# Budget Impact Analysis of Pneumococcal Vaccines for Older Adults Available in Costa Rica

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## INTRODUCTION

- Pneumococcal disease (PD) is a significant cause of morbidity and mortality worldwide in children and older adults [1-2]. *Streptococcus pneumoniae* (SP) is the most common cause of community-acquired pneumonia (CAP), which can develop into invasive pneumococcal disease (IPD), manifesting as meningitis or bloodstream infection (BSI) [2-3]. SP is classified into serotypes according to the polysaccharide capsule antigens; the distribution of serotypes and the incidence of CAP and IPD varies by country and population age group [2].
- Two pneumococcal vaccines are currently available in the National Immunization Program (NIP) for adults in Costa Rica: 13-valent pneumococcal conjugate vaccine (PCV13) and 23-valent pneumococcal polysaccharide vaccine (PPSV23) [4]. PCV13 is also available in the pediatric NIP [4]. These vaccines differ both in the design and in the number of serotypes contained (13 vs. 23) and to generate an effective immune response [5-6]. Protein conjugation available as in PCV13 is desirable as it elicits T-cell-dependent immune response, a more robust immunogenicity, and an improved memory for SP polysaccharide antibodies [6].
- Although routine use PCV13 in pediatric NIPs has demonstrated reduced PD in children (including indirect protection in older adults), there is still a substantial vaccine-preventable disease burden among older adults [7-10]. The clinical trial CAPiTA and real-word-evidence studies have demonstrated the impact of PCV13 on PD in older adults [11-12]. While PPSV23 prevents IPD, it has not been shown to reduce CAP incidence or death in adults with or without chronic diseases [13].
- Implementing a mass vaccination program requires an economic assessment to estimate the clinical and financial outcomes of preventing pneumococcal diseases in older adults.

## OBJECTIVES

- We aim to assess the budget impact (BI) of introducing different vaccination strategies with PCV13 and PPSV23 in adults ≥65 years in Costa Rica´s public healthcare system.

## METHODS

- A **BI model** was developed to estimate the change in expenditure over a **three-year time horizon** of different vaccination strategies in a population of 500,000 adults ≥ 65 in Costa Rica**,** distributed across different age groups.

### Comparators (Vaccination Strategies)

**The BIs of each of the three vaccination strategies were compared to no vaccination:**

- *PCV13 alone*
- *PPSV23 alone*
- *PCV13+PPSV23 (administered in the same year)*

### Target Population

- **Target population:** population data was obtained at the national level using the national population projection estimates for adults ≥ 65 in Costa Rica [14].

### Vaccine Uptake

- The **budget impact analysis (BIA)** assumes that no people in the target population was vaccinated at the beginning of the period and that 10% of the adults ≥65 years would be vaccinated annually (50,000 people vaccinated per year). This means a cumulative 30% of older adults will be vaccinated by the third year (n=150,000).

### Costs & Outcomes

The BIA considered the following direct healthcare costs:

- **Vaccination costs:** vaccine acquisition costs (list price) were taken from the vaccine price list (2022) of the Pan American Health Organization Revolving Fund [15]. Vaccine administration costs were assumed to be $1 per vaccine.
- **Healthcare costs:** healthcare costs included cost of pneumococcal IPD, hospital-treated CAP; outpatient CAP and sequelae caused by meningitis (hearing loss, neuropsychological deficit, epilepsy), and major adverse cardiovascular event [MACE] related to SP infections. These costs were estimated using a bottom-up method with local experts, with exception of epilepsy which was taken from literature [16].

## METHODS (continued)

- All costs and prices are in USD2022.

### Perspective and Relevant Assumptions

- The analysis was performed from the perspective of the third-party payer responsible for mass vaccination programs in the country.
- We assumed no waning for PCV13 over 3 years per the CAPiTA results [11]; PPSV23 was also assumed not to wane to simplify the model.
- Due to unavailability of data, we assumed that the distribution of pneumococcal serotypes in Costa Rica was comparable to that in Colombia, a country sharing similar geographic and social circumstances [17].

### Scenario Analysis

- A **scenario analysis** was conducted by stratifying the analysis according to different age groups (65-74 years; 75-84 years; ≥ 85 years) to demonstrate the variability of potential BI according to age of the patient.

### Study Parameters

- **Table 1** provides data on the assumptions made for incidence rates of pneumococcal infections in Costa Rica, with the proportion caused by SP in adults for each infection.

