Recent Advances in Public Health

Immunization

JOHN J. WITTE, MD

Emphasis on immunization by United States public health agencies and medical advances, such as viral vaccine combinations, have been a major factor in reducing the morbidity and mortality of smallpox, poliomyelitis, rubella, mumps, and other communicable diseases. However, efficient delivery of immunization services has declined, as shown by increasing incidence of some diseases and a decreasing proportion of persons adequately immunized.

Introduction

The use of immunizing agents to control and prevent disease is an established component of public health practice throughout the world. The emphasis on immunization by public health agencies in the United States has been a major factor in reducing the morbidity and mortality of a number of communicable diseases. Smallpox has disappeared from the United States (as well as from most areas in the world) because of effective vaccination programs. Epidemic poliomyelitis is no longer a major public health problem because of extensive use of vaccines. The occurrence of diphtheria, tetanus, and pertussis has been substantially reduced as a result of systematic and comprehensive immunization. The use of measles vaccine has accounted for a sharp decline in the number of cases and deaths from rubeola.

Recently, the availability of additional immunizing agents has expanded the scope of disease control activities. New vaccines and combinations of vaccines have been introduced and utilized widely. One established vaccine, smallpox, was deleted from the routine schedule of childhood immunizations. However, advances in the technology of vaccine delivery systems have lagged behind the technology of developing new vaccines. In fact, some aspects of the delivery system have regressed rather than advanced. The more significant recent advances (and regressions) in immunization practice in the United States are detailed in this report.

Dr. Witte is with the U.S. Department of Health, Education, and Welfare, Public Health Service, Health Services and Mental Health Administration, Center for Disease Control, Atlanta, Georgia 30333.

Newer Vaccines

Rubella

Live attenuated rubella virus vaccine was licensed for use in the United States in June, 1969. The vaccine is a highly effective immunizating agent and offers the first suitable method of preventing rubella.[1,2] The principal rationale for the use of the vaccine is the prevention of congenital abnormalities which result from maternal rubella infection early in pregnancy, particularly the first 3 months. Because the safety of the live virus vaccine for pregnant women has not been determined, the group at

highest risk (i.e., susceptible, pregnant women) cannot be vaccinated directly. Therefore, the present approach of preventing fetal infections is being accomplished by (1) the reduction of rubella virus transmission in the community through the vaccination of children, particularly young school age children, who are largely responsible for the spread of virus, and (2) the vaccination of susceptible nonpregnant women.

Prior to the introduction of vaccine, epidemics of rubella occurred every 6 to 9 years in the United States.[3] The epidemic of 1964–1965 resulted in more than 20,000 cases of congenital rubella syndrome, with an estimated economic cost of $1.5 billion.[4] Since 5 years had elapsed between the time of the epidemic and vaccine licensure, there appeared to be a relatively brief period available to reduce rubella virus transmission and to prevent a national epidemic. Therefore, the initial priority in public health programs went to children in the 5-to 9-year age group, and school-centered vaccination programs were conducted throughout the country. Children in the 1- to 4-year age group were also included in many areas, and rubella vaccine was incorporated into the routine immunization schedule for preschool children. During the first 4 years of vaccine availability, 32 million doses were administered by public health agencies.[5] Recent survey data show that more than 80 per cent of children 5 to 9 years of age and approximately two-thirds of children 1 to 4 years of age were protected against rubella.[6] To date, an epidemic has not materialized. As long as protective levels can be maintained above 80 per cent in the highest priority group, it is unlikely that a national epidemic will occur.

