Pneumococcal Vaccination and Pneumonia: Even a Low Level of Clinical Effectiveness Is Highly Cost-Effective

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Most studies of the cost-effectiveness of pneumococcal vaccination show very favorable cost-effectiveness ratios for preventing pneumococcal pneumonia, but they make the controversial assumption that vaccination is equally effective in preventing bacteremic (BPP) and nonbacteremic (NBPP) pneumonia. However, the results of our study showed that, compared with preventing BPP alone, the cost-effectiveness of pneumococcal vaccination increased substantially even when only a small proportion of additional cases of NBPP were prevented.

Vaccination against an infectious disease may be regarded as a worthwhile health-care intervention if the vaccine has high efficacy or if it produces significant clinical benefits even at low efficacy rates. Influenza vaccine, for example, has a protective efficacy of 80%–90% in healthy young adults but only of 40%–50% in the frail elderly. Despite lower efficacy, however, vaccination of older persons has been shown to substantially reduce hospitalization for pneumonia and all-cause mortality. In doing so, influenza vaccination is very cost-effective.

Observational studies have shown that 23-valent pneumococcal polysaccharide vaccine significantly protects elderly persons against invasive pneumococcal disease, >90% of which is bacteremic pneumococcal pneumonia (BPP) [1]. However, prospective clinical trials that sought to demonstrate vaccine efficacy against all pneumococcal pneumonia have been inconclusive, largely because of problems in study design such as small sample size and nonspecific outcome measures [1]. This lack of firm evidence has resulted in a polarization of opinion, one result of which has been wide variation in the extent of vaccine use among developed countries [2].

Most published studies of the cost-effectiveness of pneumococcal vaccination have focused on all pneumococcal pneumonia and have assumed that vaccination is equally effective in preventing BPP and nonbacteremic pneumococcal pneumonia (NBPP). However, the favorable results of these studies have had little impact on policy makers because of persistent uncertainty about the clinical effectiveness of vaccination in preventing all cases of pneumococcal pneumonia. Two recent studies have reported the cost-effectiveness of pneumococcal vaccination in preventing BPP [3] and invasive pneumococcal disease [4] alone. These findings provide policy makers with robust, if conservative, guidance. Nonetheless, doubts still remain.

In our study elsewhere [4], we reported the cost-effectiveness ratios (CERs) for 2 extreme situations: 1 in which vaccination prevents only cases of invasive pneumococcal disease (largely BPP), and the other in which vaccination is similarly effective against cases of NBPP. We have extended our earlier analysis by combining a well-accepted estimate of the clinical effectiveness of vaccination in preventing BPP [3, 4] with lesser degrees of clinical effectiveness against NBPP.

The underlying features of our analysis can be illustrated by a hypothetical cohort of 1000 persons aged >65 years who were hospitalized with pneumococcal infection (all serotypes) over a 6-year period. If we assume that 150 (15%) will have BPP, and that over this period vaccination prevents 60% of cases of BPP [1], 90 cases will be prevented. If, over the same period, 510 (60%) of the 850 NBPP cases are also prevented, the combined effect of vaccination on BPP and NBPP will be to prevent 600 (90 + 510) cases of pneumococcal pneumonia. This dramatic increase is due to the numerical dominance of cases of NBPP.

In extending our analysis, we assumed that the incidence of BPP was the same as the incidence of invasive disease used in our study elsewhere [4]. We also assumed the level of clinical effectiveness of vaccination would apply to the prevention of BPP. We varied the proportion of potentially vaccine-preventable cases of NBPP from 0% to 100% (i.e., at 100%, vaccination effectiveness for preventing NBPP would be the same as that for BPP). The results showed that, in each of the 5 western European countries, (Belgium, France, Scotland, Spain, and Sweden), the CERs decreased substantially in a nonlinear fash-
Figure 1. Cost-effectiveness of pneumococcal vaccination in preventing bacteremic pneumococcal pneumonia (BPP) and a varying proportion of nonbacteremic pneumococcal pneumonia (NBPP) in 5 western European countries: Belgium, France, Scotland, Spain, and Sweden. a, Cost-effectiveness ratios (CERs; ecus 1995) for preventing BPP only are those that were determined for invasive pneumococcal disease in the base-case analysis reported in reference [4], table 3. The CERs for preventing BPP + 10%, 20%, etc. of NBPP are based on the incidence of hospital discharges for all-cause pneumonia reported in reference [4], table 1. b, CERs for BPP only are those based on an assumed incidence for invasive pneumococcal disease of 50 cases/100,000 persons aged ≥65 years and a mortality of 20% in each country, as reported in reference [4], table 5.

ion, even when only a small proportion of additional cases of NBPP were prevented (figure 1a). When only 12%–14% of all potentially preventable cases of NBPP were prevented, the CERs for BPP alone were reduced by ~75%. Further increases in the clinical effectiveness of vaccination had incrementally smaller effects on the CERs. Moreover, when we used more plausible epidemiological assumptions for BPP for each country (an incidence of 50 cases/100,000 persons aged ≥65 years and a case fatality rate of 20%), the resulting CERs for preventing additional cases of NBPP were even more favorable (figure 1b). Readers interested in the details of our analysis should write to the first author.

Our analysis illustrates a hitherto unexplored aspect of the problem of determining whether pneumococcal vaccination is a cost-effective intervention for older people. It shows that vaccination is highly cost-effective even at very low levels of clinical effectiveness against NBPP. A recently published retrospective cohort study has shown that pneumococcal vaccination is effective in preventing hospitalization for all-cause pneumonia and in reducing all-cause mortality among older persons with chronic lung disease [5]. These findings support the underlying assumption of our current analysis—namely, that pneumococcal vaccination is to some degree clinically effective in preventing NBPP. When this factor is added to the known clinical effectiveness and cost-effectiveness of pneumococcal vaccination in preventing BPP, the resulting CERs clearly indicate it is economically worthwhile to prevent even a small proportion of cases of NBPP. We believe that our findings provide an even stronger basis for policy makers to recommend 23-valent pneumococcal vaccine for all persons aged ≥65 years.

References