

Immunizable Disease Occurrence and Prevention in Seattle

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WITH the excellent antigenic materials now available a person and entire communities can be provided with virtually complete protection against historically important diseases such as smallpox, diphtheria, pertussis, tetanus, and poliomyelitis. Why, then, is immunization with these antigens incomplete? Why isn't everyone immunized?

The answer is complex and varies by time, place, person, and antigen. Obviously, because of great cultural differences and varied experiences with disease the extent of application of immunization differs greatly by country. Less obviously within the United States, the extent differs by State, county, city, and neighborhood according to community origins, experience with disease, intelligence, education, wealth, and availability of immunization from public and private sources. But even under the best of circumstances in many of this country's most progressive communities, many people remain unimmunized. Why?

During recent years the authors and their co-workers have devoted considerable effort toward answering this question and toward im-

provement of the immunization status and programs of the Seattle-King County community. Therefore, this report of related findings and activities may be of value to others who are similarly engaged.

Methods

A first vital step toward improvement of anything is an accurate assessment of its current status, and though one should be able to achieve fairly accurate knowledge of a community's immunization status by examining its records on occurrence of disease and immunization activities, in most communities, as was true in Seattle, one would search in vain for thorough and readily useful records of these events.

To rectify gross defects in a community's public health records is at first an onerous but ultimately a satisfying task. Pertinent records usually are incomplete and scattered, and it is a laborious task to assemble fragmentary data from diverse sources. But by combining data from death records, routine and special reports of local and State health departments, and the daily newspapers, one can construct a useful record of disease occurrence and immunization activities, especially for recent decades (1).

Background of Immunizations

Initially, after this community was founded in 1851, problems pertaining to the occurrence of communicable disease were handled by one or more private medical practitioners. But because of a rapid increase in the population of

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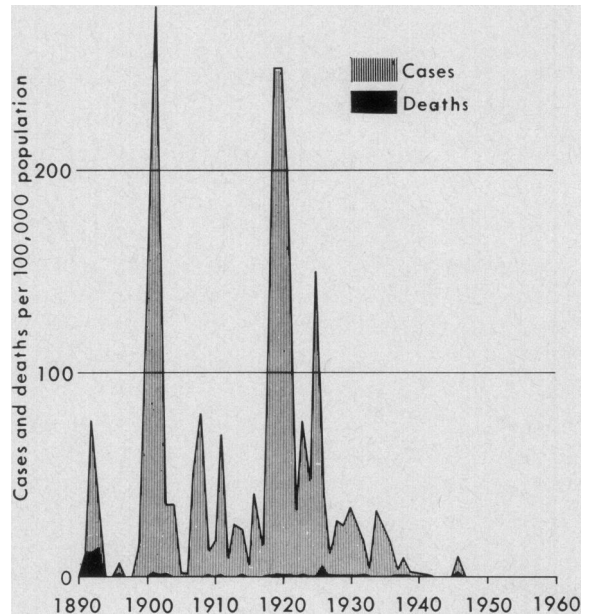
the community and therewith in its health needs, the first of many health ordinances was passed in 1872. The Seattle Board of Health was empowered to "contract with some competent physician to vaccinate all persons who in his opinion require it." In August 1872 the first health officer of Seattle, Dr. G. A. Wood, was paid \$111 for vaccinations that he had performed—the first recorded immunizations and probably the first expenditure for organized public health work in this community (2). During the 1870's and 1880's, public immunization activities by Seattle health officials consisted of an unknown number of smallpox vaccinations given school children, travelers, and others, especially whenever smallpox occurred in Seattle or in nearby communities.

Smallpox. The most severe smallpox epidemic in Seattle (37 deaths per 100,000 residents) occurred in 1888. However, a prolonged epidemic from June 1892 to February 1893, with 84 cases and 19 deaths (fig. 1) caused a greater official reaction. About 10,000 persons were vaccinated at the city's expense. A total of 490 persons in 19 dwellings were quarantined, and a hospital for the care of smallpox and other contagious diseases was established. Many of the smallpox victims during 1892 were railroad employees, and during January and February 1893 the health officer or his assistants met all "boats, ferries, and trains, and inspected all passengers for smallpox as an emergency measure. All persons unable to show evidence of recent vaccination were vaccinated and, likewise, all persons living in lodging houses were either vaccinated or the house closed" (3).

In 1899 the Seattle School Board adopted a regulation requiring all children to show satisfactory evidence of vaccination before entering school. Such compulsory vaccination was practiced to a variable extent until 1919, when anti-vaccinationists succeeded in enacting a State law making compulsory immunization illegal.

Abolition of compulsory immunization was followed by a decrease in the proportion of vaccinated children. In 1935 only about 40 percent of elementary school children had ever been vaccinated, and the persistence of variola minor during most of the first half of this century and the occurrence of epidemics of variola major in 1926 and 1946, approximately 150 years after

Figure 1. Smallpox cases and deaths per 100,000 population, Seattle-King County, Wash., 1890–1960



Jenner's discovery of an excellent immunizing agent, are indicative of persistent defects in public health leadership and practice. But with time, education, and persuasion, the acceptance of vaccination has greatly improved.

