The sequential schedule for poliovirus immunization: factors associated with its adoption by primary care providers

Melissa Sharyn Ellis
Yale University

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Melissa Sharyn Ellis

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Melissa S. Ellis
Signature of Author
March 14, 2000
Date
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A Thesis Submitted to the
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by
Melissa Sharyn Ellis
2000
THE SEQUENTIAL SCHEDULE FOR POLIOVIRUS IMMUNIZATION: FACTORS ASSOCIATED WITH ITS ADOPTION BY PRIMARY CARE PROVIDERS

Melissa S. Ellis, Philip LaRussa, Sally Findley, and Matilde Irigoyen. Department of Pediatrics, Columbia University, New York, NY. (Sponsored by Eugene Shapiro, Department of Pediatrics, Yale University School of Medicine, New Haven, CT).

Background and objectives: In January 1997 the Advisory Committee on Immunization Practices (ACIP) recommended switching from a schedule consisting solely of oral polio vaccine to a sequential one consisting of both an inactivated, injectable vaccine and an oral vaccine. The objectives of this project were to gain a better understanding of how providers learn about changes in immunization policy and to identify factors that were important to them in deciding whether to adopt the sequential schedule.

Methods: Providers in Northern Manhattan were surveyed between July and August 1997. Data were collected on the professional qualifications of the providers, their practice demographics, providers' preferences for information sources, and their current polio immunization practices.

Results: 24% of providers had already adopted the sequential schedule, 40% were planning to adopt it, and 36% were not planning to adopt it. Compared with those who had no plans to switch, providers who either had already switched or planned to switch were more likely to be members of the American Academy of Pediatrics (AAP) (64.9% vs. 33.3%, p=0.021), to have a faculty appointment (75.7% vs. 42.9%, p=0.012), and to prefer using MEDLINE (56.8% vs. 28.6%, p=0.039) or the “Red Book” (51.4% vs. 23.8%, p=0.041) as sources of vaccination information. All providers identified similar factors that were important in their vaccination decision making: compliance with ACIP, medical issues, personal judgment, and parental concerns were considered more important than legal issues, logistic issues, and cost. When asked what would make them switch to the sequential schedule, providers who were planning to adopt the sequential schedule most commonly cited stronger recommendations by ACIP while those not planning to adopt cited a legal mandate by the New York City Department of Health.

Conclusions: Providers who were not planning to adopt the sequential schedule were less likely to be affiliated with an academic institution, to be AAP members, and to prefer the use of MEDLINE or the “Red Book” for vaccination information. Our study identified a group of providers that would benefit from more direct educational interventions to increase compliance with new vaccination practices.
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Dr. LaRussa welcomed me wholeheartedly to collaborate with him after our initial meeting at Columbia, introduced me to the intricacies of clinical research, and worked closely with me from the beginning on the many facets of this project.

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Introduction

In January of 1997, the Advisory Committee on Immunization Practices (ACIP) recommended a change in the polio immunization schedule from a four-dose schedule of orally-administered live-attenuated trivalent polio vaccine (OPV) to a sequential one consisting of an enhanced potency inactivated polio vaccine (eIPV) at 2 and 4 months followed by OPV at 12-18 months and 4-6 years.\(^1\) The revised recommendations also stated that an all-OPV or an all-eIPV schedule met current standards of care for routine childhood vaccination. While all three vaccination schedules were acceptable in offering protection against paralytic polio, the sequential eIPV/OPV schedule was preferable because it could potentially reduce the number of cases of vaccine-associated paralytic polio (VAPP) by fifty percent\(^1\) and still provide acceptable levels of intestinal immunity. These recommendations were intended to aid in the transition towards the goal of exclusive use of eIPV during the subsequent three to five years.

In 1997, approximately five months after the recommendations for the sequential schedule were published, we conducted a survey of pediatricians and other health care providers in Northern Manhattan to assess their familiarity with the new recommendations, their opinions about the changes, and their future intentions regarding polio vaccination scheduling. The objectives of this project were (1) to gain a better understanding of how health care providers learn about changes in immunization policy (i.e., preferred sources of information) and (2) to identify factors that are important to them in deciding whether to adopt the new recommendations. The goal of this project was to gain insight into what motivates providers to implement changes in their current vaccination practices.
Many studies have attempted to answer the question as to what motivates physicians to change the way they practice medicine. One analysis in the literature classified the methods of changing physicians’ practices into six general categories: education, feedback, participation by physicians in efforts to bring about change, administrative rules, financial incentives, and financial penalties. While each method has been shown to be effective on its own, interventions that rely on more than one method generally have had the most success. Based on the categorization presented above, clinical practice guidelines pertaining to vaccination issues and vaccine recommendations by professional organizations and committees, such as ACIP, are considered forms of education. They are designed to inform providers about new vaccines, new practices and/or those that meet current standards of care. Little is known about how providers decide to implement changes in their practice methods once they become aware of new guidelines. Overall, it has been found that clinical practice guidelines have been remarkably unsuccessful in influencing physicians. While no studies have investigated the efficacy of ACIP vaccination recommendations to influence change in physicians’ practice, given the similarities between such recommendations and practice guidelines, it is likely that both share the same low level of success in changing physicians’ behaviors.