*Table 1. The age group in Costa Rica adjusted the annual incidence rate of CAP, meningitis, and bloodstream infection.*

| | 65-74 years | 75-84 years | ≥85 years | Source |
|---|---|---|---|---|
| Hospital-treated CAP | 0.74 % | 1.31 % | 2.08 % | [18] |
| Outpatient CAP | 0.26 % | 0.38 % | 0.86 % | [18] |
| All CAP | 1.00 % | 1.69 % | 2.94 % | |
| Meningitis | 0.02 % | 0.03 % | 0.06 % | [18,19] |
| Bloodstream infection | 0.37 % | 0.62 % | 1.08 % | [18,20] |
| Total | 1.39 % | 2.34 % | 4.08 % | |

**CAP:** community-acquired pneumonia

- **Table 2** shows the efficacy of PCV13 and PPSV23 in preventing pneumococcal infections in older adults adjusted by the type of infection.

*Table 2. Efficacy of PCV13 and PPSV23 to prevent pneumococcal infections in older adults, adjusted by the type of infection*

| Vaccines efficacy by type of infection | Mean | Min | Max | Sources |
|---|---|---|---|---|
| PCV13 CAP | 45.6 % | 21.8 % | 62.5 % | [11] |
| PCV13 IPD | 75.0 % | 41.4 % | 90.8 % | [11] |
| PPSV23 CAP | 0.0 % | 0.0 % | 0.0 % | [13] |
| PPSV23 IPD | 67.1 % | 9.5 % | 88.0 % | [13] |
| PCV13 + PPSV23 CAP* | 45.6% | 21.8% | 62.5% | [11,13] |
| PCV13 + PPSV23 IPD | 75.0% | 41.4 % | 90.8 % | [11,13] |

**CAP:** community-acquired pneumonia; **IPD:** invasive pneumococcal disease; **PCV13:** 13-valent pneumococcal conjugate vaccine; **PPSV23:** 23-valent pneumococcal polysaccharide vaccine. *The model is only applying vaccine efficacy to CAP due to serotypes covered in PCV13.

*Table 3. Health care costs of the different manifestations of pneumococcal disease and its complications, Costa Rica, 2022.*

| Clinical manifestation | Healthcare costs |
|---|---|
| Hospital-treated community-acquired pneumonia (general ward) | $ 3,134 |
| Outpatient community-acquired pneumonia | $ 282 |
| All CAP (weighted average)* | $ 2,486 |
| Meningitis | $ 6,408 |
| Bloodstream infection | $ 6,408 |
| Hearing loss | $ 550 |
| Neurological deficit (annual cost) | $ 5,500 |
| Epilepsy (annual cost)** | $ 1,155 |
| General cardiac complications | $ 698 |
| Heart failure | $ 416 |
| Acute coronary syndrome | $ 821 |
| Cardiac arrhythmia | $ 1,000 |

**CAP:** community-acquired pneumonia. *The weighted average assumes that 75% of older adults with pneumonia require hospital treatment (73% in the general ward and 2 % in ICU) and 25% receive outpatient treatment. The cost of ICU in CAP is the same for IPD. ** Annual epilepsy costs were obtained from literature [19] and adjusted to local drug prices.

- The efficacy of these vaccines was adjusted by serotype distribution in each vaccine (i.e., no cross-immunity with serotypes not included in the vaccines). Annual incidence rates of pneumococcal infections were further adjusted by age group and vaccine efficacy while considering serotype distribution according to the type of vaccine.

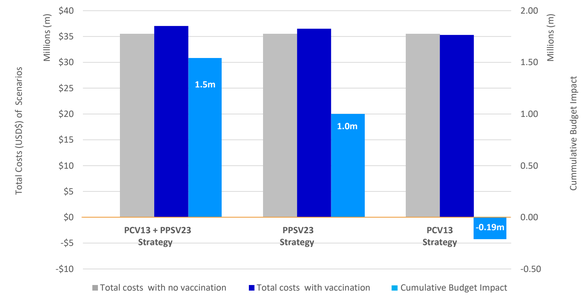
## RESULTS

- Compared with no vaccine, the 1st year of cumulative BI with PCV13 was $495,717, the 2nd year was $432,869, and the 3rd year was -$188,546.

*Table 4. Budget impact of vaccinating 150,000 adults ≥ 65 years in Costa Rica in three years (cumulative) with the different pneumococcal vaccine strategies, 2022.*

| | No Vaccine | PCV13 | PPSV23 | PCV13 + PPSV23 |
|---|---|---|---|---|
| Vaccine costs | $ - | $ 2,325,000 | $ 1,573,500 | $ 3,898,500 |
| Health care costs | $ 35,501,084 | $ 32,987,538 | $ 34,932,472 | $ 33,143,619 |
| Total costs | $ 35,501,084 | $ 35,312,538 | $ 36,505,972 | $ 37,042,119 |
| Δ Cost vs. no vaccination (Budget Impact) | - | -$ 188,546 | $ 1,004,888 | $ 1,541,035 |

*Figure 1. Graphical representation of the three-year cumulative budget impact of vaccinating 150,000 adults ≥ 65 years in Costa Rica with the different pneumococcal vaccine strategies, 2022.*




