Professional Postgraduate Services®

Clinical Insights® in
PEDIATRIC
RESPIRATORY CARE

VOLUME 3, NUMBER 4 •APRIL 2007

PEDRO A. PIEDRA, MD,* EDITOR-IN-CHIEF; JAIME E. FERGIE, MD,† REVIEWER; KATHLEEN M. MAJOR,‡ GRACE L. MCBRIDE,§ SENIOR MANAGING EDITORS; CHING-LING CHEN, PhD,‖ MEDICAL WRITER

Herd Effects Improve Cost-effectiveness of Pneumococcal Conjugate Vaccine

Pneumococcal conjugate vaccine (PCV) has been routinely used in children ≤23 months of age since its introduction to the United States in February 2000. PCV has been effective in reducing the incidence of invasive pneumococcal disease (IPD), as well as pneumonia and otitis media in children. Rates of IPD among adults have also decreased since the introduction of the vaccine.

Considering that most cases of pneumococcal disease and most deaths from this disease in the United States occur in adults, incorporating potential herd effects from an adult population may significantly improve the cost-effectiveness of the vaccine. Because previous cost-effectiveness analyses of PCV had not included the effect of the vaccine on nonvaccinated persons, this study by Ray and colleagues sought to reevaluate the impact of PCV on pneumococcal disease and its cost-effectiveness by including the effects of a reduction in IPD for nonvaccinated persons—both children and adults—during the first 5 years of PCV use in the United States.

A revised analysis model was used to simulate the effects of PCV on children vaccinated between 2000 and 2004 and to incorporate the vaccine's effectiveness in reducing IPD in nonvaccinated persons during those years. The changes in the rate of IPD in the nonvaccinated population since the introduction of PCV was estimated from data published by the Active Bacterial Core Surveillance of the Centers for Disease Control and Prevention from 2000 to 2004 and compared with the prevaccine baseline data from 1997 to 1999. The rate of IPD in the nonvaccinated population declined steadily each year from 2000 to 2004 after PCV was introduced. By 2004, rates fell by 38% for persons 5 to <15 years of age, 47% for persons 15 to <45 years of age, 20% for persons 45 to <65 years of age, and 36% for persons 65 and older.

Approximately 70% of children born during the study period received 3 to 4 doses of PCV, which represents 14 million children receiving a total of 52 million doses between 2000 and 2004 in the United States. The remaining 30% of children were included in the nonvaccinated population. A considerable herd effect was also observed in children <5 years of age and the reduction in IPD among nonvaccinated children increased from 5% in 2000 to 68% in 2004, similar to the average direct effect of the vaccine in that age group.

Using a previously published model without incorporating herd effects in the analysis, PCV was estimated to have averted 38,000 cases of IPD during its first 5 years of use at a cost of $33,000 per IPD case averted and $112,000 per life-year saved. After incorporating the reductions in IPD for nonvaccinated individuals, the vaccine averted 109,300 cases of IPD at a cost of $5,500 per IPD case averted

Continued

Disclosures:

* Dr Piedra is professor of molecular virology and microbiology, and pediatrics at Baylor College of Medicine. He has indicated relevant financial relationships as noted: he receives grant/research support from MedImmune, Inc.; is a speaker for MedImmune, Inc.; is an expert witness for Sanofi-Pasteur; and is an ad hoc consultant for GlaxoSmithKline, MedImmune, Inc., and Sanofi-Pasteur.

† Dr Fergie is director, Pediatric Infectious Disease, Driscoll Children's Hospital, Corpus Christi, Texas. He has indicated grant/research support from MedImmune, Inc.; and is a speaker for MedImmune, Inc., Sanofi-Pasteur, and Merck.

‡ Ms Major is a senior managing editor for Professional Postgraduate Services®. She has indicated no relevant financial relationships.

§ Ms McBride is a senior managing editor for Professional Postgraduate Services®. She has indicated no relevant financial relationships.

