



POLICY RESPONSES TO THE GROWING THREAT OF ANTIBIOTIC RESISTANCE

POLICY BRIEF 1

AUGUST 2007

CAN VACCINES REDUCE ANTIBIOTIC USE? THE SUCCESSES AND CHALLENGES OF PNEUMOCOCCAL VACCINES

Children take antibiotics more often than any other group in the population—more than 15 million antibiotic prescriptions were written in the year 2000 for children under 5 in the United States.^{1,2} Parents know all too well about preschoolers' sore throats, coughs, and ear infections. Many of these are caused by the bacteria we know as "strep," more formally, *Streptococcus pneumoniae*. Strep (or pneumococcal) infections are much less frequent among young and middle-aged adults but reappear as a problem in people over 65. At older ages, strep causes pneumonia and dangerous infections of the bloodstream (bacteremia).

Two vaccines, an older one for adults and a newer one for children, can prevent many strep infections, which is good for people and good for preserving the effectiveness of antibiotics. This brief is about the impact these vaccines have already had on both illness and antibiotic use, and about ways we can increase their impact.

***Streptococcus pneumoniae* and Vaccines to Prevent Infection**

Children under 5 and adults over 65 are most susceptible to strep infections (see figure). Although small children (and their parents) are made miserable by these infections, they are usually curable with a course of antibiotics. Older people may not be so lucky: 2,500 adults over age 65 died from invasive strep infections in the United States in 2005.³

Vaccine development against *S. pneumoniae* in adults began in the 1940s. In 1981, the adult pneumococcal vaccine was found to be so cost-effective against bacteremia (although not against pneumonia caused by strep)⁴ that it became the first *preventive* intervention routinely paid for by the Medicare program. A different vaccine was needed for children, whose immune systems respond differently than those of adults. It was not until 2000 that a pneumococcal vaccine designed for children was approved in the United States. This vaccine (known as PCV7) targets the seven strep types ("serotypes"*) that caused more than 80% of strep infections when it was developed.

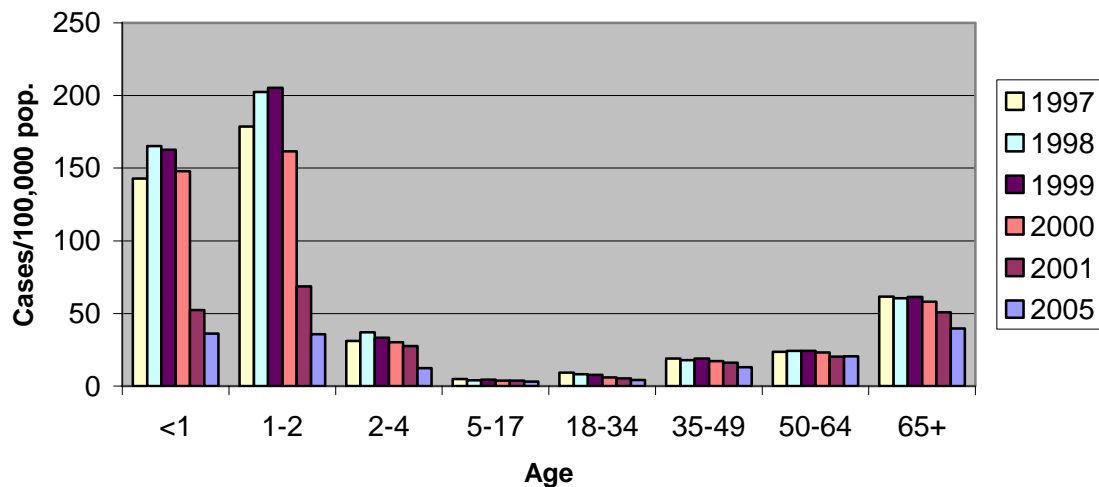
Vaccine Coverage

In 1984, the Advisory Committee on Immunization Practices (ACIP), a respected group of independent experts appointed by the federal government, recommended that all adults 65 and older be vaccinated. Only a single dose is needed for protection. Despite more than 20 years of availability and full payment for the vaccine by Medicare, only about 60% of people over 65 have been vaccinated. Some minority groups have even lower rates: in 2004, 39% of African Americans and 34% of Hispanics 65 and over had been vaccinated.⁵

In 2000, the ACIP recommended that all children under 2 years of age be vaccinated with the newly licensed childhood vaccine. Children get three doses in the first 6 months of life and a fourth (booster) dose between 12 and 15 months of age. This vaccine is paid for by the

* Serotypes of a bacterium represent slight, but important, variations in genetic makeup. Vaccines are only effective against the specific serotypes that they include.