Although complete success in preventing smallpox in the Seattle-King County community since 1946 is no doubt especially the result of thorough vaccination of international travelers, additional protection has been attained by the routine vaccination of a large proportion of the children, and special vaccination programs for certain occupational groups such as military trainees and workers in hospitals and airports, who would be likely receptors and propagators of imported smallpox if they remained susceptible.

Although annual school immunization programs ordinarily produce a moderate number of undesirable events, such as contact vaccination of siblings and playmates with eczema and occasionally some spread of the vaccination to other parts of the body, no definite instances of encephalitis or death from such vaccination has been observed in this community among the several hundred thousand persons vaccinated during the last decade. Smallpox vaccination

remains an imperfect procedure, but as long as endemic foci of the disease exist anywhere on this earth it probably would be premature to discontinue the routine vaccination of children. The public body possesses enormous inertia, and it was only after many decades of professional and public education that the vaccination of virtually all children in this community was achieved. Now it remains essential to maintain this hard-won vaccination momentum by continuation of sound vaccination programs, at least until worldwide eradication of smallpox has been achieved.

Diphtheria. Coincidental with the Alaska Gold Rush in 1898, diphtheria attained a peak mortality rate of 62 deaths per 100,000 residents (fig. 2). At that time diphtheria was a major scourge of childhood, as can be seen in the following item from the *Seattle Post Intelligencer*, October 11, 1898:

DIPHTHERIA PURSUES A FAMILY. Bessie M. Coates, the 2-year-old daughter of Mr. and Mrs. Frank Coates, died at South Park Sunday of diphtheria. This dread disease has nearly destroyed the family. Virde Coates died September 30 and Jessie Coates, September 24. A nephew of Mrs. Coates is now ill with the same disease. Two of the Coates children have just recovered. Mr. Coates is in Alaska.

A rapid increase in Seattle's population, from 110,053 residents in 1900 to 284,638 in 1910, accompanied and followed the rush to the Alaska goldfields. This great immigration and improved reporting of disease resulted in a recorded peak diphtheria morbidity of 268 cases per 100,000 residents in 1908. Subsequent major waves of diphtheria coincided with the unusually great immigration and travel associated with World Wars I and II.

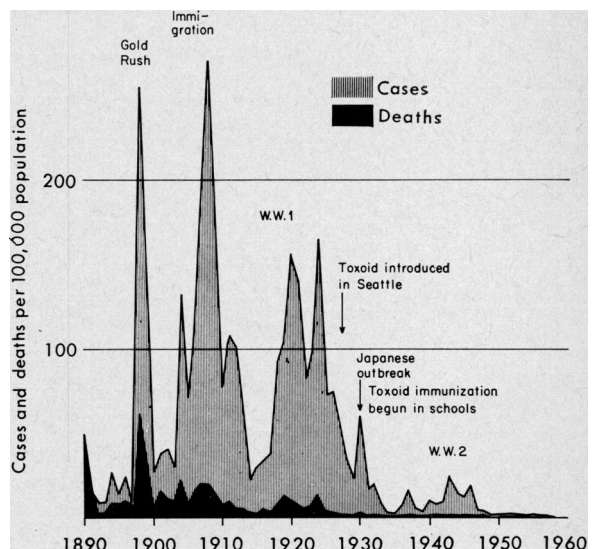
Diphtheria antitoxin, introduced during the 1890's, caused little change in morbidity and mortality from diphtheria, and toxin-antitoxin, introduced about 1922, was not used much in this community. However, the advent of diphtheria toxoid in 1927 made possible the general substitution of artificial active immunization for the naturally occurring diphtheria infection and disease.

In 1931, in response to an outbreak of diphtheria especially among Japanese children (fig. 2), a continuing annual program of immunization was started in the schools, and each

year since has been an important component of the health department's total immunization activities. Yet three decades elapsed from the introduction of diphtheria toxoid until it was applied sufficiently to entirely prevent diphtheria in this community.

As elsewhere in the United States, diphtheria continued to be a cause of illness and death among adults in Seattle after it had largely ceased to be a problem among the children (fig. 3). Some epidemiologists have attributed the extended occurrence among adults and the shift in median age distribution of cases and deaths as indicating an increasing problem of diphtheria among adults—supposedly because of waning immunity due to decreased repetitive natural experience and little artificial experience with diphtheria antigen. For this reason a small amount of diphtheria toxoid has been combined with tetanus toxoid, and the combination (adult DT) is often recommended for reimmunization of adults. However, it now seems evident that the shift in the median age distribution of diphtheria during the 1950's was but a manifestation of the decreased occurrence of diphtheria among children, the main recipients of the vaccine, and the straggling occurrence of diphtheria among skidroad and other pockets of susceptible, never-immunized adults.

Figure 2. Diphtheria cases and deaths per 100,000 population, Seattle-King County, Wash., 1890–1960



During the last decade especially, the immunity status of adults in the community has improved because of the durable effects of toxoid immunization in childhood. Furthermore, thorough immunization of children with diphtheria toxoid has achieved virtual eradication of the causative organism from this community, as indicated by the prolonged absence of diphtheria from the small proportion of residents who have never been immunized and by the absence of *Corynebacterium diphtheriae* from the many thousands of throat cultures examined by the Seattle-King County Health Department yearly. Both local and national diphtheria patterns during the last two decades indicate that if a person is thoroughly immunized with diphtheria toxoid during childhood he is ordinarily adequately protected for life, especially if he resides in a well-immunized community.