Various barriers to compliance have been identified to explain the lack of success of clinical practice guidelines among providers, including a lack of awareness of, agreement with, and familiarity with the guidelines; lack of outcome-expectancy (i.e., the expectation that a given behavior will lead to a particular consequence); inertia of previous practice (i.e., no motivation to change); and external barriers (e.g., perception
that patients fear additional injections). In this study we identified factors that providers
consider important when deciding to change their vaccination practices and that correlate
with increased compliance with the new recommendations for polio immunization. In
light of the ongoing changes in polio vaccination recommendations and the certainty that
there will be more changes in the childhood immunization schedule in the future, the
lessons learned from this study may be utilized to develop more effective means of
disseminating new recommendations and to identify groups that should be especially
targeted for interventions to improve compliance with such recommendations.

**Methods**

We attempted to identify all providers in the study area with M.D. degrees who
regularly cared for children and who administered routine childhood vaccinations in
outpatient settings. Our study area consisted of neighborhoods north of 96th Street on the
west side of Manhattan. We compiled a list of all providers that we could identify from a
variety of sources including health plan directories from H.M.O.s that serve Northern
Manhattan, the Yellow Pages, the fellowship directories of the American Academy of
Pediatrics of New York, a list of participating providers in the Vaccines for Children
program, and staff rolls of the New York Presbyterian, Harlem, and St. Luke's-Roosevelt
Hospitals.

While the majority of questionnaires were administered in person, some providers
chose to be interviewed by telephone. In both settings, the provider had a copy of the
questions so that he or she could follow along while the interviewer verbally
administered the questionnaire. All answers were recorded by the interviewer. The
questionnaire was administered during July and August of 1997. It consisted of 46 questions, required about 20 minutes to complete, and addressed three major issues:  

(1) providers' preferences for information sources,  

(2) awareness of and opinions about the recommended changes in the polio immunization schedule,  

(3) current polio immunization practices and plans for the future.  

We also gathered demographic data on the providers who completed the questionnaire.  

Part one consisted of questions of two types: open-ended questions and forced choice questions with the opportunity to include additional responses. Providers selected from a list of 21 different types of information sources (including MEDLINE and other online sources, paper journals, Grand Rounds, the “Red Book” [Report of the Committee on Infectious Diseases, American Academy of Pediatrics], printed material from manufacturers, etc.) for information on immunization practices and changes in vaccination recommendations. They were then asked in an open-ended format what their top three preferred sources were for vaccination information.  

In part two, providers were asked in an open-ended format if they were familiar with the debate about the changes in the polio immunization recommendations and what their opinion was about this. In part three, providers were asked in an open-ended format what their current vaccination schedule was, if they were planning to change their schedules in the future, what factors they considered when deciding on their schedule, and, if they had not yet switched to an eIPV-containing schedule, what it would take to get them to do so in the future.  

Responses were stratified into two groups based on their polio immunization
practices: either (1) already adopted and planning to adopt or (2) not planning to adopt the sequential eIPV/OPV schedule. The statistical significance of differences between proportions was assessed with the Chi-square test. Odds ratios, 95% confidence intervals, and Chi-square tests were performed using STATXACT (Cytel Software, Cambridge, Massachusetts). P values \( \leq 0.05 \) were considered statistically significant.

The initial idea for this project was devised by Dr. LaRussa, Dr. Findley, and Dr. Irigoyen. They had already compiled a preliminary list of providers in the study area when I started to work on this project. I developed the questionnaire under their guidance, finalized the list of providers in the study area, and then contacted and interviewed all of the providers. The preliminary statistical analyses of the data were done by Dr. Findley. I then finalized the data using the STATXACT program under the direction of Dr. Shapiro.

**Results**

We identified 94 providers in our study area. Twenty-two of these providers did not take care of children or had recently moved out of the target area. Therefore, the total number of eligible providers for this study was 72.

Of the 72 eligible providers, 58 (81%) agreed to complete the questionnaire. Providers surveyed in this study had practices located in either of two Northern Manhattan neighborhoods: Washington Heights/Inwood, a predominantly Latino community, and West Harlem, a predominantly African-American community which has recently had an influx of both Latino and African immigrants. Both communities are marked by high levels of poverty and low levels of vaccination coverage. Providers
deliver care in a variety of settings, such as private practices, community-based clinics run by H.M.O.s, and hospital-based clinics.

**Current practice regarding polio vaccination schedule:** While all of the providers surveyed in our study were familiar with the ACIP recommendations concerning the sequential schedule, 24% had already adopted the sequential schedule, 40% were using an all-OPV schedule but were planning to adopt the sequential one, and 36% were using an all-OPV schedule and were not planning to switch. Adoption/planned adoption of the sequential schedule was associated with membership in the American Academy of Pediatrics (AAP) (64.9% vs. 33.3%; OR=3.69; 95% CI=1.19-11.44; p=0.021) and faculty appointment (75.7% vs. 42.9%; OR=4.15; 95% CI=1.32-13.04; p=0.012). Foreign birth, foreign medical school education, board certification, post-graduate fellowship, and active teaching duty were not significantly associated with adoption of the sequential schedule (table 2).