FIGURE: This chart illustrates the rate of invasive strep infection (the most serious types) by age group between 1997 and 2005. The dramatic reduction among children follows licensing of the childhood vaccine in 2000. Even after this drop in incidence, young children and adults over 65 still have the highest rates of invasive strep infection.



main Federal programs that provide care for poor children, and by most private insurers. In 2005, just 5 years after the vaccine was licensed, 81% of U.S. children under 2 were fully vaccinated.⁶

Vaccine Effectiveness

The childhood vaccine has prevented more than 70% of severe, invasive strep infections⁷ and reduced doctor visits for ear infections by 5-10%.⁸ With such a high proportion of children vaccinated, even *unvaccinated* children benefit: there are simply fewer strep bacteria around for them to be exposed to (a concept known as “herd immunity”). At a cost of about \$300 for a full course in the private sector, the children’s strep vaccine is in the range of other childhood vaccines, and is considered highly cost-effective (\$7,500 per life-year saved).⁷

An unexpected bonus of the childhood vaccine is that herd immunity extends to older adults: fewer adults have been hospitalized for invasive strep infections because of increased use of the children’s vaccine, which has reduced their exposure to bacteria (from grandchildren to grandparents, for example).⁹

Antibiotic Use Reduction

By reducing the number of strep cases, vaccines against *S. pneumoniae* reduce the use of antibiotics. For every 100 children vaccinated, 35 antibiotic prescriptions are avoided, adding up to 1.4 million fewer prescriptions in the United States each year.⁸ The adult vaccine also must have reduced antibiotic use, but no recent estimates are available.

Continuing Challenges and Opportunities

There is room for higher vaccination rates among people over 65, especially among African Americans and Hispanic Americans. Education campaigns and other efforts to change behavior are likely to be most effective at bridging the gaps in coverage. Illinois, Minnesota, and New York have already begun education programs and institutional partnerships to promote vaccine use and improve access among these groups.⁵

Both the childhood and adult pneumococcal vaccines would be more effective if they protected against a larger number of serotypes. If a newer childhood vaccine, currently in clinical trials, is successful, it will protect against 13 serotypes, but continued vigilance will be needed to make sure that strep infections do not resurge. In the few short years since the childhood vaccine came into use, serotypes not targeted by the vaccine have become more frequent. These non-targeted types appear to be filling an empty niche left by the targeted types.^{10,11,12} Even more worrisome, some of these non-targeted types appear to have high levels of antibiotic resistance, making them harder to cure.^{12,13}

The limited effectiveness of the adult vaccine against pneumococcal pneumonia also poses a challenge for research and development. Incentives for developing better childhood and adult vaccines may be needed if work is to proceed quickly.

References

1. McCaig, L. F., R. E. Besser, et al. (2002) "Trends in antimicrobial prescribing rates for children and adolescents." *Journal of the American Medical Association* 287(23): 3096-3102.
2. Finkelstein, J. A., C. Stille, et al. (2003) "Reduction in antibiotic use among US children, 1996-2000." *Pediatrics* 112(3): 620-627.
3. Centers for Disease Control and Prevention. (2005) "*Streptococcus pneumoniae*, 2005." Active Bacterial Core Surveillance (ABCs) Report, Emerging Infections Program Network.
4. Sisk, J. E. and R. K. Riegelman. (1986) "Cost effectiveness of vaccination against pneumococcal pneumonia: an update." *Annals of Internal Medicine* 104: 79-86.
5. Flowers, L. (2007) "Racial and ethnic disparities in influenza and pneumococcal immunization rates among Medicare beneficiaries." AARP Public Policy Institute: Issue Brief #83.
6. Centers for Disease Control and Prevention. (2005) *National Immunization Survey*. <http://www.cdc.gov/vaccines/stats-surv/imz-coverage.htm#nis> (accessed June 15, 2007).
7. Ray, G. T., C. J. Whitney, et al. (2006) "Cost-effectiveness of pneumococcal conjugate vaccine: evidence from the first 5 years of use in the United States incorporating herd effects." *The Pediatric Infectious Disease Journal* 25(6): 494-501.
8. Fireman, B., S. B. Black, et al. (2003) "Impact of the pneumococcal conjugate vaccine on otitis media." *The Pediatric Infectious Disease Journal* 22(1): 10-16.
9. McBean, A. M., Y. Park, et al. (2005) "Declining invasive pneumococcal disease in the U.S. elderly." *Vaccine* 23: 5641-5645.
10. Pai, R., M. R. Moore, et al. (2005) "Postvaccine genetic structure of *Streptococcus pneumoniae* serotype 19A from children in the United States." *Journal of Infectious Diseases* 192: 1988-1995.
11. Singleton, R. J., T. W. Hennessy, et al. (2007) "Invasive pneumococcal disease caused by nonvaccine serotypes among Alaska Native children with high levels of 7-valent pneumococcal conjugate vaccine coverage." *Journal of the American Medical Association* 297(16): 1784-1792.
12. Kyaw, M. H., R. Lynfield, et al. (2006) "Effect of introduction of the pneumococcal conjugate vaccine on drug-resistant *Streptococcus pneumoniae*." *The New England Journal of Medicine* 354(14): 1455-1463.
13. Farrell, D. J., K. P. Klugman, et al. (2007) "Increased antimicrobial resistance among nonvaccine serotypes of *Streptococcus pneumoniae* in the pediatric population after the introduction of 7-valent pneumococcal vaccine in the United States." *The Pediatric Infectious Disease Journal* 26(2): 123-128.