Pertussis. Pertussis continued to be a prevalent cause of childhood illness and a not infrequent cause of infant death until after World War II (table 1). Since then the combined

effects of preventive use of pertussis vaccine (killed organisms) and, to a much lesser extent, the therapeutic use of antibiotics has virtually eliminated both morbidity and mortality from pertussis in Seattle. During the last 15 years, only one death has been ascribed to pertussis in this community, although hundreds of cases have been recorded. Many of these cases of severe and prolonged bronchitis, reported as whooping cough during recent years, probably were not caused by *Bordetella pertussis*.

It is known that the thorough application of pertussis vaccine was delayed, especially because pediatricians and others were apprehensive concerning the possibility that the vaccine might cause encephalopathy (4). For this reason pertussis antigen was omitted from the annual school immunization program during the mid-1950's, until additional knowledge of its safety accumulated and opposition to its use waned, and until the investigation (by H. F. Newman, M.D.) of an outbreak of pertussis in 1958 among poorly immunized children in a lower socioeconomic neighborhood and school

Figure 3. Diphtheria mortalogram, Seattle-King County, Wash., 1890-1960

YEAR	Age	0-1	1-4	5-9	10-14	15-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+	TOTAL DEATHS BY SEX	TOTAL DEATHS	DEATHS PER 100,000 POPULATION AT RISK		MEDIAN AGE AT DEATH
																	BY SEX	TOTAL	
1890	M		4	7	2	1									14	28	35.0	43.8	6.0
	F	1	7	3	1	1									14		57.8		
1895	M		1	1	1										3	6	6.1	7.7	5.0
	F	1	1	1											3		10.4		
1900	M							2							5	5	7.0	4.5	3.0
	F	2	1																
1905	M			3	1	3			1						9	15	7.3	7.4	10.0
	F	1		4	2										6		7.6		
1910 ¹	M		4	3	2	1				2					13	21	7.8	7.3	7.5
	F	1	2	3	2										8		6.6		
1915	M							1							1	7	0.6	2.2	12.5
	F	1		2	1		1	1							6		4.3		
1920	M		13	7	3	2				1					26	44	12.0	11.2	5.7
	F		6	7	5										18		9.8		
1925	M		3	4	1					1					10	16	4.5	3.8	5.0
	F	1	3	1	1										6		2.9		
1930	M		4	4		1									9	12	3.8	2.6	6.0
	F		1	1					1						3		1.3		
1935	M			1											2	2	0.8	0.4	5.0
	F		1																
1940	M							1				1			3	4	1.2	0.8	30.0
	F						1								1		0.4		
1945	M		2				1	1	1	2					7	12	2.2	1.9	40.0
	F		1		1					1	2				5		1.6		
1950	M																		
	F																		
1955	M						1	1	2						4	5	0.5	0.6	35.0
	F			1											1		0.1		
1960	M																		
	F																		

¹ Registration of deaths in King County, outside of Seattle, incomplete before 1908.

SOURCE: From review of all death records for indicated years.

in King County re-emphasized the need for use of the pertussis antigen in the school program.

Since then, although pertussis immunization has been more thoroughly applied, a substantial number of cases have been recorded each year

Table 1. Pertussis in Seattle-King County, Wash., 1916-64

Year	Number cases	Number deaths	Morbidity rate ¹	Mortality rate ¹
1916	1,672	17	481.3	4.9
1917	1,158	16	323.6	4.5
1918	422	11	114.6	3.0
1919	690	21	182.2	5.5
1920	709	19	182.1	4.9
1921	833	9	210.0	2.3
1922	864	12	213.8	3.0
1923	1,150	15	279.5	3.6
1924	194	3	46.3	.7
1925	1,967	30	461.3	7.0
1926	355	10	81.8	2.3
1927	787	12	178.4	2.7
1928	460	7	102.5	1.6
1929	1,642	14	360.0	3.1
1930	776	2	167.4	.4
1931	1,908	11	407.9	2.4
1932	285	3	60.4	.6
1933	753	2	158.2	.4
1934	2,059	8	428.9	1.7
1935	197	3	40.7	.6
1936	284	2	58.1	.4
1937	1,421	8	288.5	1.6
1938	1,900	5	382.5	1.0
1939	320	1	63.9	.2
1940	1,019	5	201.8	1.0
1941	1,699	6	321.9	1.1
1942	1,194	1	216.8	.2
1943	783	4	136.6	.7
1944	412	1	69.1	.2
1945	506	1	81.7	.2
1946	609	3	94.9	.5
1947	458	0	68.9	-----
1948	433	3	63.0	.4
1949	246	0	34.6	-----
1950	679	0	92.6	-----
1951	165	0	21.9	-----
1952	40	0	5.2	-----
1953	154	0	19.4	-----
1954	360	1	44.2	.1
1955	220	0	26.4	-----
1956	56	0	6.6	-----
1957	69	0	7.9	-----
1958	354	0	39.6	-----
1959	167	0	18.2	-----
1960	49	0	5.2	-----
1961	55	0	5.8	-----
1962	179	0	18.6	-----
1963	77	0	7.9	-----
1964	16	0	1.6	-----

¹ Per 100,000 population.

until 1964. But during 1964, when a particular attempt was made to verify the clinical and epidemiologic validity of each reported diagnosis, only 16 cases qualified for acceptance of the diagnosis, according to Dr. Donald Peterson, now director of the epidemiology and communicable disease division, Seattle-King County Health Department. If specific identification of *B. pertussis* also were required for each diagnosis, one might now experience difficulty in demonstrating the presence of this disease in the community.

