attributed to Antonie van Leeuwenhoek, who in 1676 observed and recorded what he called 'animalcules'. About a century later, researchers including Louis Pasteur identified microorganisms as the causes of the souring of wine and milk. A classification scheme for bacteria was devised by Ferdinand Cohn based groups on shapes (sphere, rod, thread, or spiral). In 1876, Robert Koch found that anthrax isolated from the blood of infected cattle could infect other animals, linking a specific agent to a specific disease. With an agent-disease link established, it became possible to conduct focused surveillance and public health interventions.

Laboratory Support for Public Health

A scientific system that supported testing for and identifying infectious agents could support public health disease surveillance, treatment, and prevention measures. Tracking communicable disease depends on standardized collection of information including diagnostic criteria with supportive laboratory and clinical testing. Today's notifiable conditions case definitions are highly dependent on diagnostic testing for confirmation, with only a few exceptions such as shellfish poisoning, paralytic poliomyelitis, and tickborne paralysis which do not involve any laboratory criteria for the case.

Prevention measures addressing actual or suspected transmission of some infectious agents expanded with improved understanding of microbiology. The public health recommendations that developed during the 20th century ranged widely, and included increasing general sanitation, antisepsis during surgery, pasteurization of milk, and testing water for coliform bacteria. Control of diseases such as typhoid fever depended on the ability to culture and detect asymptomatic chronic infections. Requirements for cultures prior to returning to food preparation work or to childcare settings continue today as a public health intervention for several enteric infections such as shigellosis and STEC.





Public health interventions of social distancing, closure of businesses and other gathering places, case isolation, and contact quarantine may have had some impact on reducing the disease burden during the 1918-1919 influenza pandemic. The measures were taken for what was recognized as respiratory transmission even though the specific agent itself had not yet been identified. Several incorrect hypotheses were developed about the lethality of that influenza pandemic including attributing severe illness to one mistaken bacterial candidate that still carries the name *Haemophilus influenzae*.

YEARS	TUBERCULOSIS*			
	CASES REPORTED	RATE PER 100,000 POP.	DEATHS REPORTED	RATE PER 100,000 POP.
1920	999	73.2	1,314	96.3
1921	1,150	83.0	1,127	81.3
1922	1,593	113.3	1,079	76.3
1923	1,835	128.7	1,083	75.9
1924	2,202	152.2	1,060	73.3
1925	1,729	117.9	1,176	80.2
1926	2,074	139.4	1,114	74.9
1927	1,986	131.7	1,050	69.6
1928	1,982	129.7	1,056	69.1
1929	2,108	136.1	1,034	66.8
1930	1,982	126.8	912	58.1
1931	1,876	118.4	994	62.8
1932	1,650	103.3	846	52.9
1933	1,555	96.5	857	53.2
1934	1,544	94.9	774	47.5
1935	1,659	101.3	833	50.9
1936	1,789	108.6	822	49.9
1937	1,569	92.6	768	45.5
1938	1,462	85.5	692	40.6
1939	1,589	92.1	693	40.2
1940	1,647	94.5	665	37.9
1941	1,777	97.8	?	?
1942	1,557	82.8	674	35.8
1943	2,012	103.4	?	?
1944	2,204	109.6	214	10.6
1945	2,752	132.7	147	7.1
1946	2,299	107.6	?	?
1947*	2,564	116.4	113	5.1
1948	2,886	127.3	108	4.8
1949	2,703	115.9	?	?
1950	2,095	88.1	308	12.9
1951	1,691	69.2	285	11.7

Annual Report of Communicable Diseases and Deaths – State of Washington 1920-1982

Although communicable disease surveillance data in Washington date back a century, the quality of data collected during early years is uncertain for conditions such as tuberculosis. However, it is clear that the disease caused considerable mortality which spurred research and public health activities. By 1882 Robert Koch had identified the agent *Mycobacterium tuberculosis* and within a few years the first laboratory stains detecting the organism became available. These discoveries supported screening methods for pulmonary infection, isolation of patients, development of an injectable test for latent tuberculosis by 1907, the first tuberculosis vaccine in 1921, and two decades later development of effective therapeutics.

Until testing methods develop to address public health concerns, surveillance and intervention into communicable disease control may lag for a particular condition. Diseases such as acute hepatitis were difficult to track without the development of diagnostic serology tests able to distinguish the different types. Hepatitis A was termed “infectious hepatitis” because of known waterborne and similar outbreaks, while transmission of hepatitis B from transfusion of contaminated blood products resulted in the label “serum hepatitis.” The category non-A, non-B hepatitis comprised mainly hepatitis C but also hepatitides D and E until tests became available for those agents. The first report of HIV infection was in 1981, but it took three years for the virus to be identified and another year for a serologic test to be developed to assist with diagnosis and reporting.

Increasingly sophisticated testing has improved the ability to detect agents and outbreaks. There was no rapid strain typing available in 1993 during the large Shiga toxin-producing *E. coli* outbreak in Washington associated with hamburgers. Pulsed field gel electrophoresis (PFGE) became available soon after that outbreak, and became the major tool to identify outbreaks. PFGE was recently replaced by whole genome sequencing to characterize strains of an organism more precisely. Such advanced diagnostic methods were available with the emergence of a new viral agent in 2019 which was rapidly identified as a novel coronavirus named SARS-CoV-2.

Additional communicable disease agents are likely to emerge in the future. Public health agencies will be expected to respond rapidly. Prompt access to diagnostic tests will support surveillance, investigation, and intervention actions for disease control.