‖ Dr Chen is a medical writer for Professional Postgraduate Services®. She has indicated no relevant financial relationships.

prci Pediatric Respiratory Care Initiative™

Release Date: April 2007
Valid Until: June 2007

This educational activity is conducted as a part of the *Pediatric Respiratory Care Initiative*™ (PRCI®), sponsored by Professional Postgraduate Services® (PPS), Secaucus, NJ.

Participants who wish to receive CME credit for this educational activity should do the following: (1) read the current issue; (2) complete the post-test and evaluation form. To apply for CME credit, return the completed post-test and evaluation form to:

Professional Postgraduate Services®
CME Dept. T314
150 Meadowlands Parkway
Secaucus, NJ 07094-2304

You may also fax the completed materials to 1 (201) 430-1441. If you have any questions, please call 1 (800) 606-6106 Ext. 8892.

Applicants will receive a certificate of participation from PPS by return mail within 6 to 8 weeks of the date of receipt of the completed evaluation form and post-test.

Learning Objectives
After studying the literature presented in this Pediatric Respiratory Care series, participants will be able to:

- Describe the herd effects of pneumococcal conjugate vaccine on the prevention of pneumococcal disease among nonvaccinated children and adults
- Assess the herd effects on the improvement in cost-effectiveness of pneumococcal conjugate vaccine
- Outline the benefits of mass influenza immunization in schoolchildren on the reduction in influenza-associated diseases in unvaccinated elderly persons

Target Audience
This educational activity is designed for pediatricians, primary care physicians, pediatric and family nurse practitioners, neonatologists, infectious disease specialists, allergists, pulmonologists, immunologists, and other healthcare professionals involved in the care and management of pediatric respiratory patients.

Professional Postgraduate Services® is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

Professional Postgraduate Services® designates this educational activity for a maximum of 0.50 *AMA PRA Category 1 Credit*™. Physicians should only claim credit commensurate with the extent of their participation in the activity.

This CME activity is supported by an educational grant from MedImmune, Inc.

Clinical Insights, Pediatric Respiratory Care Initiative, and PRCI are trademarks used herein under license.

Off-Label Disclosure
Some of the drug treatments discussed in this issue may note uses not approved by the Food and Drug Administration. Articles containing such uses will be noted at the end of the article.

Herd Effects Improve Cost-effectiveness *(Continued)*

and $7,500 per life-year saved. It was cost-saving if the indirect effect included the reduction of pneumonia in the unvaccinated population. When the herd effect was assumed to be half that of the base case, the cost per life-year saved was $18,400. The net cost per child vaccinated was also reduced from $91 to $43 when herd protection was incorporated.

Based on these data, Ray and colleagues concluded that the rate of IPD was substantially reduced in nonvaccinated children and adults since the introduction of PCV. Furthermore, the IPD herd effects in the nonvaccinated population also greatly improved the cost-effectiveness of PCV. Overall, the cost-effectiveness of PCV in actual use has been more favorable than predicted by estimates created before the vaccine was licensed in 2000.

Ray GT, Whitney CG, Fireman BH, et al. Cost-effectiveness of pneumococcal conjugate vaccine: evidence from the first 5 years of use in the United States incorporating herd effects. *Pediatr Infect Dis J.* 2006;25:494-501.

COMMENTARY

JAIME E. FERGIE, MD, Director, Pediatric Infectious Disease, Driscoll Children's Hospital, Corpus Christi, Texas.

The most intuitive way to measure the benefit of a vaccine is to quantify the reduction in the number of cases that occur after a vaccine has been implemented. From this perspective, the results of the widespread use of the pneumococcal conjugate vaccine (PCV) have been remarkable. In the article by Ray et al, the first 5 years of PCV use averted 109,300 cases of invasive pneumococcal disease when the benefits of herd immunity were calculated. Policymakers need a measure of cost-effectiveness for every medical intervention. A frequently used measure of cost-effectiveness is the cost per life-year saved. Previous studies did not include the decrease in invasive pneumococcal disease for the nonvaccinated population. When the authors incorporated herd immunity into their calculations, they found the vaccine could generate a cost savings because of the potential impact it had on pneumonia in nonvaccinated persons; otherwise, it would cost $7,500 per life-year saved.