Tetanus. Tetanus never has been an important cause of illness or death in the Seattle-King County community. Only six cases and one death from tetanus are known to have occurred in the community during the last decade. Throughout this century, the occurrence of tetanus has been remarkably sparse and scattered (fig. 4), and there is no record of epidemic occurrence of neonatal or wound tetanus in Seattle such as has occurred elsewhere (5, 6). As with diphtheria, thorough immunization of all children during infancy and at the time of entry to school will expectedly provide the community with virtually complete pro-

Figure 4. Tetanus mortalogram, Seattle-King County, Wash., 1890-1960

YEAR	AGE	0-1	1-4	5-9	10-14	15-19	20-29	30-39	40-49	50-59	60-69	70+	TOTAL DEATHS
1890	M												0
	F												
1895	M	1	1										2
	F												
1900	M							1					1
	F												
1905	M				1								1
	F												
1910	M												1
	F						1						
1915	M						1						1
	F												
1920	M	1									1		3
	F							1					
1925	M		1				1						3
	F		1										
1930	M												0
	F												
1935	M			1									1
	F												
1940	M												0
	F												
1945	M							1					1
	F												
1950	M										1		1
	F												
1955	M												0
	F												
1960	M												0
	F												
1960	M												0
	F												

SOURCE: From review of all death records for indicated years.

tection from tetanus. However, unlike the disappearance of *C. diphtheriae*, the causative organism of tetanus will probably persist in the community indefinitely despite optimum immunization (6).

Poliomyelitis. This disease was first recognized in Seattle in 1901, and the first epidemic (88 cases with 15 deaths) occurred in 1910, soon after major improvements were made in the community water supply (1, 7). During the next four decades, poliomyelitis attack rates manifested a natural epidemic periodicity, usually 3 or 4 years (fig. 5). Reported morbidity, which included some nonparalytic disease, was then sustained at the high rate of about 20 cases per 100,000 residents for 7 years until the introduction of Salk vaccine in 1955 and its rapid application. Poliovirus apparently was eradicated from King County within 6 years after the Salk vaccine was introduced and before the live, attenuated Sabin oral vaccine was introduced.

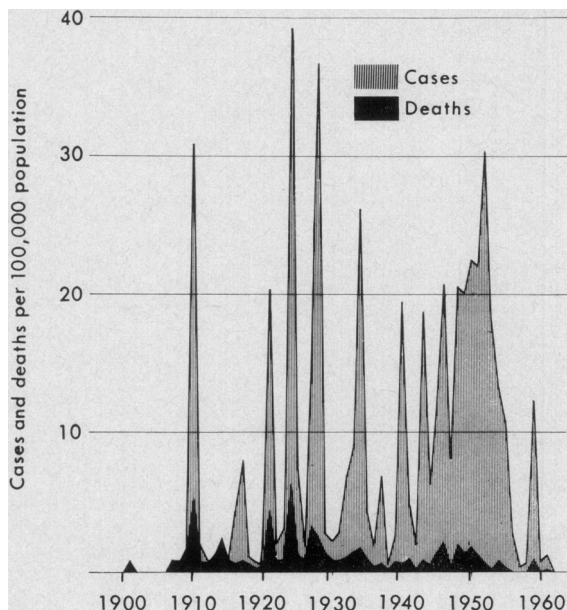
The effects of application of the killed poliovirus (Salk) vaccine on the epidemiologic patterns of poliomyelitis occurrence in this community indicated clearly that such immunization not only provided individual protection but also had a substantial inhibitory effect on the propagation of poliovirus (7). Detailed accounts of the difficulties experienced in achieving thorough immunization of the community against poliomyelitis and of an exhaustive investigation of a "rebound" epidemic of poliomyelitis in 1959 have been published (7-9). Since 1961 poliomyelitic disease has not been identified in Seattle-King County.

The live attenuated poliovirus vaccine is now being used for immunization of infants and preschool children in Seattle, but because of its residual slight pathogenicity in adults (especially type III) little of this vaccine has been used for adults in the community.

Influenza. This disease remains a sporadic cause of extraordinary morbidity and mortality. During epidemic years such as 1918-20 and 1957-60, it was the foremost micro-parasitic cause of illness and death in Seattle.

The recent Asian influenza, although much less virulent than the agent causing the 1918 epidemic, produced an excess of 265 deaths in Seattle-King County during the last 4 months

Figure 5. Poliomyelitis cases and deaths per 100,000 population, Seattle-King County, Wash., 1890-1964



of 1957 compared with the number of deaths during the same months of 1956 (table 2).

All age groups experienced increased mortality from respiratory disease, though most of the excess deaths were of elderly persons and ascribed to diseases of the cardiovascular system. Four school children died of respiratory disease (probably influenza) during the time that roughly half of the 190,000 school children in the community were ill with influenza—a case fatality rate of roughly 1 per 25,000. Interestingly, despite these four deaths from influenza, an appreciable decrease (-24 percent) occurred in the total number of deaths of school children during the fall of 1957, compared with the same months of 1956. This unexpected finding prompted a review of all death certificates of children for the 2 years, which showed that the lower mortality for school children during 1957 was mainly a result of comparison with the unusually large number of deaths of children from leukemia during the autumn of 1956 (10). This finding illustrates the current relative importance of leukemia as a cause of death of children and also indicates that children with leukemia are not especially susceptible to death from Asian influenza.

