Position Paper

Alan R. Hinman

Center for Disease Control, Atlanta, Georgia, USA

There appear to be four major categories of public concerns of immunization to be addressed: effectiveness of immunization, safety of immunization, need for immunization, and willingness to participate in immunizations. I should like to deal with each of these aspects and conclude with some general comments. I will limit my presentation to the childhood vaccines recommended for routine use in this country.

EFFECTIVENESS OF IMMUNIZATION

INDIVIDUAL

There are seven vaccines presently recommended for routine use in all children: Diphtheria and tetanus toxoids, pertussis, polio, measles, mumps, and rubella vaccines. Administration of these vaccines should begin at about 2 months of age (Table 1). For

Table 1. Suggested immunization schedule for normal infants and children¹

Age	Vaccine
2 months	DTP, TOPV
4 months	DTP, TOPV
6 months	DTP
15 months	Measles, rubella, mumps
18 months	DTP, TOPV
4-6 yr	DTP, TOPV

¹ Source: AAP, ACIP.

optimal protection, a child should receive five doses of combined DTP vaccine, four doses of trivalent oral polio vaccine, and one dose each of measles, mumps, and rubella vaccines by the time of school entry (1, 7). This course of immunization will give protection from disease in 90% or more of individuals (with the possible exception of pertussis). Protection conferred by immunization is long lasting. For most of these vaccines, protection is probably lifelong. For tetanus and diphtheria, however, boosters are recommended every 10 years throughout life. Thus, individual effectiveness of the vaccines is quite high, although not perfect.

COMMUNITY

Community effectiveness of vaccines can best be demonstrated by looking at the patterns of disease incidence after use of the vaccines. The accompanying graphs and tables demonstrate the remarkable decline that has been seen in the occurrence of these diseases associated with the widespread use of vaccines (6). Although many factors are involved in the declines, it is clear that use of the vaccines is primarily responsible. Figure 1 demonstrates the reported occurrence of diphtheria in the US from 1920-1977. In the 1920's, there were more than 100,000 cases of diphtheria reported each year. The incidence of diphtheria began to decline even before vaccine became available in the 1930's, but declined at a more rapid rate after the introduction of the vaccine. Table 2 demonstrates the changes observed in the past 25 years. In 1952, there were 2960 cases of diphtheria reported from 44 of the states. In 1977, there were only 84 cases of diphtheria reported and only 8 states reported cases.

REPORTED DIPHTHERIA CASES, UNITED STATES
1920 - 1977

Tetanus (Figure 2) has not been as common a disease as diphtheria; only 500–600 cases were reported per year in the late 1940's. Nonetheless, since 50–60% of people who contract tetanus die from it, it represents a fairly serious problem. There has been a major decline in the occurrence of tetanus. A 25-year comparison (Table 3) indicates that there has been a decline from 484 cases of tetanus reported in 1952 to 70 cases in 1977.

Pertussis (whooping cough) has been very common in the past (Figure 3). In the 1930's, there were well over 150,000 cases reported each year with a maximum of over 250,000 cases reported. The incidence of pertussis began to decline before the widespread use of pertussis vaccine (which began in the 1940's) and has declined at a more rapid rate since. A 25-year comparison (Table 4) shows that as recently as 1952 there were 45,000 cases of pertussis reported in the US. In 1977, there were 1890 cases. Unfortunately, the 1890 cases reported in 1977 represented nearly a 90% increase over the preceding year. The increase has continued into 1978 and cannot yet be totally explained.

One of the great success stories of the vaccine era is polio (Figure 4). Polio is a disease which became epidemic in a major fashion in the US in the 20th century, reaching a peak in 1952. The introduction of the inactivated (Salk) vaccine in 1955 had a remarkable effect on the occurrence of polio in this country. The subsequent introduction of the live oral (Sabin) vaccine in 1961

continued this decline. A 25-year comparison (Table 5) demonstrates that in 1952 there were more than 21,000 cases of paralytic polio reported in the United States, and all 48 states reported cases. In 1977, only 17 cases were reported. This represents a remarkable success.