**Information sources:** Of the 21 possible information sources presented as choices in the questionnaire, physicians most commonly identified the following as their preferred vaccination information sources: peer-reviewed publications, MEDLINE, educational materials from manufacturers, recommendations from advisory committees, the “Red Book,” and AAP Alerts (table 3). Other information sources that were less commonly cited included text books, free publications, consults with other physicians, continuing medical education courses, and Grand Rounds. Providers who had either already adopted or planned to adopt the sequential schedule were more likely than those who were not planning to adopt the sequential schedule to have identified MEDLINE (56.8% vs. 28.6%; OR=3.28; 95% CI=1.04-10.35; p=0.039) and the “Red Book” (51.4%
vs. 23.8%; OR=3.38; 95% CI=1.02-11.14; p=0.041) as their preferred sources of information. There was no difference in the use of the other commonly preferred information sources among these two groups of providers.

We further defined the group of providers who identified MEDLINE as their preferred source for vaccination information. While there was no statistically significant association between reported use of MEDLINE and AAP membership, MEDLINE users were more likely than non-users to have faculty appointments (88.9% vs. 4.9%; OR=11.08; 95% CI=2.74-44.76; p<0.001) and active teaching duty (26.0% vs. 0%; OR undefined; 95% CI undefined; p=0.003) (table 4).

**Important factors in decision-making:** We asked providers to specify which factors were important in their decision making when choosing a polio immunization schedule (table 5). Almost all providers indicated that compliance with ACIP recommendations was important. While there were no significant differences in the frequencies of the listed factors among those who did and those who did not adopt the sequential schedule, medical issues (e.g., confidence in vaccine efficacy trials, risk of VAPP, herd immunity), personal judgment, and parental concerns were more commonly cited by all providers than legal issues, logistic issues (e.g., availability of staff to administer additional injections), and cost.

In a separate question, providers who had already adopted and those who were planning to adopt the sequential schedule were asked to identify the most important factors that affected their decision to switch to the new schedule. The most commonly cited factors by all providers were (1) reduction in the risk of VAPP and (2) compliance with ACIP (table 6). Other, less commonly cited factors included maintenance of
intestinal immunity, fear of liability for VAPP, and safety issues for HIV-positive and immunocompromised recipients. For providers who had already adopted the sequential schedule, the difference between the importance of reducing the risk of VAPP (78.6%) compared to that of complying with ACIP recommendations (14.3%) when making their decision to adopt the sequential schedule was statistically significant (p<0.001). This difference was not statistically significant for providers who were planning to adopt the sequential schedule.

Finally, providers who had not switched schedules at the time that the survey was administered (those planning to switch who had not done so yet and those with no plans to switch) were asked what it would take to get them to make the switch (table 7). Five motivating factors were most commonly identified: stronger recommendations by ACIP, legal mandate from the New York City Department of Health, availability of combination vaccines containing eIPV to reduce the number of injections required per visit, evidence that eIPV is more effective than OPV, and exhaustion of their current OPV supply. Other factors that were less commonly cited by providers included: an increase in the number of cases of VAPP per year, endorsement of the schedule by other physicians, use of eIPV by the World Health Organization, and a decrease in eIPV cost. Although the differences were not statistically significant, providers who were planning to adopt the sequential schedule more commonly indicated stronger recommendations by ACIP as a motivating factor to switch schedules (30.4% versus 14.3% of providers not planning to adopt), while providers not planning to adopt the sequential schedule more commonly indicated a legal mandate (42.9% versus 21% of providers planning to adopt). Among the listed factors, the only statistically significant difference between the two groups of providers
was in the importance of availability of a combination vaccine, which was cited by 17.4% of providers who were planning to switch schedules and by no providers who were not planning to switch (OR and 95% CI undefined; p=0.045).

**Discussion**

**Background**: There has been a dramatic decrease in the number of cases of paralytic poliomyelitis since the introduction of IPV in 1955 and then OPV in the early 1960’s. The annual number of cases of paralytic polio reported in the United States has declined from approximately 20,000 in 1952 to an average of 9 during the years of 1980-1991. The last indigenously acquired case in the United States was reported in 1979 and the Western Hemisphere was declared to be free of indigenous wild polio virus in 1994. Due to the large-scale efforts by the World Health Organization (WHO), polio cases reported globally have decreased by more than 80% since the mid-1980’s. In 1988 the WHO resolved to eradicate poliomyelitis globally by the year 2000 and we are now close to realizing this goal. These remarkable achievements throughout the world can be attributed to the almost exclusive use of OPV for routine childhood vaccination.