Theoretically, it should now be possible to substitute artificial immunization for the natural occurrence of influenza. But in Seattle, as elsewhere, the influenza vaccine has been used mainly in persons with known health handicaps or in members of certain occupational groups. No attempt has yet been made to prevent the introduction and propagation of influenza in the community by thorough immunization of children and young adults. Despite more than two decades of use and development, immunization for influenza remains so unsatisfactory that few experts recommend its general application (11, 12). However, it is perhaps only by general application of still imperfect vaccines that the evolutionary emergence of new antigenic strains of influenza could be suppressed—by inhibiting the great reproduction of stem organisms which is ordinarily a requisite for large evolutionary divergence of antigenic characteristics by means of serial selection.

Measles. In Seattle, as in most large urban communities, measles epidemics have occurred with a natural periodicity of not more than several years. But despite its continued importance as a cause of severe short-term illness of nearly all children and as an occasional cause of encephalitis, mortality from measles has greatly decreased. During the peak year of

1924 a total of 44 deaths in Seattle were ascribed to measles, whereas during the last decade only 4 deaths have been ascribed to measles among the roughly 200,000 children in this community who have had the disease. Although considerable immune globulin has been administered in the Seattle population during recent decades for the purpose of modifying the disease, little of the favorable mortality trend can be ascribed to this practice. More important has been the decreased prevalence of virulent streptococci and certain other microorganisms, and the effective treatment of complicating infections with antibiotics.

This community has recently participated in cooperative field studies of the measles vaccine (13), and local practitioners are now administering the vaccines to many children. However, the duration of artificially acquired immunity and its long-term effects on the ecology of measles is not yet known. It is not unlikely that the partial application of the measles vaccines may for some time upset the naturally favorable ecologic trend of the disease—as the number of susceptible adults increases because of decreased prevalence of measles virus due to immunization of many, but not all, children and perhaps because of a waning of artificially induced immunity. Unless public health agen-

Table 2. Mortality impact of Asian influenza, Seattle-King County, Wash., September-December 1957

Groups, by ages (years)	Respiratory disease deaths				Deaths from all causes			
	1956	1957	Difference	Percent increase	1956	1957	Difference	Percent increase
Preschool children: 0-4	17	39	22	129	196	220	24	12
School children	0	4	4		42	32	-10	¹ 24
5-9	0	2	2		17	14	-3	
10-14	0	2	2		9	5	-4	
15-19	0	0	0		16	13	-3	
Work force	32	55	23	72	1, 219	1, 224	5	. 4
20-29	2	0	-2		34	42	8	
30-39	3	6	3		86	73	-13	
40-49	7	10	3		171	188	17	
50-59	5	12	7		312	352	40	
60-69	15	27	12		616	569	-47	
Senior citizens	34	58	24	70	1, 164	1, 410	246	21
70-79	16	25	9		685	756	71	
80-89	15	27	12		410	559	149	
90 or more	3	6	3		69	95	26	
All groups	83	156	73	88	2, 621	2, 886	265	10

¹ Decrease.

cies now assume the burden of immunizing children of low socioeconomic status against measles, the number of adults susceptible to the disease will increase greatly.

Typhoid. Many Seattle residents have been immunized against typhoid during the last half century. For many years such immunization was mandatory for loggers and others working on the Cedar River (municipal) watershed. During recent decades many residents preparing for foreign travel and all military recruits have been immunized, despite poor evidence of the vaccine's effectiveness (12). In this community as elsewhere, the conquest of typhoid has been achieved mainly by sanitary improvements in water and food supplies and not by immunization (14).

Rabies. Despite the sporadic prevalence of rabies among dogs during the first three decades of the 20th century, especially during World War I and during the depression years (1932-38), only six deaths of local residents have been ascribed to this disease. During 1934, when 82 dogs were reported to have died of rabies in King County, 68 persons received the "complete Pasteur treatment," and 75 were treated incompletely. Nevertheless, two Seattle children died of rabies, one after being severely bitten about the head by a rabid dog and despite a full course of Pasteur treatment, and a nonimmunized 8-year-old girl, not known to have been bitten, 20 days after her pet dog died of rabies.

In recent decades a moderate proportion of dogs have been immunized for rabies, and all dogs in Seattle are now required to be leashed when not restrained to private property. Since 1938 the rabies virus has been identified in King County only in bats, one in 1962, three in 1963, and three in 1964; with the prolonged absence of rabies among dogs during recent decades, few persons have been immunized against the disease.

Other diseases. Immunizations for plague, typhus, cholera, yellow fever, and Rocky Mountain spotted fever have been used selectively among small numbers of local residents preparing for travel to endemic areas. Of these diseases only plague, with three deaths in 1907 and two in 1913, and Rocky Mountain spotted fever, with single cases in 1935, 1937, 1938, and 1940, have been identified in Seattle.

Although BCG is known to be an effective immunizing agent (12), few Seattle residents have been immunized with the vaccine because of the great efficacy of other control methods and the current low risk of tuberculous infection.