Measles is a disease which most of us had as children. Before measles vaccine became available in 1963, 95% of Americans could count on having measles before they reached 15 years of age (11). It is a disease which most people do not think of as being particularly serious. However, of every 100 children who get measles, three or four will develop pneumonia or ear infection. Out of every 1000 children who develop measles, one will develop encephalitis. For every three cases of encephalitis, one will die and one will be left with permanent brain damage. All told, for every 10,000 infections, at least one child will die (19). Because there were several hundred thousand cases of measles reported in the US each year before the introduction of vaccine (Figure 5), this relatively low case fatality rate nonetheless added up to a serious problem. There were hundreds of deaths due to measles in the country each year. Immediately after the introduction of measles vaccine in 1963, the reported occurrence of measles and of measles deaths began to decline. The rate of decline was accelerated when Federal immunization project grant funds were provided in support of measles vaccination in 1966. Unfortunately, these funds

Table 2. Reported diphtheria in USA, selected years, 1952–1977

Year	No. cases	No. states
1952	2960	44
1960	918	43
1970	435	24
1976	128	13
1977	84	8

Table 3. Reported tetanus in USA, selected years, 1952–1977

Year	No. cases	No. states
1952	484	38
1960	368	37
1970	148	33
1976	75	27
1977	87	28

REPORTED PERTUSSIS CASES, UNITED STATES
1922* - 1977

Table 4. Reported pertussis in USA, selected years, 1952-1977

Year	No. cases	No. states
1952	45,030	48
1960	14,809	49
1970	4,249	46
1976	1,010	45
1977	2,177	46

terminated in 1969, and the reported incidence of measles once again began to rise. After reinstitution of Federal support in 1972, the reported incidence began to decline once again, reaching a low level of 22,094 cases reported in 1974. From 1974-1977, there was a progressive increase in the reported occurrence of measles reaching a peak of 57,345 cases reported in 1977. During the latter part of 1977 and the first six months of 1978, there has been a substantial decline in the reported incidence, compared to the same time the preceding year. In large measure, we feel this is a result of the increased efforts being directed toward immunization.

Mumps is an illness which has not received prominent public health emphasis in the past. Nonetheless, thousands of cases of mumps have been reported each year in this country (Figure 6). Mumps vaccine was licensed in 1968 and soon thereafter gained fairly wide acceptance in the private sector. It was not widely used in public health departments until the mid 1970's. Nonetheless, the occurrence of mumps has shown a striking decline in the last few years associated with the use of vaccine.

The newest of the routinely recommended childhood vaccines is rubella vaccine. Rubella is an illness which typically is quite mild in the individual who contracts it. It lasts only about 3 days and often goes unnoticed in those who are infected. However, if a pregnant woman should contract rubella, the chances are quite high that the fetus that she is carrying will be infected and either

will be born dead or be born with several congenital anomalies. The last major epidemic of rubella in the US occurred in 1964, and in its wake, an estimated 20,000 children were born with congenital anomalies resulting from maternal rubella infection (23). In the US, it was decided to give the vaccine routinely to children at a young age because they are the primary transmitters of the disease and are in large measure responsible for transmission of the disease to pregnant women. Additionally, it was anticipated that the protection given these children would last them until the girls reach the childbearing age themselves. Because the vaccine has only been in use for 9 years, it is so far impossible to determine whether or not protection will, in fact, be lifelong. However, it can be said that, although antibody levels may decline somewhat, there is no clinical evidence of loss of immunity (17). Figure 7 shows the pattern of reported rubella in the US. The widespread use of rubella vaccine has resulted in a substantial decline in the occurrence of rubella and of congenital rubella syndrome in the US.

SAFETY OF IMMUNIZATION

With each of the vaccines currently being used routinely, there is a small, but measurable, incidence of untoward effects. These range from local soreness, which is quite common with DTP vaccine, to the occurrence of paralysis associated with polio vaccine, which occurs somewhere in the range of 1 for every 4 million vaccinations (15). For many of these apparent untoward effects, particularly the very rare ones, it is very difficult to ascertain whether or not the adverse effect is caused by the vaccination. For example, encephalitis is seen in about 1 of every 1 million measles vaccinees in the month after measles vaccination, which might lead one to believe that the vaccination caused the encephalitis (3). On the other hand, there are data to indicate that children of the same age who do not receive measles vaccine have an occur-