Vaccine administration to adult women has proceeded more slowly. Prior to vaccination, serological screening is recommended, since 80 per cent of women are immune and do not need the vaccine. Despite the recommendation that vaccine not be administered to pregnant women and that they not become pregnant for 2 months following vaccination, more than 200 cases of rubella vaccination given shortly before or after conception have been reported to the Center for Disease Control (CDC).[7] Only 11 per cent of the women vaccinated had serological testing for rubella prior to vaccination; the remainder were of unknown immune status when vaccinated. Although no infants with congenital infection were born to those women, only a small number of women known to be susceptible have delivered thus far. Many women elected to undergo therapeutic abortions. Virological studies from abortion specimens have revealed the presence of rubella virus (vaccine-like) in fetal tissues on three occasions and in placenta of decidua in four others. There are no conclusive pathological data regarding developmental abnormalities. Thus, the question of the potential threat of rubella vaccine virus to the developing fetus remains unanswered, and it continues to be essential that the recommended precautions about serological testing and pregnancy be diligently followed for all postpubertal females considered for vaccination.

Antibody levels have declined very little during the 7-year period of observation of children who were among the first to be immunized with rubella vaccine.* Long- term protection is expected but can be documented only by continued observation.

Vaccinees exposed to natural rubella infection may have rises in antibody titers without clinical symptoms.[8,9] There is no detectable viremia and little pharyngeal excretion of virus associated with these reinfections. Spread of virus to susceptible contacts has not been documented.[10] Therefore, there is no evidence that rubella reinfection poses any risk for susceptible contacts. Further, the apparent absence of viremia suggests that immune women reinfected by rubella virus while pregnant would be unlikely to transmit virus to the fetus. Further study is continuing to define fully the clinical and public health significance of reinfection.

Rubella vaccination programs have been remarkably effective in providing high levels of immunity in a short period of time. The epidemic predicted for the early 1970s has not occurred. In fact, it is unlikely to occur because of the high levels of protection among young children. This is an outstanding public health achievement, an example of health protection in its finest form!

Mumps

A live mumps virus vaccine was introduced in 1968. Studies conducted prior to licensure showed that more than 95 per cent of susceptible persons develop antibodies following administration of the vaccine and there are no demonstrable clinical reactions.[11] Although antibody titers are considerably lower than those following natural infection, antibody persistence parallels that of overt mumps.[12] The duration of protection is not known; however, observations after 8 years show continuing protection against natural infection, and vaccine-induced antibodies persist without decline.†

Mumps is primarily a disease of young school age children; only 15 per cent of reported cases occur after puberty.[13] The disease is generally mild and self-limited. Although meningeal symptoms may complicate clinical mumps, overt central nervous system involvement is rare. Orchitis has been reported in up to 20 per cent of cases of clinical mumps in postpubertal males, but sterility rarely results.

Because mumps is less of a public health problem (compared, for example, to measles or rubella), the Public Health Service Advisory Committee on Immunization Practice has recommended that "mumps vaccination programs should not take priority over more essential community immunization activities."[15] As a result, public funds for the purchase of mumps vaccine have not been available in most areas. The incorporation of mumps vaccine into a combined measles-mumps-rubella (M-M-R) vaccine (see below) may permit more public agencies to begin routine use of mumps vaccine in the future.

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* Parkman, P. D. Personal communication, May, 1973.

† Hilleman, M. R. Personal communication, May, 1973.

Combined Viral Vaccines

Recently, several new viral vaccine combinations have been licensed in the United States, including measles-rubella (M-R) and measles-mumps-rubella vaccines. Both are administered as a single inoculation. Immunological responses are comparable to those seen following single antigen administration and the clinical reaction rates are not increased.[15]

The advantages of using combined vaccines include (1) reducing the number of clinic visits, particularly during the second year of life, when many children are lost to follow-up before completing the necessary immunizations and (2) reducing administrative costs. Since they first became available in 1971, combined vaccines are being used increasingly by health departments, particularly the M-R vaccine for immunization of preschool children. More than 3 million doses of the combined M-R vaccine were administered by public health agencies during the year 1972.