An inactivated mumps virus vaccine has been used experimentally in a few men after exposure to mumps, with little evidence of its value. Similarly, autogenous and other vaccines have been used experimentally or hopefully by various investigators and medical practitioners in the community, without evidence of substantial benefit (10).

Patterns of Immunization

Passive immunization. Antibodies have been administered to many residents of this community for the prevention and treatment of various diseases.

Diphtheria antitoxin, introduced during the 1890's, has usually been administered to persons with recognized cases of diphtheria and their known nonimmunized contacts, but without much improvement in the case fatality rate.

Tetanus antitoxin has, since the beginning of this century, been administered to persons with recognized cases of tetanus, without accurate measurement of its value, and during the last several decades tetanus antitoxin has been administered prophylactically to many persons with lacerations—a practice which has probably caused more disease than it has prevented.

Likewise botulinus antitoxin has been administered in the few recognized cases of botulism, without clear evidence of benefit.

During the first several decades of the 20th century many physicians administered antisera experimentally to patients with meningitis, pneumonia, and so forth, but this practice was discontinued with the advent of antibiotics.

Immune globulin, the usual material of choice for passive immunization during the last two decades, has been used rather extensively for temporary prevention or modification of rubeola, infectious hepatitis, and poliomyelitis—but with comparatively trivial overall effect upon mortality and morbidity from these diseases. This material has also often been administered to pregnant women exposed to rubella, despite lack of dependable evidence of its

effectiveness. During 1953 and 1954 when the health department distributed virtually all immune globulin available in the community, a limited amount was allocated to pregnant women; when the material once again became available commercially this practice was discontinued.

Passive immunizing agents have usually provided only an illusory solution to problems of microparasitism, and despite the known efficacy of immune globulin for modification of rubeola and prevention of icteric hepatitis, the difficulties of administering this short-term protection to the right person at the right time remain generally insurmountable.

Previous immunization activities. The record of immunizations provided by the Seattle-King County Health Department during recent decades (table 3) reveals a pattern of increasing kinds and numbers of immunizations. A demogram of the population to which these immunizations were given has been published (1) and also an account of the programs by which the population has been immunized against poliomyelitis (7). Thorough knowledge of past immunization activities is a necessary basis for accurate and authoritative decisions concerning needed improvement in community immunization programs. And descriptions of previous epidemics and related immunization activities

Table 3. Number of immunizations performed by the Seattle-King County Health Department(s), Wash., 1930-59

Immunizations	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
Total number ¹	3, 427	22, 750	11, 446	12, 893	10, 847	16, 891	13, 542	18, 972	6, 585	7, 518
Smallpox.....	150	250	171	418	400	11, 663	3, 512	11, 051	3, 080	4, 365
Diphtheria.....	3, 277	22, 500	11, 275	12, 475	10, 447	5, 228	10, 030	7, 921	3, 505	3, 153
	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949
Total number ¹	16, 016	15, 293	16, 941	26, 465	26, 873	29, 136	428, 559	23, 560	34, 835	45, 195
Smallpox.....	5, 740	5, 169	11, 262	13, 007	13, 164	11, 351	415, 535	4, 124	5, 344	10, 476
Diphtheria.....	10, 223	10, 096	5, 679	13, 439	10, 238	16, 268	8, 845	13, 576	18, 059	20, 209
Pertussis.....					971	1, 490	3, 923	2, 627	5, 493	6, 924
Tetanus.....							3	2, 664	5, 484	6, 961
Typhoid.....	53	28		19	2, 500	27	114	378	276	352
Typhus.....							53	92	97	148
Cholera.....							51	73	71	100
Plague.....							34	20	1	
Rocky Mountain spotted fever.....							1	6	10	25
	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Total number ¹	55, 914	22, 197	118, 647	97, 289	87, 163	194, 826	265, 402	257, 900	324, 598	299, 681
Smallpox.....	13, 439	3, 551	30, 575	24, 655	22, 925	33, 934	30, 188	6, 085	51, 367	51, 996
Diphtheria.....	17, 669	5, 308	34, 808	30, 793	25, 881	36, 864	67, 675	41, 280	52, 104	49, 783
Pertussis.....	5, 483	5, 110	15, 484	7, 054	7, 330	33, 333	8, 788	7, 650	11, 997	27, 898
Tetanus.....	17, 612	5, 968	35, 303	31, 084	26, 211	36, 868	67, 957	41, 581	52, 301	50, 470
Typhoid.....	1, 132	1, 606	2, 033	2, 683	3, 519	3, 540	3, 495	4, 255	4, 139	4, 756
Typhus.....	288	218	151	284	258	466	435	417	388	740
Cholera.....	206	205	162	437	383	426	497	493	600	822
Rocky Mountain spotted fever.....	47	50	47	104	143	43	42	41		
Immune globulin.....	38	181	84	195	513	207	198	182	200	286
Poliomyelitis.....						49, 145	86, 127	152, 001	149, 090	112, 418
Influenza.....								3, 915	2, 412	512

¹ Conferred by a lesser number of procedures, using combinations of antigens. For example, some diphtheria immunizations were by DTP, some by DT, and some by diphtheria toxoid alone.