REPORTED PARALYTIC POLIOMYELITIS ATTACK RATES, BY YEAR, UNITED STATES, 1951-1977

Table 5. Reported paralytic polio in USA, selected years, 1952-1977

Year	No. cases	No. states
1952	21,269	48
1960	2,525	48
1970	31	7
1976	12	11
1977	17	11

rence of encephalitis in a typical 1-month period of approximately two in every million children (20). Thus, it could be argued that measles vaccine prevented encephalitis. The success of our control over polio is such that we have reduced the occurrence of the disease from more than 20,000 cases in 1952 to only 17 cases in 1977. However, of the 17 cases reported in 1977, 13 were associated with the polio vaccine. This pattern is consistent with what has been seen in recent years. In the past 8 years, more than one-third of all cases of polio in the US have been associated with vaccine. We have been so successful in conquering polio in this country that this rare event (occurring approximately once in every 4 million vaccinations) has become relatively prominent. This has led to continuing discussion as to whether or not we ought perhaps to revert to using the inactivated Salk vaccine, which does not carry with it any known risk of vaccine-associated paralysis. The professional consensus in this country has been that, given the relatively low levels of completed immunization in this country and the proven ability of the oral vaccine to provide community protection, the oral vaccine ought to continue to be the primary vaccine for the present (10, 18, 22).

Thus, although the vaccines are quite safe, they are not perfectly safe, and there needs to be a continuing weighing of the relative magnitude of the benefits conferred by immunization vs. the risks associated with immunization. This continued weighing of benefits and risks led to the abandonment of routine smallpox vaccination in the US even before smallpox was eradicated from the world (12).

REPORTED MEASLES CASES, UNITED STATES, 1960-1978

*1978 ANNUAL TOTAL EXTRAPOLATED FROM NUMBER OF CASES REPORTED FOR FIRST 38 WEEKS OF 1978

The existence of untoward effects, particularly vaccine-associated paralysis, has led to a growing concern about vaccine liability and means of providing care and compensation for those inadvertently injured as a result of vaccination (9). A series of court decisions has established that, at least outside the private physician's office, the manufacturer of the vaccine has an obligation to

REPORTED CASES OF MUMPS, UNITED STATES, 1922 - 1977

ensure that the prospective recipient understands the risks as well as the benefits of vaccination. The manufacturers have said that they cannot be present in each clinic site around the country and have passed this "duty to warn" on to the Federal and State Governments as a part of the contracts established for the purchase of vaccines. To fulfill the obligation, a series of vaccine information forms has been developed for use in public clinics using federally-supplied vaccine.

The transfer of the duty to warn has alleviated some of the manufacturer's concerns about product liability issues. It has not, however, eliminated concerns of many health care providers about their own vulnerability to claim in the event of an untoward reaction. Additionally, it may have made it harder for the victim of vaccine injury to receive compensation for injuries. To try to deal with this problem, many have called for the establishment of a "no-fault" compensation system for those inadvertently injured by vaccines. The whole problem is exceedingly complex, and whether or not such a system would, in fact, solve current problems is subject to debate (8).

NEED FOR IMMUNIZATION

It seems unlikely that any of the causative agents of the vaccine-preventable diseases under discussion will disappear from the US in the near future. As a consequence, if we are to maintain the gains we have achieved, there will be a continuing need for immunization to prevent continued and increasing circulation of the causative agents. This is particularly true in the case of measles, which is highly responsive to the amount of immunizations administered.

The results of the annual US Immunization Survey clearly indicate that there is a need, not only for maintained emphasis on immunization, but for increased emphasis on immunizations. The US Immunization Survey is carried out in September of each year by the Bureau of the Census as part of their Current Population Estimates (21). The survey carried out in September 1977 (Table 6) indicated that of 1-4-year-old children in the US, more than one-quarter lacked at least one dose of DTP vaccine in order to be considered fully protected, more than one-third lacked at least

one dose of polio vaccine in order to be considered fully protected, more than one-third lacked measles vaccine, more than one-third lacked rubella vaccine, and more than one-half lacked mumps vaccine. Immunization rates for nonwhites and for the poor were even lower than these overall rates. In all, it is estimated that perhaps 20 million children in the US under the age of 15, lack at least one dose of vaccine in order to be considered fully protected.