In addition to measles and rubella vaccines, a booster dose of trivalent oral poliovirus vaccine (TOPV) is also recommended during the second year of life. Following licensure of M-R and M-M-R vaccines, questions were raised by many health departments about the efficacy and safety of the simultaneous administration of M-R or M-M-R with TOPV. Because there were no available data, the Center for Disease Control and the Bureau of Biologics, Food and Drug Administration, conducted several studies designed to answer these questions. The results showed that when the licensed M-M-R combination vaccine is administered simultaneously with TOPV, the antibody responses are comparable to those following administration of the component vaccines at different times and there is no increase in frequency or severity of clinical reactions.[16] Accordingly, the Public Health Service Advisory Committee on Immunization Practice has recommended that the M-M-R and M-R vaccines may be given in simultaneously with a booster of TOPV.[17]

Smallpox Vaccination Reconsidered

The rationale for discontinuing the routine use of smallpox vaccination in the United States is based upon (1) the declining probability of introduction of cases of smallpox into the United States, (2) the reduced likelihood of significant spread of smallpox following an importation of the disease, and (3) the occasional occurrence of untoward side effects of vaccination. As recently as 1945, smallpox was considered endemic in a majority of countries (91) of the world, including the United States. Since 1945, smallpox has been eliminated from large geographic areas. The total number of countries reporting cases of smallpox has declined steadily: 61 in 1962, 23 in 1970, and only six countries early in 1973.[18] As the global incidence declines, there is a diminishing threat of introduction of smallpox into areas free of the disease. The risk of importation into the United States at present, based on current incidence in the remaining endemic areas of the world and frequency of travel from these areas, approximates one importation every 20 years.

Although smallpox has been feared as highly contagious, the control measures following the introductions of smallpox into Europe during the last decade have been