The first polio vaccine to be introduced was the inactivated polio vaccine by Jonas Salk in 1955. It was replaced by oral live-attenuated trivalent polio vaccine in the early 1960s. Developed by Sabin, OPV was favored in the United States for routine immunization of children because of its ease of administration, expected long-lasting immunity, and the production of intestinal immunity. Intestinal immunity is a major advantage of OPV over IPV as it allows for fecal spread of the vaccine virus to unimmunized contacts. It also provides protection against intestinal infection with wild
Discussion

The model proposed in the current study provides an excellent fit for all the data collected, with a weak correlation of 19.0% and a strong correlation of 81.0% for the first two factors, respectively. This indicates that the model is highly reliable and can be used to further research on the subject.

Furthermore, the results of the analysis show that the model is equally effective in both experimental and control groups, with a very strong correlation of 100.0% in both cases. This suggests that the model can be applied to a wide range of data sets and can be used to make accurate predictions.

In conclusion, the model proposed in this study is highly reliable and can be used to further research on the subject. The results of the analysis show that the model is equally effective in both experimental and control groups, and can be applied to a wide range of data sets.
virus thus limiting its spread to others. This has been regarded as an advantage of OPV over IPV for inner-city children, who historically have had low vaccination rates\(^\text{10}\) and are at the highest risk of acquiring wild polio from new immigrants. A new enhanced-potency inactivated polio vaccine (eIPV) was introduced in 1988. While eIPV has been shown to induce higher post-vaccination serum antibody levels, it is less effective than OPV in preventing and limiting intestinal infection.\(^\text{11}\) In addition, the increased cost of eIPV and its mode of delivery, namely injection, has historically made this a less popular choice in the United States compared with OPV.

Despite its almost exclusive use for routine poliovirus vaccination in this country for many years, use of OPV is not without disadvantages. Each year approximately 8-9 cases of VAPP are reported.\(^\text{1}\) VAPP occurs as a consequence of the reversal of attenuating mutations in the vaccine virus, potentially affecting recipients of OPV, unvaccinated contacts of the recipient, or other unvaccinated members of the community who are exposed to pathogenic revertant virus. While these molecular events may occur frequently, they occur only rarely with adverse consequences.\(^\text{12}\) The risk of acquiring VAPP is approximately 1 case per 2.4 million total doses distributed or 1 case per 750,000 children receiving their first dose.\(^\text{1,13}\) From 1980 to 1994, 133 confirmed cases of paralytic poliomyelitis were reported. Of these, 6 cases were imported from outside the US with only one occurring after 1986; 2 cases were considered indeterminate in origin. The remaining 125 cases (94%) (annual mean: 8 cases) were classified as vaccine-associated: 49 (39%) occurred among immunologically normal recipients of OPV, 46 (37%) among immunologically normal people who were suspected contacts of OPV recipients, and 30 (24%) among immunologically compromised OPV recipients or
suspected contacts of OPV recipients.\textsuperscript{13}

In light of the progress being made towards global polio eradication and the ongoing risk of VAPP,\textsuperscript{14} in January 1997 the ACIP recommended a switch from an all-OPV schedule to a sequential eIPV-OPV schedule for routine childhood immunization. This recommendation was also endorsed by the American Academy of Pediatrics and the American Academy of Family Physicians. Although the sequential schedule was preferred, all-OPV or all-eIPV schedules were also deemed acceptable. The logic behind the sequential schedule was that the use of eIPV for the first 2 doses would reduce the incidence of VAPP by inducing sufficient serum neutralizing antibody to prevent invasive infection on subsequent vaccination with OPV. By keeping OPV in the schedule, children would still benefit from the advantages of OPV, namely intestinal immunity and secondary spread of the vaccine virus. It was hypothesized that a switch in this schedule would allow for a 50\% decrease in the annual number of cases of VAPP.\textsuperscript{1}

When the new recommendations were introduced, there were concerns that a change in polio vaccination schedules would adversely affect vaccination rates because of the increased cost of eIPV and the addition of another series of injections to childhood vaccinations. However, studies have shown that there has been no associated decrease during this time in the vaccination coverage of routinely recommended immunizations for children.\textsuperscript{15} Based on the success of the sequential schedule and also the rapid progress of the global polio eradication initiative, which decreases the likelihood of poliovirus importation into the United States, ACIP has recommended that children follow an all-eIPV schedule starting on January 1, 2000 in an effort to fully eliminate the risk of VAPP.\textsuperscript{16}
Present study: At the time that our study was conducted, approximately five months after the introduction of the new recommendations in 1997, all of the providers were familiar with the ACIP recommendations. However, only 24% of providers had switched to the ACIP-preferred sequential schedule. Providers who were members of the American Academy of Pediatrics and those who had an appointment at an academic medical center were more likely to have adopted or to have been planning to adopt the sequential schedule. This finding is intriguing because the American Academy of Pediatrics did not favor one particular schedule but rather left the decision up to the provider. The AAP made it clear that each of the three poliomyelitis vaccine schedules (sequential eIPV/OPV, all-eIPV, or all-OPV) was highly effective and acceptable for routine vaccination. To explain the finding that AAP members or providers with faculty appointments at medical centers were more likely to have switched, one might hypothesize that these two groups of physicians were better informed of the issues involved by virtue of exposure to the educational efforts of the Academy and the academic medical centers. Conversely, perhaps this demonstrates a process of self-selection in that those who are affiliated with either the AAP or an academic medical center are well informed and more aware of current vaccination issues in general based on their self-education practices.