Mass Influenza Immunization in Children Reduces Morbidity of Unvaccinated Elderly

Both kindergarten and school children from the vaccinated communities had significantly fewer incidences of influenza-like illnesses than children from the control communities.

Children of preschool and school age are known to be more susceptible to influenza infection and play a major role in spreading the disease. Although infection with influenza is less frequent in persons aged >65 years, the influenza-related death rate is the highest in this age group.

During the 1999-2000 epidemic season in the United States, the elderly accounted for 40% of hospital admissions due to influenza-related causes and 90% of influenza-associated fatalities. Previous studies demonstrated that immunization of schoolchildren against influenza substantially reduced the infection rate in other age groups as well as mortality among non-immunized elderly persons during influenza epidemics. In this study, Ghendon and colleagues evaluated the clinical effectiveness of mass influenza immunization in schoolchildren and its impact on the morbidity of unvaccinated elderly adults who normally reside in the same household as their children and grandchildren.

A mass immunization campaign using a single dose of the inactivated influenza vaccine (Influvac®) was conducted in November of 2001 involving children 3 to 6 years of age attending kindergartens (57.4% of 6,374) and aged 7-17 years attending schools (72% of 34,237) in two Moscow regional communities. Over 80% of the medical staff working in the schools and outpatient care facilities were vaccinated in all study communities. The vaccine strains were well matched to the circulating strains (A/H3N2 and B) from the December 2001 to March 2002 influenza epidemic. Incidence of influenza-like illnesses in children from these communities was compared with those in children from control communities, where not more than 1% of children were immunized against influenza. Both kindergarten and school children from the vaccinated communities had significantly fewer incidences (2.56 times and 3.2 times, $P<0.01$) of influenza-like illnesses than children from the control communities. The clinical effectiveness

Continued

Mass Influenza Immunization in Children *(Continued)*

of vaccination was 60.9% for kindergarten children, 68.8% for school children, and 63.7% for both kindergarten and school children ($P<0.01$).

The impact from the mass influenza immunization of schoolchildren on the morbidity of the unvaccinated elderly was evaluated using a comparison of the occurrence of influenza-like illnesses with other influenza-related diseases in noninstitutionalized elderly persons aged >60 years (n=158,451) residing both in the immunized communities (n=82,051) and in the control communities (n=76,401). A significant reduction (3.4 times, $P<0.01$) in the rate of influenza-like illnesses was also observed in the elderly from the immunized communities as compared with the control communities (0.07% vs 0.24%).

Furthermore, significant decreases (1.7 to 2.6 times, $P<0.01$) were also found in the episodes of seven diseases considered to be possible complications of influenza, including pneumonia, bronchial asthma, chronic bronchitis, cardiovascular diseases, diabetes mellitus, gastrointestinal diseases, and chronic pyelonephritis. The immunized communities, however, had a higher incidence of rheumatoid arthritis than the control communities (0.17% vs 0.13%, $P<0.05$).

The authors conclude that the mass influenza vaccination of children not only effectively prevented influenza-like illnesses in most children but also substantially reduced the occurrence of these and several associated illnesses in unvaccinated noninstitutionalized elderly persons living in the same community.

Ghendon YZ, Kaira AN, Elshina GA. The effect of mass influenza immunization in children on the morbidity of the unvaccinated elderly. *Epidemiol Infect*. 2006;134:71-78.

Clinical Insights® in Pediatric Respiratory Care Post-Test

1. As described in Ray et al, during a previously published model without incorporating herd effects in the analysis, how many cases of IPD was PCV estimated to have averted during its first 5 years of use?
   a. 20,000 cases
   b. 38,000 cases
   c. 50,000 cases
   d. 60,000 cases

2. Which of the following statements ***is false*** regarding the results of mass influenza immunization described in the Ghendon et al study?
   a. Both kindergarten and school-age children had a higher incidence of influenza-like illness in the immunized communities.
   b. The unvaccinated elderly in the control communities had a higher incidence of influenza-like illness.
   c. Fewer episodes of influenza-associated illnesses were observed in the unvaccinated elderly from the immunized communities.
   d. Similar clinical effectiveness was observed after the influenza vaccination was administered to both kindergarten and school-age groups of children.