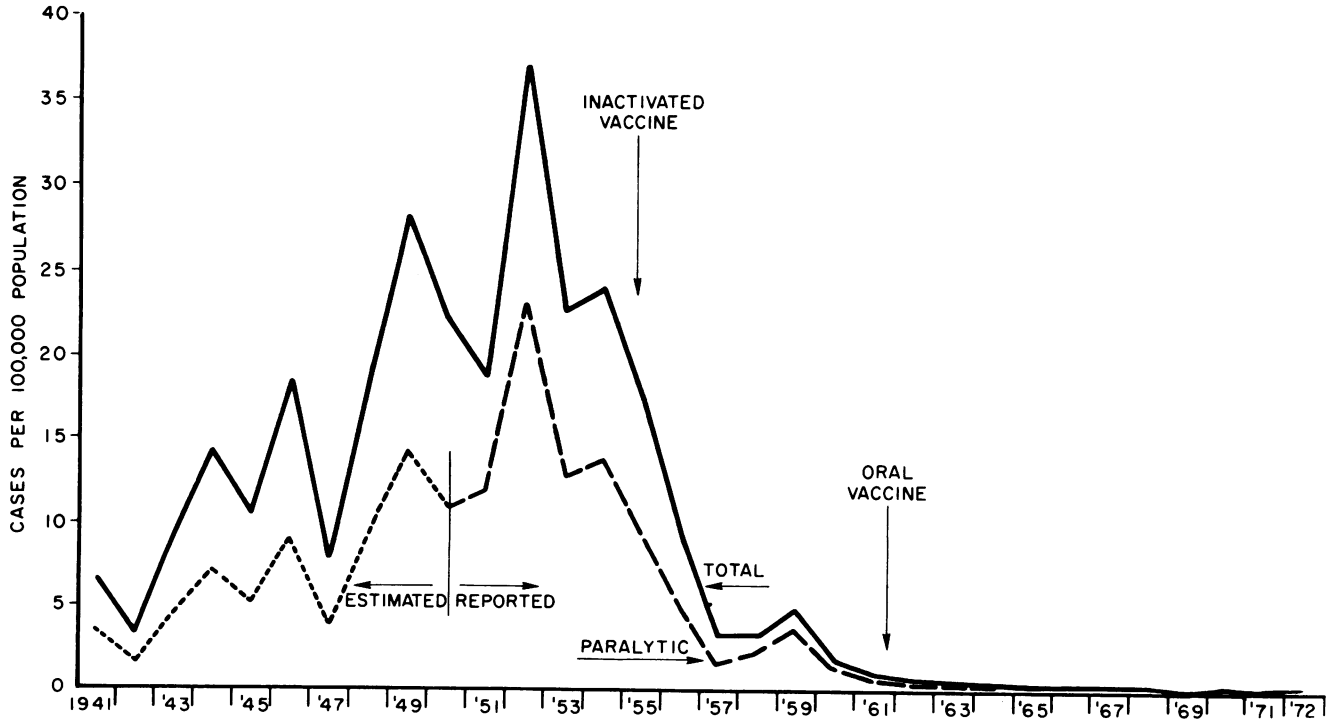

FIGURE 1 Annual poliomyelitis incidence rates in the United States, 1941–1972.

remarkably successful in reducing further spread of the disease. In the United States, where surveillance procedures are at least as effective as in Europe, the probability of a large outbreak occurring after an importation is exceedingly low.

Smallpox vaccination, on the other hand, has a definite measurable risk of untoward reactions and, on occasion, death. National surveys to determine the frequency of smallpox vaccine complications in the United States were conducted in 1963 and 1968.[19,20] In 1968, among 5.6 million primary vaccinees and 8.6 million revaccinees and their contacts, there were 16 cases of encephalitis, 11 cases of vaccinia necrosum, and 126 cases of eczema vaccinatum. Nine persons died. The majority of deaths and complications occurred following primary vaccination.

At present, with the risks from smallpox so small, the morbidity and mortality associated with universal vaccination can no longer be tolerated in the United States. Accordingly, a change in policy was announced by the Public Health Service and endorsed by the American Academy of Pediatrics discontinuing the recommendation for routine vaccination of children.[21] Vaccine continues to be recommended for travelers going to endemic or infected areas and for health personnel, who constitute the first line of defense after importation.

Elimination of routine smallpox vaccination can be viewed as the beginning of a new era for public health in the United States. A major plague is being effectively eliminated from the world through wide usage of an effective vaccine. In the United States, the risks associated with vaccination now outweigh whatever threat the disease itself may pose. For the first time, we are abandoning the routine use of a widely accepted and effective immunizing agent because the vaccine is now more of a hazard than the disease. This experience can provide a model for other disease control programs to emulate in the future.

Delivery of Immunization Services

The technology of delivering immunization services by public health agencies has not kept pace with the technology of developing new vaccines. Relatively few effective delivery techniques have been developed in the past decade. Vaccines are generally administered in (1) health centers or physicians' offices, (2) community programs, and (3) special, or selective, programs. When a new vaccine becomes available or when an epidemic is threatened, community immunization programs can be highly effective in delivering vaccines to a large number of people in a short period of time. The oral polio vaccination programs in the early 1960s ("Sabin on Sunday," etc.) and community vaccination programs against measles in the late 1960s were enormously successful in producing immunity in a large number of persons and significantly reduced the morbidity associated with these diseases. Following the community programs, interest in immunization against these diseases waned and attempts to vaccinate the susceptible children entering the population on a continuing basis have been notably less successful. These continuing efforts have included "routine" well child care by practicing physicians and public health agencies as well as special programs designed to immunize particular segments of this population (children entering school, attending day care centers or nursery schools, etc.). In an effort to achieve higher community immunization levels, many areas have enacted laws requiring specific immunizations prior to school entry. Laws have been enacted in 38 states and are currently pending in six additional states. Although methods of enforcement have varied, these laws, in general, have contributed to the improvement of immunization levels and the reduction of morbidity among school age children. In some areas, this legal authority to require specific immunizations extends to day care centers and nursery schools. However, this has not had a significant impact on the immunization levels of preschool age children.