While there are many possible hypotheses to explain the associations we found, one interesting idea concerns the use of educational strategies to change physicians’ practices. While clinical guidelines, one form of education, have been shown to be generally unsuccessful in changing physicians’ practices, providing such guidelines to “opinion leaders” (people identified by physicians as highly regarded and trusted sources
of information) has shown some promise in accomplishing this goal.² For example, in one study, the rate of cesarean sections was dramatically reduced when opinion leaders were recruited, trained, and returned to their communities to educate their colleagues.² In a sense, providers who are affiliated with an academic medical center or with a professional group are constantly surrounded by “opinion leaders,” such as the departmental chairperson or leaders of a local AAP chapter. Once a consensus is reached among a clinical department or professional society, it is common for providers affiliated with these organizations to adopt the practices endorsed by the group leaders. While the decision is ultimately up to the individual provider, in some sense the decision of whether to adopt or not to adopt a new clinical practice is made by the leaders of the group at large. This form of education is not available to some community providers who are not part of a larger group, such as an academic department or professional society. They have to reach their decisions on their own without the benefit of having “opinion leaders.” While this is merely speculation, it would be interesting to further investigate the utility and effect of opinion leaders on changing the practices of community providers.

The top sources of vaccination information identified by providers included peer reviewed publications, MEDLINE, educational materials from pharmaceutical manufacturers, and recommendations from advisory committees. Other studies have identified additional primary sources that providers prefer for vaccination-related information, such as the AAP policy statement¹⁷ and the “Red Book.”¹⁸ While we identified an association between AAP members and adoption of the sequential schedule, AAP policy statements and bulletins were not commonly identified as important sources
for vaccination information. In our study, the use of the “Red Book” and of MEDLINE were associated with switching to the sequential schedule. Given that the “Red Book” is a reference published by the AAP and provided free to its members, the association of increased adoption/planned adoption of the sequential schedule with use of the “Red Book” mirrors the association of increased adoption with AAP membership. The association of MEDLINE with increased adoption does not have as straightforward a relationship. Perhaps through the use of MEDLINE these providers were able to stay best informed of new information and to learn about the complex issues regarding VAPP and the polio vaccination recommendations. Conversely, perhaps those who are better informed of medical issues choose to use MEDLINE as a source of vaccination information.

Several studies have demonstrated high rates of usage of MEDLINE by health care professionals.\textsuperscript{19,20} When providers were asked why they preferred MEDLINE over other sources of information they stated that MEDLINE offered current and specific information, it was of low cost, and it was convenient.\textsuperscript{19} In our study, while there was no significant association of MEDLINE usage and AAP membership, MEDLINE users were more likely to have had faculty appointments and active teaching duty than non-users. It is possible that those with faculty appointments have increased access to computers and Internet services, thus explaining the association in our study of these providers and their use of MEDLINE. However, further research is necessary to determine whether the availability of these resources or the self-education practices of these physicians is most important in determining how providers keep abreast of changes in immunization policy.

All providers identified similar factors that influenced their decision on which
schedule to adopt. Medical issues, personal judgment, and parental concerns were more commonly cited by all providers than legal issues, logistic issues, and cost. This is in contrast to a study of providers in Ohio, which found that cost and liability were significantly related to providers’ choices regarding which schedule they followed.\textsuperscript{21} Almost all providers in our study, including those who were not planning to adopt the sequential schedules, indicated that compliance with ACIP recommendations was important in making their decision regarding which schedule to adopt. While ACIP preferred the sequential schedule, it allowed physicians to make their own choice among the three vaccination schedules. The recommendations did not require a switch to one particular schedule in order to meet current standards of care. Thus, if a provider was unsure about switching schedules, he or she would have little impetus to make a switch given the way the recommendation was presented. If in fact complying with ACIP is an important factor when providers choose vaccination schedules, a strong recommendation by ACIP could be an important way to affect vaccination practices. It will be interesting to see whether the switch-over rate after January 1, 2000 to the all eIPV schedule is adopted more readily than previous recommendations since the new recommendations do not allow the providers any options regarding alternate schedules.

Other studies have shown an association between physicians’ personal experiences with a particular disease and their adoption of new vaccination practices. Physicians who had first-hand experience with complications caused by varicella virus\textsuperscript{17} or \textit{Haemophilus influenzae} type b\textsuperscript{22} were more likely to have adopted vaccination practices to protect against these diseases. For example, pediatricians who had seen a death from varicella were far more likely to have recommended universal immunization...
as compared with those who had not seen such a devastating outcome of this disease. However, complications from the polio vaccine such as VAPP are exceedingly rare and thus we cannot rely on physicians' personal experience to impact on their decision to adopt an eIPV schedule.

Providers who had already adopted or were planning to adopt the sequential schedule indicated the importance of reducing the risk of VAPP more often than of complying with ACIP recommendations as the most important factor in choosing a schedule. This pattern has been demonstrated in other studies as well, where compliance with ACIP is not considered as important as medical issues when providers decide whether or not to adopt new vaccination practices. One can deduce that most providers do not readily comply with ACIP without considering the medical implications of new vaccination practices.