Other surveys, of 2-year-old children and of children entering school, have also demonstrated immunity levels which are below what we should consider acceptable levels in this country. The resurgence of measles incidence in recent years also highlights the need for continuing and increased emphasis on immunizations. This need has led to the development of a childhood Immunization Initiative, which has as its goals the achievement and maintenance of immunity levels of at least 90% in the nation's children.

WILLINGNESS TO PARTICIPATE

The letter inviting participation in this symposium stated that "Two of our major concerns have been the reluctance of the public to willingly accept mass immunization as a necessary aspect of preventive medicine and also the inadequate dissemination to the public of information regarding immunization. We realize that much of the reluctance in regard to mass immunization has been engendered by the unfavorable press concerning the swine flu vaccine." I must disagree with the statement that the public is reluctant...to willingly accept mass immunization.... There are at least three lines of evidence to show that the public is entirely willing to accept mass immunization. These include: patterns of vaccine administration, compliance with school immunization requirements, and attitudinal surveys.

PATTERNS OF VACCINE ADMINISTRATION

Since the beginning of the Immunization Initiative in April 1977, there has been a substantial increase in the amount of vaccine administered in the public sector. In 1977, there was a 19% increase in vaccine administration in the public sector as compared with 1976 (Table 7). In the first 6 months of 1978, there

REPORTED RUBELLA CASES PER 100,000 POPULATION BY YEAR, UNITED STATES, 1966-1977*

*PROVISIONAL 1977 TOTAL

has been a further 11% increase over the same period in 1977 (4). This indicates clearly that vaccinations are being offered, and accepted, at an increasing rate in the public sector.

COMPLIANCE WITH SCHOOL IMMUNIZATION REQUIREMENTS

Numerous examples exist, demonstrating that the public is willing to comply with laws or regulations which require immunization as a condition of school entry or school attendance. Reported experiences in Alaska, Detroit, and Los Angeles all indicate that, when people are reminded of the obligation, they seek immunization for their children (13, 14, 16). In Missouri, there has recently been completed a review of the immunization status of all children at all grades of school, both public and private. As a result of this review and the immunization activities that accompanied it, well over 90% of all Missouri school children are fully immunized (2). Similar experiences are being encountered as other states carry out total school record reviews and enforcement of school immunization requirements.

ATTITUDES TOWARDS IMMUNIZATION

The Bureau of Health Education of the Center for Disease Control has contracted with the Opinion Research Corporation to

carry out a series of surveys relating to public attitudes about immunization. This series started as a part of the swine influenza campaign and has continued since that time. Several surveys were carried out during the course of the swine influenza program and repeat surveys were conducted in August 1977 and February 1978. I will present some results from the February 1978 survey (5). One of the questions asked was, "Do you think that trying to immunize people by a mass program is a very effective way to fight a very contagious disease?" (Table 8). Eighty-one percent answered yes, 7% answered no, and 12% either did not know or did not respond. Whites were more likely to respond yes than blacks, and the proportion of yes answers increased with increasing family income and with increasing education.

Another question asked was, "If a nationwide program to immunize everyone against a contagious disease like polio was started, do you think you would want to be immunized?" (Table 9). Eighty-nine percent answered yes, only 4% answered no, and 7% either didn't know or said that it would depend. Once again, whites were more likely to answer yes than blacks, and there was an increase in the proportion of positive answers with increasing income and increasing education.

By contrast, there was a different response to the question, "If a nationwide immunization program against influenza (flu) were

Table 6. *Percent of population 1-4 yr of age with specified doses of polio, diphtheria-tetanus-pertussis (DTP), measles, rubella, and mumps vaccines in US 1964-1977*