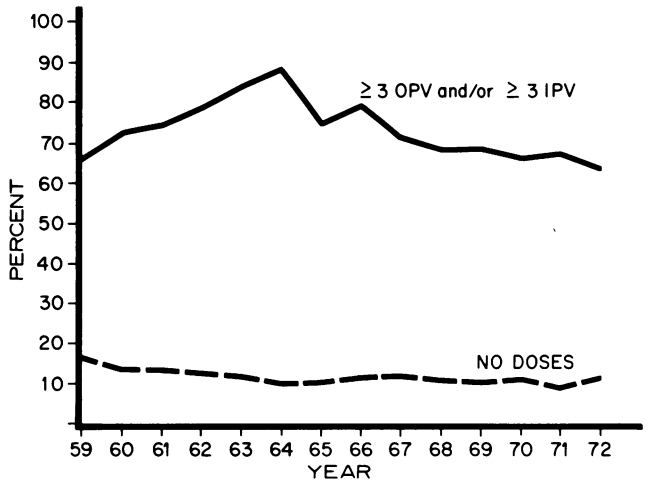

FIGURE 2 Polio immunization status of 1- to 4-year-old children, 1959–1972.

There are two methods utilized to evaluate the effcacy of the delivery system: (1) incidence of disease and (2) proportion of persons adequately immunized. Examination of the trends in both of these parameters for poliomyelitis and measles illustrates some of the deficiencies in our present delivery system. The annual incidence rates for poliomyelitis in the United States from 1941 through 1972 are shown in Figure 1. Since the introduction and wide use of oral polivovirus vaccine the incidence is just a small fraction of the rates recorded during the prevaccine era. There have been no major epidemics in the last 10 years. Obviously, vaccine use has had a significant impact on the incidence of poliomyelitis in the United States. The community oral poliovirus vaccine campaigns were conducted in 1962, 1963, and 1964. By 1964, 88 per cent of children in the 1- to 4-year age group received three or more doses of vaccine (Figure 2). Subsequently, immunization levels have declined steadily, and by 1972 only 63 per cent of children in this age group were adequately protected.[6] Not only have we failed to sustain the levels attained in community programs, we have reached relatively fewer children with vaccine with each succeeding

year. Clearly, the current delivery system for poliomyelitis immunization is inadequate. If this trend continues, epidemic poliomyelitis may recur in the United States, which would be a tragic way of reminding health personnel of the need for immunization.

The number of reported cases of measles in the United States between 1960 and 1972 is shown in Figure 3. Vaccine was introduced in 1963 and by 1968 there were only 22,000 reported cases of measles (compared to an average of 400,000 to 500,000 reported cases per year in the pre-vaccine era). Community measles vaccination programs were conducted in 1966, 1967, and 1968. In 1969, there were 25,000 reported cases of measles. This increased to 47,000 cases in 1970 and 75,000 cases in 1971. The proportion of preschool age children protected against measles has not changed significantly in the last 6 years (Figure 4).[6] National survey data for young school age children show a similar trend with no substantive change in recent years. Despite considerable publicity about the increasing incidence of the disease since 1971, there has been no observable change in the proportion of children protected against measles. This is hardly indicative of an effective delivery system for measles vaccination services.

Immunization is one public health program that offers great potential for disease control. The conquest of smallpox is an excellent example. Vaccines are available which are highly effective; however, they do not afford any protection unless they are removed from the bottle and given to people! The major public health advance in immunization for the 1970s can be the development of more efficient and comprehensive delivery systems. Better delivery of vaccines will be necessary to obviate polio epidemics in the future, to effectively prevent congenital rubella, and to achieve better control of measles and diphtheria. This will require a high priority and considerable effort on the part of health workers at local, state, and national levels. The goal of more effective disease prevention is worthy of this effort.