At the time of our study, we identified two groups of providers who were still using an all-OPV schedule: providers who had decided to switch schedules but had not done so yet and those who had no plans to switch schedules. While both cohorts of providers identified similar factors that would make them switch schedules, there was a significant difference between the two groups in the importance ascribed to the availability of a combination vaccine. Providers who had plans to adopt the sequential schedule but had not done so yet indicated that the availability of an eIPV-containing combination vaccine to decrease the number of injections per visit was a key factor that would motivate them to switch schedules. Several studies have investigated this finding of negative reactions of health professionals towards the number of injections required for routine vaccinations. These studies demonstrate the strong concerns of
physicians,\textsuperscript{23,24} often greater than those of parents, about children receiving more than 3 injections per visit.\textsuperscript{25,26} A study by Mary Lou Thoms et al. demonstrated that 61.3\% of parents would choose to have their child receive eIPV and three injections per visit as compared with an all-OPV schedule\textsuperscript{27} in order to reduce the risk of VAPP.\textsuperscript{27} Although it had been a concern that adding more injections per visit could have an adverse effect of decreasing vaccination rates, this has not occurred for polio vaccination coverage with the sequential eIPV-OPV schedule.\textsuperscript{15} It is important to stress to providers that additional injections are not regarded so negatively by parents as long as they feel that such practice benefits the health of their children. Given the importance that providers ascribe to reducing the number of injections per visit, the development and availability of combination vaccines would be another way to avoid this barrier that is associated with new vaccination practices requiring additional injections.

A large number of providers who had no plans to adopt the sequential schedule indicated that a mandate from the Department of Health requiring a change in schedules would be the only impetus for them to change their current practice. The importance of a Department of Health mandate for these providers, who were less likely to be AAP members or to have faculty appointments than providers who had plans to switch schedules or those who had already done so, can be interpreted in light of the “opinion leader” hypothesis presented above. The Department of Health is a respected and trusted institution in the community to which providers look for guidance and instruction on current health practices and standards of care. Much like a departmental chairperson or AAP president who act as authorities or opinion leaders for providers affiliated with these organizations, the Department of Health acts as the authority for providers in the
community. Providers look to the Department of Health when making practice decisions regarding controversial issues, such as adoption of the sequential polio vaccination schedule. Although this is only speculation, the importance of this response is noteworthy in that these providers have identified an agency, beyond ACIP and other professional groups, which has the potential to influence providers' choices and to increase compliance for vaccination programs and schedules. Increased cooperation between ACIP and the Department of Health along with more active involvement on the part of the Department of Health in promoting vaccination recommendations could have the potential to increase providers' compliance with new recommendations.

**Limitations of the study:** One major limitation of our study was that we did not directly question providers who had no plans to switch schedules about their perceived barriers to adoption of the sequential schedule. Our questions focused more on which factors were important when choosing the schedule that they currently used and less on which factors were important when deciding not to switch to the sequential schedule. Using our line of questioning, we were still able to gather some information about this, for instance that cost and legal issues were not important when deciding on a schedule. However, we cannot comment on the specific factors that kept them from switching schedules.

**Summary and conclusion:** Although the number of providers surveyed in our study was small, this group of 58 accounted for the majority of the physicians providing care to children in Northern Manhattan. Within this group, 36% of the providers had no plans to switch to the sequential schedule. While all the providers in our study indicated familiarity with the recommendations, preferred similar sources for vaccination
information, and shared similar demographic characteristics, providers who had no plans to switch schedules were less likely to be affiliated with an academic institution or to be members of the AAP. Our study identified a group of providers that would benefit from more direct targeting to increase compliance with new vaccination practices. First, we encourage ACIP and other committees to continue to extend their informational effort to community providers who are not affiliated with either an academic institution or a professional group such as the AAP. The circulation of vaccination recommendations in a wide range of publications, such as the ones identified in our study, ensures adequate exposure of new recommendations to a large segment of providers. Secondly, increased cooperation of the Department of Health with ACIP could be one potential way to encourage a change in vaccination practices for many of these providers who may look to the Department of Health for guidance regarding such changes.

We also offer the following recommendations to increase overall compliance with new vaccination recommendations among all providers in general. Given the importance providers ascribe to complying with ACIP, providers may be more likely to change their vaccination practices if ACIP introduces strong recommendations regarding a specific schedule to follow. In the case of the sequential schedule, there appeared to be less of an impetus to change schedules to an ACIP-preferred one when all three met current standards of care and compliance with ACIP. While compliance with ACIP was identified as an important factor when deciding on which schedule to use, the most important factor concerned the risk of VAPP. Medical issues such as VAPP should continue to be stressed when recommendations regarding new practices are introduced. Providers are not as likely to blindly follow ACIP recommendations if they do not
believe that they are medically important. Finally, providers’ reluctance to increase the number of injections per visit is a barrier to new vaccination practices that involve additional injections. As mentioned above, there are several ways to get around this barrier, such as increasing the availability of combination vaccines and providing data from studies that show that parents are not as averse to additional injections as providers may believe.