Year	Polio doses		DTP doses		Measles, 1 dose	Rubella, 1 dose	Mumps, 1 dose
	3+	0	3+	0			
1964	78.6	8.5	76.0	11.4	24.0	1	2
1965	73.9	9.9	73.9	10.9	33.2	1	2
1966	70.2	11.3	74.5	10.8	45.5	1	2
1967	70.9	11.7	77.9	9.3	56.4	1	2
1968	68.3	10.5	76.5	8.6	58.8	1	2
1969	67.7	10.2	77.4	7.2	61.4	1	2
1970	65.9	10.8	76.1	7.0	57.2	37.2	2
1971	67.3	8.6	78.7	5.8	61.0	51.2	2
1972	62.9	10.7	75.6	6.9	62.2	56.9	2
1973	60.4	13.9	72.6	6.2	61.2	55.6	34.7
1974	63.1	11.7	73.9	5.2	64.5	59.8	39.4
1975	64.8	10.3	75.2	4.5	65.5	61.9	44.4
1976 ³	61.6	9.5	71.4	3.7	65.9	61.7	48.3
1977 ³	60.1	8.7	69.5	3.3	63.1	59.4	48.1

¹ Rubella vaccine was licensed in June 1969.

² Mumps vaccine was included in the questionnaire in 1973.

³ Data collected during and since 1976 are not directly comparable with data collected before 1976 because of a change in the questionnaire design.

Table 7. *Vaccine administration in public programs in USA, 1976-1977*

Vaccine	1976	1977	Change (%)
DTP	8,059,697	9,193,362	+14
Polio	7,785,551	8,374,860	+8
Measles	2,976,483	4,585,149	+54
Rubella	2,517,470	3,032,724	+20
Mumps	1,180,317	1,618,046	+37
Total	22,519,518	26,804,141	+19

Table 8. *Do you think that trying to immunize people by a mass program is a very effective way to fight a very contagious disease?*¹

	Yes (%)	No (%)	Other (%)
Total	81	7	11
Race			
White	84	7	9
Black	64	11	36
Family income			
<\$5,000	63	4	31
\$5,000-9,999	79	8	13
\$10,000-14,999	86	8	6
\$15,000-19,999	83	9	8
\$20,000+	89	6	5

¹ Source—ORC, 1978.

started this fall or winter, do you think you would want to be immunized?" (Table 10). Only 51% answered yes, 29% answered no, and 20% either said it would depend or that they didn't know. For this question, whites were less likely to respond yes than blacks and the proportion of positive answers declined with increasing family income and with increasing educational level. This indicates a clear difference in the public's mind concerning influenza immunization as compared with other immunizations.

Individuals were also asked if their states had laws requiring immunization. Of the 76% of respondents who said that their states did have laws, 93% said that they would have their children immunized even if the state did not have such laws or regulations.

All of these lines of evidence clearly indicate that the public is quite willing to participate and to accept mass immunization. If one grants that the vaccines are effective and safe, that there is a

continuing need for immunization, and that the public is willing to accept immunization, the question then arises as to how participation and immunization levels can be increased. It seems clear that a combination of information, motivation, and services is needed.

People should know their immunization status and that of their children. They should have immunization records in a known location in their home. They should be reminded about the need for immunizations at all health encounters and through periodic messages in the media, schools, etc. We hope that through the combined efforts of all of the individuals and groups which are participating in the Immunization Initiative that this kind of information dissemination is improving.

It also seems clear that some additional stimulus is often needed to provoke action on the part of a basically interested person who has many other concerns competing for attention. The kinds of social pressures generated by community leaders speaking in favor of immunization and by the enforcement of school immunization requirements are very useful in this regard. We are promoting the rigorous enforcement of school laws as a means of bringing to individuals' attention the continuing publicly perceived need for immunization.

Lastly, it is clear that services must be available to provide immunizations to those who want and need them. Services must be available both in the private sector and in the public sector. We believe that through the increased support being given from the Federal, state, and local levels services will be widely available and accessible in the public sector. Through the expressed support of organized medical groups, services should be available in the private sector.

In conclusion, from the professional perspective, we can say that the vaccines presently recommended for routine use are effective and safe, that there is a continuing need for immunizations in this country and that the public is willing to participate. We hope that through the Immunization Initiative there will be an increase in public education and information concerning immunizations, an increase in efforts to motivate people to seek

Table 9. *If a nationwide program to immunize everyone against a contagious disease like polio was started, do you think you would want to be immunized?*¹

	Yes (%)	No (%)	Other (%)
Total	89	4	7
Race			
White	90	4	6
Black	82	5	13
Family income			
<\$5,000	85	6	9
\$5,000-9,999	86	4	10
\$10,000-14,999	93	3	4
\$15,000-19,999	87	4	9
\$20,000+	93	3	4

¹ Source—ORC, 1978.