SOURCE: Records of the Seattle-King County Health

Department (1947-59), King County Health Department (1945-46), Seattle Health Department (1930-46), and estimates of former health officers of the number of immunizations performed by the King County Health Department for 1930-44.

can be useful for educating the public to participation in current immunization programs.

Ascertaining immunization status. In addition to knowledge of previous immunization activities, the director of public immunization programs needs accurate knowledge of the current immunization status of children and selected other groups within the community. Because an unrecorded number of immunizations are performed by private physicians, accurate knowledge of the immunization status of the community can be obtained only by special surveys. Representative or quota sampling surveys have been made in many communities with the leadership and assistance of the Communicable Disease Center of the Public Health Service (15). These surveys were useful for a time in measuring and emphasizing immunization deficiencies among lower socioeconomic groups and as a stimulus to community immunization activities, but they have limited value for routinely ascertaining and improving the immunization status of most communities.

In Seattle, crude estimates of community immunization status were used until 1959, when the poliomyelitis immunization status of all children in selected schools was ascertained. Deficiencies in school records of each student's immunization status were remedied by the school nurses, who obtained information from parents by interviews via telephone or in the home, and plans were formulated for a more comprehensive survey the following year. In preparation for that survey, the school nurses, with the assistance of Dr. Vivian Harlin, direc-

tor, medical department, Seattle Public Schools, were encouraged specifically to obtain and record, as accurately as possible, each student's immunization history.

After completion of the 1960 school immunization program (in April), a roster-type survey form was prepared and used for studying a representative one-third sample of all second-grade children attending public and private schools in Seattle and King County. School nurses were directed to list every second-grade student in each school and to indicate their immunization experience, especially the most recent date of vaccination against smallpox, diphtheria, pertussis, tetanus, and poliomyelitis. For each student with inadequate immunization, the nurses were asked to ascertain the reason(s). Whenever school nurses failed to obtain all the requested information, the authors (M.J.L. or A.M.R.) remedied the deficiencies by interviews via telephone or in the home.

Status of immunization. The 1959 survey of a few schools had revealed that roughly 93 percent of the elementary school children in Seattle had received at least three doses of Salk vaccine (7). In the poorest districts, however, only about 46 percent of the kindergarten children were protected on entry to school, despite the general availability of free immunization at neighborhood clinics.

The 1960 survey of 34 percent, or 6,595 of the 19,334 second-grade children in 87 of the 273 elementary schools of the city and county, provided more accurate knowledge of the immunization status of elementary school children

Table 4. Immunization status of second-grade children, by antigen, Seattle-King County, Wash., May 1960¹

Immunizations	Students completely immunized ²		Students incompletely immunized ³		Students never immunized	
	Number	Percent	Number	Percent	Number	Percent
Smallpox.....	5,936	90	444	6.7	215	3.3
DTP.....	6,199	94	291	4.4	105	1.6
Poliomyelitis.....	6,219	94	234	3.5	142	2.2
All antigens.....	5,563	84	958	14.0	74	1.1

¹ All schools combined; 6,595 children in survey.

² Students had smallpox vaccination within 5 years, DTP within 3 years, and at least 3 poliomyelitis inoculations.

³ Students had received antigen sometime but less completely or recently than those considered adequately immunized.

(table 4). The vaccination status of children in the city and county public schools and in private schools was similar. A total of 84 percent of the children were fully immunized with all antigens, 14 percent were incompletely immunized, and 1.1 percent had never been immunized with any antigen.

Reasons for nonimmunization. The leading reason for nonimmunization was religious objection, as indicated in table 5. In addition to the parents who forthrightly stated that they objected to immunization because of religious beliefs, there were others who said that they did

Table 5. Reasons why second-grade children never immunized—Seattle-King County, Wash., May 1960¹

Reasons	Number of children never immunized for—			
	Small-pox	DTP	Polio-mye-litis	All-anti-gens
Child factors.....	67	10	11	2
Allergy:				
Eczema.....	26	1		
Eczema of sibling.....	2			
Asthma.....	3	1	1	1
Allergy ²	22	5	3	1
Illness or absence at time of clinics.....	5	2	3	
Muscular dystrophy.....			1	
Sickly child ²	9		2	
Has had pertussis ²		1		
Child objects to immunization ²			1	
Parental factors ³	148	95	131	72
Religious objection.....	55	50	49	47
Did not believe in immunizations.....	20	11	26	11
Opposed but reason not stated.....	16	6	8	3
Neglect or procrastination.....	26	7	14	1
Fear of immunization.....	19	4	16	2
Ignorance.....	1	5	3	1
Chiropractor.....	3	3	3	3
Naturopath.....	1	1	1	1
Food fadists.....	1	1		
Frequent moving.....		2	2	
Foster home.....			1	
Reason refused.....	4	4	7	2
Unknown.....	2	1	1	1
Total.....	215	105	142	74

¹ From survey of 6,595 second-grade children enrolled in public and private schools.

² Quote.

³ Opposition to immunization, like causation of death, is usually complex, but the stated simple reasons appeared to be the dominant or most informative reasons.

“not believe in immunization” or were “opposed to immunization” but did not state the reasons. It is likely that some of these also were opposed because of religious training. Chiropractors, naturopaths, and food fadists—people who are generally unimpressed by scientific evidence—not infrequently refused immunization for their children.