- **Table 4 and Figure 1** shows the results of the BIA to vaccinate 30 % of adults ≥ 65 years in Costa Rica in three years (150,000 adults > 65 years). **Table 4** further separated the costs of vaccines from those of health care caused by the management of pneumococcal diseases.
- Estimated total cost with no vaccine over 3 years was $35.5million (m), and were $35.3m, $37.0m or $36.5m for PCV13 alone, PCV13+PPSV23, or PPSV23, respectively **(Table 4 and Figure 1).**
- For PCV13+PPSV23 or PPSV23 alone, the annual total costs were higher than no vaccine. Overall, PCV13 alone resulted the lowest budget impact (-188.546 of all 3 vaccination strategies over a 3-years period **(Table 4 and Figure 1).**
- Scenario analysis is presented in **Tables 5-7** where the BIA results of vaccinating 96,000 people between 65-74 years (30% of 320,000 adults), 36,000 people between 75-84 years (30% of 120,000 adults) , and 18,000 people ≥ 85 years (30% of 60,000 adults).

*Table 5. Budget impact of vaccinating 96,000 adults between 65 to 74 years in Costa Rica in three years (cumulative) with the different pneumococcal vaccine strategies, 2022.*

| | No Vaccine | PCV13 | PPSV23 | PCV13 + PPSV23 |
|---|---|---|---|---|
| Vaccines costs | $ - | $ 1,488,000 | $ 1,007,040 | $ 2,495,040 |
| Health outcomes costs | $ 16,248,030 | $ 15,097,623 | $ 15,959,938 | $ 15,053,615 |
| Total costs | $ 16,248,030 | $ 16,585,623 | $ 16,966,978 | $ 17,548,655 |
| Δ Cost vs. no vaccination (Budget Impact) | - | $ 337,594 | $ 718,948 | $ 1,300,625 |

*Table 6. Budget impact of vaccinating 36,000 adults between 75 to 84 years in Costa Rica in three years (cumulative) with the different pneumococcal vaccine strategies, 2022.*

| | No Vaccine | PCV13 | PPSV23 | PCV13 + PPSV23 |
|---|---|---|---|---|
| Vaccines costs | $ - | $ 558,000 | $ 377,640 | $ 935,640 |
| Health outcomes costs | $ 10,294,838 | $ 9,566,019 | $ 10,173,314 | $ 9,790,429 |
| Total costs | $ 10,294,838 | $ 10,124,019 | $ 10,550,954 | $ 10,726,069 |
| Δ Cost vs. no vaccine (Budget Impact) | - | -$ 170,819 | $ 256,116 | $ 431,231 |

*Table 7. Budget impact of vaccinating 18,000 adults ≥ 85 years in Costa Rica in three years with the different pneumococcal vaccine strategies, 2022.*

| | No Vaccine | PCV13 | PPSV23 | PCV13 + PPSV23 |
|---|---|---|---|---|
| Vaccines costs | $ - | $ 279,000 | $ 188,820 | $ 467,820 |
| Health outcomes costs | $ 8,958,216 | $ 8,323,896 | $ 8,799,221 | $ 8,299,575 |
| Total costs | $ 8,958,216 | $ 8,602,896 | $ 8,988,041 | $ 8,767,395 |
| Δ Cost vs. no vaccine (Budget Impact) | - | -$ 355.320 | $ 29,824 | -$ 190,821 |

- **Tables 5-7** showed that PCV13 generated net cost-savings over a three-year period across most age groups (75-84 years and ≥ 85), in addition to being the strategy including vaccination with the lowest cumulative BI in adults between 65 to 74 years.

## DISCUSSION

- Vaccination with PCV13 alone was the only strategy to generate potential financial savings through vaccinating 30% of adults ≥ 65 years in three years, though the costs during the first two years might be higher than no vaccine. These savings observed with PCV13 are related to the prevention of expensive pneumococcal infections (particularly CAP compared to PPSV23) and its complications.
- Other vaccination strategies (PPSV23 and PCV13+PPSV23) would imply economic investments between 1 and 1.5 million US dollars by vaccinating the same amount of population in the same period.
- The population of older adults with the lowest risk of getting sick with PD is 65 to 74 years old. Scenario analysis evidenced that using PCV13 alone in the 65 to 74 age group has a much lower BI than other strategies (representing between 26% to 47% of the investment required with the different strategies).

## CONCLUSION

- Vaccination against PDs in adults aged >65 years with PCV13 in Costa Rica would result in the lowest healthcare BI to the healthcare system and could be net cost saving over 3 years compared with no vaccine.

## DISCLOSURES

Pfizer sponsored this study.

For questions, please contact **jaime.ordonez@trueconsulting.co**

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