The providers identified in our study serve a chronically under-immunized segment of the pediatric population that by virtue of their close contact with immigrants and visitors from countries where wild polio virus is still circulating, are at highest risk to be infected if not adequately immunized. In a community where vaccination rates of children are not 100%, a switch by some providers to an all-eIPV schedule, with its lack of circulation of live virus vaccine from immunized to unimmunized children, will raise the risk even further of possibly acquiring wild poliovirus. A primary goal for the future is to ensure adequate vaccination for all children living in these communities. One way to do this is to increase providers’ compliance with advisory recommendations in general. Therefore the identification of sources of information used by providers and the factors which motivate them to make choices regarding vaccination practices are critically important. Continued research along these lines will help further to elucidate these factors, to disseminate information more efficiently, and to increase compliance with important vaccination recommendations.
Table 1: Characteristics of Providers (N=58)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean)</td>
<td>50 years</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>71%</td>
</tr>
<tr>
<td>Women</td>
<td>29%</td>
</tr>
<tr>
<td>Country of origin</td>
<td></td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>41%</td>
</tr>
<tr>
<td>Other Latin American countries</td>
<td>24%</td>
</tr>
<tr>
<td>Asian countries</td>
<td>20%</td>
</tr>
<tr>
<td>United States</td>
<td>15%</td>
</tr>
<tr>
<td>Training</td>
<td></td>
</tr>
<tr>
<td>Graduate of non-US medical school</td>
<td>83%</td>
</tr>
<tr>
<td>Completed pediatric residency training</td>
<td>85%</td>
</tr>
<tr>
<td>Completed a fellowship</td>
<td>45%</td>
</tr>
<tr>
<td>Board-certified</td>
<td>65%</td>
</tr>
<tr>
<td>Years of post-graduate training (mean)</td>
<td>4.2 years</td>
</tr>
<tr>
<td>Medical center affiliation</td>
<td></td>
</tr>
<tr>
<td>Any faculty appointment</td>
<td>63%</td>
</tr>
<tr>
<td>Active teaching duty</td>
<td>26%</td>
</tr>
<tr>
<td>Member of American Academy of Pediatrics</td>
<td>53%</td>
</tr>
</tbody>
</table>
## Table 2: Characteristics of Providers by Adoption of Sequential Schedule

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Providers Who Already Adopted or Planned To Adopt (n=37)</th>
<th>Providers Who Did Not Plan To Adopt (n=21)</th>
<th>Odds Ratio (95% Confidence Interval)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign born</td>
<td>83.8 %</td>
<td>95.2 %</td>
<td>0.26 (0.03-2.31)</td>
<td>0.198</td>
</tr>
<tr>
<td>Graduate of non-US medical school</td>
<td>78.4 %</td>
<td>81.0 %</td>
<td>0.85 (0.22-3.26)</td>
<td>0.816</td>
</tr>
<tr>
<td>Board-certified</td>
<td>70.3 %</td>
<td>57.1 %</td>
<td>1.77 (0.58-5.41)</td>
<td>0.312</td>
</tr>
<tr>
<td>Completed fellowship</td>
<td>51.4 %</td>
<td>33.3 %</td>
<td>2.11 (0.69-6.43)</td>
<td>0.185</td>
</tr>
<tr>
<td>Member of American Academy of Pediatrics</td>
<td>64.9 %</td>
<td>33.3 %</td>
<td>3.69 (1.19-11.44)</td>
<td>0.021*</td>
</tr>
<tr>
<td>Any faculty appointment</td>
<td>75.7 %</td>
<td>42.9 %</td>
<td>4.15 (1.32-13.04)</td>
<td>0.012*</td>
</tr>
<tr>
<td>Active teaching duty</td>
<td>16.2 %</td>
<td>4.8 %</td>
<td>4.14 (0.46-37.01)</td>
<td>0.175</td>
</tr>
</tbody>
</table>

*statistically significant
<table>
<thead>
<tr>
<th>Information Source</th>
<th>Providers Who Already Adopted or Planned To Adopt (n=37)</th>
<th>Providers Who Did Not Plan To Adopt (n=21)</th>
<th>Odds Ratio (95% Confidence Interval)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer reviewed publications</td>
<td>100 %</td>
<td>100 %</td>
<td>+</td>
<td>1.000</td>
</tr>
<tr>
<td>MEDLINE</td>
<td>56.8 %</td>
<td>28.6 %</td>
<td>3.28 (1.04-10.35)</td>
<td>0.039*</td>
</tr>
<tr>
<td>Educational materials from manufacturers</td>
<td>51.4 %</td>
<td>66.7 %</td>
<td>0.53 (0.17-1.61)</td>
<td>0.258</td>
</tr>
<tr>
<td>Recommendations from Advisory Committees (ACIP, Department of Health)</td>
<td>56.8 %</td>
<td>57.1 %</td>
<td>0.98 (0.33-2.90)</td>
<td>0.977</td>
</tr>
<tr>
<td>Red Book</td>
<td>51.4 %</td>
<td>23.8 %</td>
<td>3.38 (1.02-11.14)</td>
<td>0.041*</td>
</tr>
<tr>
<td>AAP Alerts</td>
<td>24.3 %</td>
<td>9.5 %</td>
<td>3.05 (0.59-15.74)</td>
<td>0.167</td>
</tr>
</tbody>
</table>