References

1. Parkman, P. D., et al. Attenuated Rubella Virus. I. Development and Laboratory Characterization. N. Engl. J. Med. 275:569—574, 1966.
2. Meyer, J. M., Parkman, P. D., and Panos, T. C. Attenuated Rubella Virus. II. Production of an Experimental Live-Virus Vaccine and Clinical Trial. N. Engl. J. Med. 275:575—580, 1966.
3. Witte, J. J., et al. Epidemiology of Rubella. Am. J. Dis. Child. 118:107—111, 1969.
4. Center for Disease Control. Rubella Surveillance

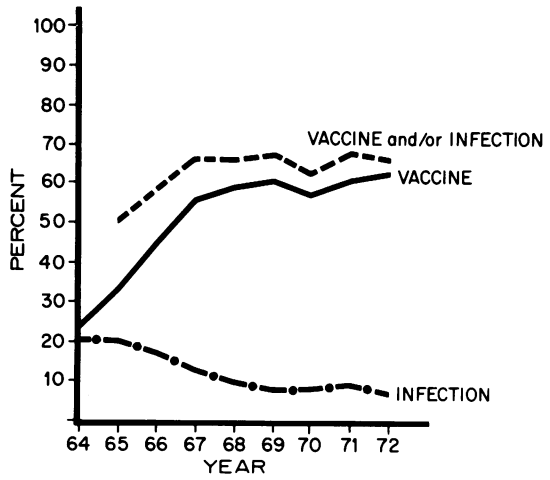

FIGURE 4 Measles immunization status of 1- to 4-year-old children, 1964–1972.

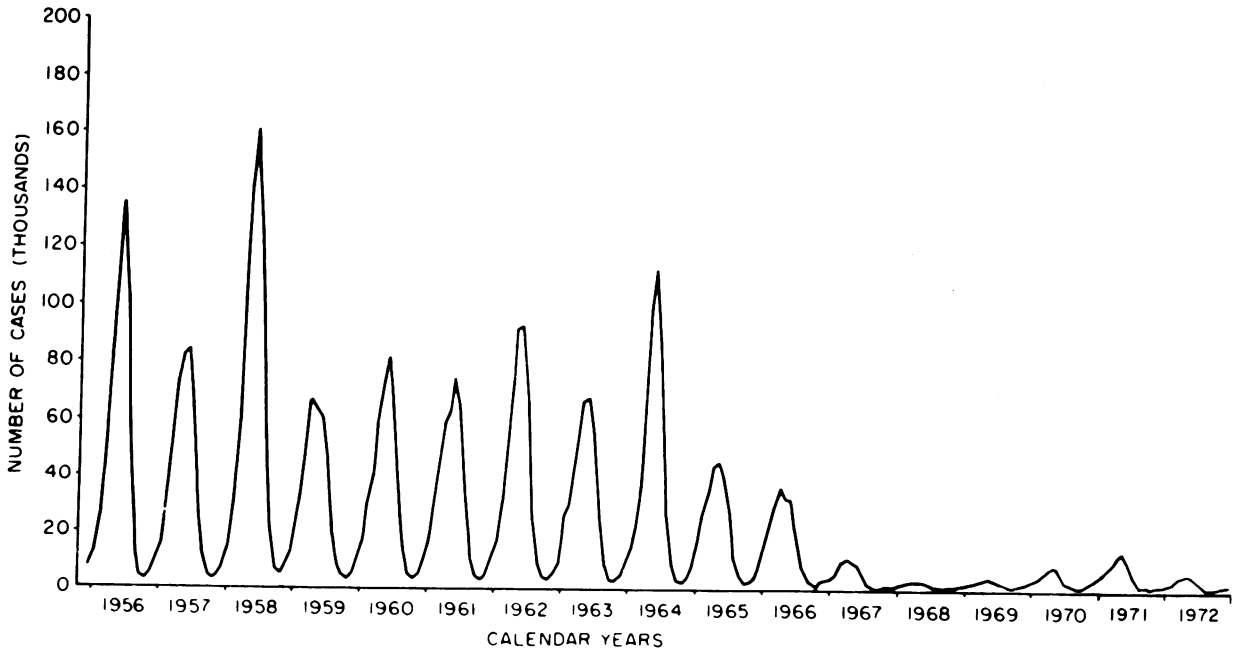

FIGURE 3 Reported cases of measles by 4-week periods in the United States, 1956 to December, 1972.