Parental factors were much more important causes of nonimmunization than child factors. Seventy-two (1.1 percent) of the 6,595 children had never been immunized because of parental factors, whereas only 2 children had never been immunized because of child factors. An appreciable proportion (0.8 percent) of the children had never been vaccinated for smallpox because of various allergic conditions. In the lowest socioeconomic school districts, neglect, procrastination, and fear of immunization, rather than religious objection, were the main reasons for nonimmunization.

These findings indicate the high level of immunization that can be attained, without legal compulsion, by a combination of private and public means. Immunizations have been provided by various programs in the Seattle-King County area for: (a) persons of all ages, at a continuing central clinic, where almost all the antigens have been offered free of charge on a walk-in basis, 8 hours per day, 5 days per week; (b) children at central and neighborhood weekly well-child clinics and in the annual school program; and (c) the general public or selected high-risk groups by special programs.

Improving Community Immunization Status

Because roll-call surveys of immunization status are simple to perform and facilitate implementation of corrective measures, three are recommended for routine or periodic use to improve the immunization status of communities.

Birthday roll call. A survey based on birth certificates of all or a representative sample of all infants when they are 1 year old could be accomplished by interviews via telephone and in the home by public health nurses.

School-enrollment roll call. The immunization status of every child entering elementary school and the reasons for nonimmunization

could routinely be ascertained by school nurses and their assistants and recorded on rosters listing all students by age and school. Copies of these rosters could then be sent to the communicable disease control officer to provide him with maximally accurate knowledge of the immunization status of children entering each school and to facilitate the planning of appropriate remedial programs.

Public housing move-in roll call. It is well known that the least provident families generally are also the least well immunized. Many outbreaks of poliomyelitis and other diseases have shown the great epidemiogenic potential of a moderate number of nonimmunized children congregated in public housing projects (7, 9). Therefore, it is recommended that public health nurses routinely visit all families moving into public housing to inform them of available services, to ascertain their immunization status, and to encourage and arrange for needed improvement.

The parents' objection to immunization is usually less than absolute and changes with time, disease occurrence, and many other factors. Hence if immunization were made readily and persuasively available repeatedly, many children whose parents initially refused immunization could be immunized. Not only is it important to attain maximum reduction in the number of nonimmunized children for their individual protection and because of their epidemiogenic potential but it is important because resistance to immunization is communicated from one nonimmunized generation to another.

The hard core of resistance to immunization, which exists in most communities, presents a fascinating and worthy challenge to the ingenuity of public health workers, and it is only by adequate immunization of these social groups that eradication of disease or complete prevention by immunization can be achieved.

Summary

The secular experience of the Seattle-King County community with the occurrence of immunizable diseases such as smallpox, diphtheria, pertussis, tetanus, poliomyelitis, influenza, and measles, with related preventive activities, is reviewed. The findings of the study indicate

that eradication of these and other diseases by means of immunization is especially dependent on thorough immunization of children of all socioeconomic, cultural, and neighborhood groups within the community rather than on the general level of immunization.

For this reason three routine or periodic roll-call surveys of immunizations and reasons for nonimmunization (at first birthday, on entry to elementary school, and when moving into public housing) are recommended for ascertaining and improving the status of immunization in every community.

Such a roll-call, or roster, survey of all (6,595) second-grade school children in a representative one-third sample (87) of the elementary schools in Seattle and King County during 1960 revealed that 84 percent of all the children were fully immunized with all recommended vaccines, 14 percent were incompletely immunized, and 1.1 percent had never been immunized with a vaccine.

In the upper socioeconomic neighborhoods, immunization was deficient mainly because of religious beliefs. In the lower socioeconomic neighborhoods, neglect, procrastination, and fear of immunization, rather than religious beliefs, were the main reasons for non-immunization.

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Public Health Service Staff Appointments

Dr. Donald Harting has been appointed director of the National Institute of Child Health and Human Development, Public Health Service.

Dr. Harting was assistant director of the Institute in 1963-64, and became acting director October 1964, succeeding Dr. Robert A. Aldrich. He joined the Institute after serving as director of the Center for Research in Child Health, which became the nucleus of the Institute of Child Health and Human Development when it was established in January 1963.

Commissioned in the Public Health Service in 1947, Dr. Harting served as chief of the Public Health Administration Branch, Bureau of State Services, 1960-62, and chief of the Program Development Branch, Division of General Medical Services, 1954-60. During 1951-54, he served in Chicago as regional medical director of the Children's Bureau in the Midwestern States.

Dr. Harting received his medical degree from Harvard Medical School, Boston, in 1946. He interned in pediatrics at Massachusetts General Hospital and was research

fellow in pediatrics there until September 1949. He received the master of public health degree in maternal and child health from Johns Hopkins School of Public Health in 1950, and served a year's residency in clinical pediatrics at the University of Colorado Medical Center in Denver.

Dr. Alfonso H. Holguin has been appointed chief of the Tuberculosis Branch, Communicable Disease Center. He has been assistant chief of the branch since July 1964.

A native of El Paso, Tex., Dr. Holguin received his medical degree from the University of Texas and his master's degree in public health from Harvard University. He has been with the Public Health Service's Communicable Disease Center since 1958, in both the Laboratory Branch and the Tuberculosis Branch.

Dr. Holguin is a member of the American Medical Association, the Association of Military Surgeons of the United States, the American Public Health Association, and the Alpha Omega Alpha Honor Medical Society.