Table 10. *If a nationwide program against influenza (flu) were started this fall or winter, do you think you would want to be immunized?*¹

	Yes (%)	No (%)	Other (%)
Total	51	29	20
Race			
White	48	31	21
Black	68	15	17
Family income			
<\$5,000	64	20	16
\$5,000-9,999	67	19	14
\$10,000-14,999	50	32	18
\$15,000-19,999	45	30	25
\$20,000+	44	32	24

¹ Source: ORC, 1978.

immunizations, and an increase in the availability and accessibility of immunization services. Our goal, as you are aware, is to attain 90% immunization levels in America's children by October 1979, to maintain these levels, and to affect even further reductions in the incidence of vaccine-preventable diseases.

REFERENCES

1. American Academy of Pediatrics: Report of the Committee on Infectious Diseases (1977).
2. Center for Disease Control: Immunization Status of 400 Children. Pediatric Group Practice (Missouri, 1977). Overend, D. S.: Article Stimulates Review of Immunization Practices (Letter). *Pediatrics*, 60: 258 (1977).
3. Center for Disease Control: Measles Surveillance Report No. 10 (1973-1976, Issued July 1977).
4. Center for Disease Control: *MMWR*, 27: 7 (1978).
5. Center for Disease Control: Opinion Research Corporation Survey (October, 1978).
6. Center for Disease Control: Reported Morbidity and Mortality in the United States, Annual Summary (1977), *MMWR*, 26 (53), September 1978.
7. Center for Disease Control: Selected Recommendations of the Public Health Service Advisory Committee on Immunization Practices. Collected Recommendations on Routine Childhood Vaccines (December, 1977).
8. Center for Disease Control: Summary Reports of Vaccine Administration in Public Sector (1978).
9. Center for Disease Control: US Immunization Survey, Preliminary Report (1977, issued February 1978).
10. Center for Disease Control: Vaccination Against Smallpox in the United States, A Reevaluation of the Risks and Benefits (Revised February, 1972).
11. Collins, S. D., Wheeler, R. E., and Shannon, R. D.: Occurrence of Whooping Cough, Chickenpox, Mumps, Measles, and German Measles in 200,000 Surveyed Families in 28 Large Cities. National Institute of Health (1943).
12. Department of Health, Education and Welfare: Liability Arising out of Immunization Programs (Final Report to Congress, May 1978).
13. Donnel, H. D., Donoho, J. E., and Shipley, G.: School Records and Immunization Levels (Presented at the 106th Annual meeting of the American Public Health Association. Los Angeles, California, October 18, 1978).
14. Fannin, S.: Untitled presentation at 12th Annual Immunization Conference (Atlanta, Georgia, May 23-26, 1977).
15. Gregg, M. B.: Presented to Institute of Medicine Committee on Evaluation of Poliomyelitis Vaccines (1977).
16. Gunn, W. J. and Scatko, J.: A study of National Attitudes at the PHS Professional Association (Atlanta, Georgia, March 28, 1978).
17. Herrmann, K. L., Halstead, S. B., Brandling-Bennett, A. D., Witte, J., Wiebenga, N. H., and Eddins, D. L.: Rubella Immunization. Persistence of Antibody Four Years after a Large-Scale Field Trial. *JAMA*, 235: 2201 (1976).
18. Institute of Medicine: Evaluation of Poliomyelitis Vaccines (DHEW Contract No. NOI-OD-F-2105, 1977).
19. Krugman, S., and Ward, R.: Infectious Diseases of Children and Adults. (C.V. Mosby, St. Louis, 1973).
20. Landrigan, P. J., and Witte, J. J.: Neurologic Disorders Following Live Measles Virus Vaccination. *JAMA*, 223: 1459 (1973).
21. Middough, J. P., and Zyla, L. D.: Enforcement of School Immunization Law in Alaska. *JAMA*, 239: 2128 (1978).
22. Reports and Recommendations of the National Immunization Work Groups (March 15, 1977, DHEW Contract No. 263-77-E-0076).
23. Shavell, S. M.: Costs of the 1964-1965 Rubella Epidemic. Presented at the 6th Immunization Conference (Atlanta, Georgia, 1969).