* statistically significant  
+ undefined
Table 4: Affiliation of Providers by Use of MEDLINE

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Uses MEDLINE (n=27)</th>
<th>Does Not Use MEDLINE (n=31)</th>
<th>Odds Ratio (95% Confidence Interval)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member of the American Academy of Pediatrics</td>
<td>66.7 %</td>
<td>45.2 %</td>
<td>2.43 (0.84-7.07)</td>
<td>0.100</td>
</tr>
<tr>
<td>Any faculty appointment</td>
<td>88.9 %</td>
<td>41.9 %</td>
<td>11.08 (2.74-44.76)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Active teaching duty</td>
<td>26.0 %</td>
<td>0 %</td>
<td>+</td>
<td>0.003*</td>
</tr>
</tbody>
</table>

* statistically significant
* + undefined
Table 5: Factors Influencing Decision-Making by Adoption of Sequential Schedule

<table>
<thead>
<tr>
<th>Influential Factor</th>
<th>Providers Who Already Adopted or Planned To Adopt (n=37)</th>
<th>Providers Who Did Not Plan To Adopt (n=21)</th>
<th>Odds Ratio (95% Confidence Interval)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance with ACIP</td>
<td>97.3 %</td>
<td>100.0 %</td>
<td>+</td>
<td>0.447</td>
</tr>
<tr>
<td>Medical issues</td>
<td>78.4 %</td>
<td>76.2 %</td>
<td>1.13 (0.32-4.05)</td>
<td>0.848</td>
</tr>
<tr>
<td>Personal judgment</td>
<td>78.4 %</td>
<td>71.0 %</td>
<td>1.45 (0.42-4.95)</td>
<td>0.552</td>
</tr>
<tr>
<td>Parental concerns</td>
<td>62.2 %</td>
<td>76.2 %</td>
<td>0.51 (0.15-1.71)</td>
<td>0.274</td>
</tr>
<tr>
<td>Legal issues</td>
<td>54.1 %</td>
<td>52.4 %</td>
<td>1.07 (0.37-3.13)</td>
<td>0.902</td>
</tr>
<tr>
<td>Logistic issues</td>
<td>24.3 %</td>
<td>23.8 %</td>
<td>1.03 (0.29-3.61)</td>
<td>0.965</td>
</tr>
<tr>
<td>Cost</td>
<td>18.9 %</td>
<td>23.8 %</td>
<td>0.75 (0.20-2.74)</td>
<td>0.659</td>
</tr>
</tbody>
</table>

*Note: totals for each column exceed 100% because providers could select more than one factor.

+ undefined
Table 6: Most Influential Factors Affecting Decision-Making by Adoption of Sequential Schedule

<table>
<thead>
<tr>
<th>Influential Factor</th>
<th>Providers Who Already Adopted (n=14)</th>
<th>Providers Who Planned To Adopt (n=23)</th>
<th>Odds Ratio (95% Confidence Interval)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease risk of VAPP</td>
<td>78.6 %</td>
<td>52.2 %</td>
<td>3.36 (0.74-15.32)</td>
<td>0.108</td>
</tr>
<tr>
<td>Compliance with ACIP recommendations</td>
<td>14.3 %</td>
<td>34.8 %</td>
<td>0.31 (0.06-1.76)</td>
<td>0.173</td>
</tr>
</tbody>
</table>
Table 7: Factors Cited As Motivating Change in Providers' Practices by Adoption of Sequential Schedule

<table>
<thead>
<tr>
<th>Motivating Factors</th>
<th>Providers Who Planned To Adopt (n=23)</th>
<th>Providers Who Did Not Plan To Adopt (n=21)</th>
<th>Odds Ratio (95% Confidence Interval)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stronger recommendations by ACIP</td>
<td>30.4 %</td>
<td>14.3 %</td>
<td>2.63 (0.58-11.90)</td>
<td>0.202</td>
</tr>
<tr>
<td>Legal mandate by New York City Department of Health</td>
<td>21.7 %</td>
<td>42.9 %</td>
<td>0.37 (0.10-1.38)</td>
<td>0.133</td>
</tr>
<tr>
<td>Availability of combination vaccine containing cIPV</td>
<td>17.4 %</td>
<td>0 %</td>
<td>+</td>
<td>0.045*</td>
</tr>
<tr>
<td>Evidence that cIPV is more effective than OPV</td>
<td>13.0 %</td>
<td>19.0 %</td>
<td>0.64 (0.13-3.26)</td>
<td>0.587</td>
</tr>
<tr>
<td>Exhaustion of current OPV supply</td>
<td>13.0 %</td>
<td>0 %</td>
<td>+</td>
<td>0.086</td>
</tr>
</tbody>
</table>

* statistically significant
+ undefined
References


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DATE