1. *b*. Using a previously published model without incorporating herd effects in the analysis, PCV was estimated to have averted 38,000 cases of IPD during its first 5 years of use at a cost of $33,000 per IPD case averted and $112,000 per life-year saved.
2. *a*. Both kindergarten and school-age children had *significantly fewer* incidences of influenza-like illnesses than the control communities.

PRCI MISSION STATEMENT

The PRCI is a multicomponent educational program on pediatric respiratory disorders designed for pediatricians, primary care physicians, pediatric and family nurse practitioners, neonatologists, infectious disease specialists, allergists, pulmonologists, immunologists, and other healthcare professionals involved in the care and management of pediatric respiratory patients. PRCI programs address issues concerning asthma, respiratory syncytial virus, and other respiratory tract infections and disorders. Methods to prevent, control, and treat respiratory illnesses in children are also evaluated.

For more information about upcoming PRCI® CME activities, visit us at **www.ppscme.org.**

EM-T314-04-PHYCME-0407-25K

prci Pediatric Respiratory Care Initiative™

Activity Code: T314-04
Issue Date: April 2007
CME Credit Availability: June 2007

CME Activity Evaluation/Registration Form

Participants who wish to obtain CME credit, please complete the contact information below, sign this form, and fax it with the completed post-test to 1 (201) 430-1441 or mail to PPS, CME Dept. T314, 150 Meadowlands Parkway, Secaucus, NJ 07094-2304. You may download previous issues of *Clinical Insights® in Pediatric Respiratory Care* e-newsletters by visiting us online at www.ppscme.org.

I completed this activity as designed: _____
(Signature)

PLEASE PRINT CLEARLY:

Name: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Address: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

City: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ **State:** ☐☐ **ZIP Code:** ☐☐☐☐☐

Phone: ☐☐☐-☐☐☐-☐☐☐☐ **Fax:** ☐☐☐-☐☐☐-☐☐☐☐

Email Address: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Professional Classification: ☐ MD ☐ DO ☐ NP ☐ RN ☐ PhD
☐ Other _____

Specialty: ☐ Family Practice ☐ Pediatrics ☐ General Practice ☐ Neonatal
☐ Other _____

Overall Program

	Strongly Disagree		Disagree	Agree		Strongly Agree
1. The activity met the stated objectives in such a way that I am better able to:						
a. Describe the herd effects of pneumococcal conjugate vaccine on the prevention of pneumococcal disease among nonvaccinated children	1	2	3	4	5	6
b. Assess the herd effects on the improvement of cost-effectiveness of pneumococcal conjugate vaccine	1	2	3	4	5	6
c. Recognize the benefits of mass influenza immunization in schoolchildren on the reduction in influenza-associated diseases in unvaccinated elderly persons	1	2	3	4	5	6

2. Overall, the activity was presented in a fair-balanced manner. ☐ Yes ☐ No*

* If you checked "No," please explain. _____

3. Overall, the activity was free of commercial bias. ☐ Yes ☐ No*

* If you checked "No," please explain. _____

4. In reflecting on your practice, what type of impact will this educational activity have?
   - ☐ Consider the impact on cost per life-year saved when accounting for herd immunity with the pneumococcal conjugate vaccine.
   - ☐ Recognize that mass influenza vaccination of schoolchildren will result in fewer episodes of influenza-associated illnesses observed in the unvaccinated elderly.

   (*Please specify what information you would require.*) _____

   I will:
   - ☐ Use the pneumococcal conjugate vaccine in my practice, being cognizant that its herd effects in the nonvaccinated population improve its overall cost-effectiveness.
   - ☐ Advocate for mass immunization in school-aged children for the prevention of influenza-like illnesses in both children and the elderly within the same community.

5. What topics should be dealt with in more detail? (*List topics.*)

_____ _____

_____ _____

Thank you for your participation.