Report No. 1: 11-14, June, 1969.
5. Center for Disease Control. Rubella, Measles, Polio Immunization Status Report No. 20, June, 1973.
6. Center for Disease Control. United States Immunization Survey, 1972.
7. Wyll, S. A., and Herrmann, K. L. Risk to the Fetus from Inadvertent Vaccination of a Pregnant Woman. J. A. M. A. 225:1472—1476, 1973.
8. Abrutyn E., et al. Rubella Vaccine Comparative Study: Nine Month Followup and Serologic Response to Natural Challenge. Am. J. Dis. Child. 120:129—133, 1970.
9. Horstmann, D. M., et al. Reinfection of Vaccinated and Naturally Immune Persons Exposed in an Epidemic. N. Engl. J. Med. 283:711—788, 1970.
10. Meyer, H. M., and Parkman, P. D. Rubella Vaccination—A Review of Practical Experience. J. A. M. A. 215:613—619, 1971.
11. Hilleman, M. R., et al. Live Attenuated Mumps Virus Vaccine. N. Engl. J. Med. 278:227—232, 1968.
12. Weibel, R. E., et al. Measurement of Immunity Following Live Mumps (5 Years), Measles (3 Years), and Rubella (2 1/2 Years) Virus Vaccines. Pediatrics 49:334—341, 1972.
13. Witte, J. J., and Karchmer, A. W. Surveillance of Mumps in the United States as Background for Use of Vaccine. Public Health Rep. 83:95—100, 1968.
14. Center for Disease Control. Morbidity and Mortality Weekly Report. 25:13—14, July 24, 1972.
15. Boynaic, E. B. Combined Live Measles, Mumps and Rubella Virus Vaccines. J. A. M. A. 207:2259—2262, 1969.
16. Witte, J. J. Simultaneous Administration of Live or Killed Vaccines. In Symposia Series in Immunobiological Standardization, International Conference on the Vaccination Against Communicable Disease, Vol. 22, pp. 163—171, 1973.
17. Center for Disease Control. Morbidity and Mortality Weekly Report. 21:402—403, November 25, 1972.
18. World Health Organization Weekly Epidemiological Record, Vol. 48, No. 5, February, 1973.
19. Neff, J. M., et al. Complications of Smallpox Vaccination. I. National Survey in the United States 1963. N. Engl. J. Med. 276:125—132, 1967.
20. Lane, J. M., et al. Complications of Smallpox Vaccination 1968. J. Infect. Dis. 122:303—304, 1970.
21. Center for Disease Control. Morbidity and Mortality Weekly Report. 20:339—345, September 25, 1971.

LEGAL ASPECTS OF COMPUTER USE IN HEALTH CARE DELIVERY IS SUBJECT OF NATIONAL CONFERENCE

A national conference on the Legal Aspects of Computer Use in Health Care Delivery will be held November 7 and 8 in Boston, MA, under the sponsorship of the American Society of Law and Medicine and Blue Shield of Massachusetts.

Topics on the program will include: "How Computers Relate to Health-Care Delivery," "Present and Reasonably Potential Applications of Computers in Health-Care Delivery, and "Common Information Processing Deficiencies in Health-Care Delivery and Their 'Legal' Consequences."

The program has been approved for 15 hours accreditation toward the Physician's Recognition Award of the American Medical Association. Application for accreditation for 15 elective hours has been made to the American Academy of Family Practice.

Conference details are available from the American Society of Law and Medicine, 454 Brookline Ave., Boston, MA 02215.