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ISPOR Europe 2024, 17-20 November, Barcelona, Spain

A public health and budget impact analysis (BIA) of vaccinating adults older 60 years and risk-groups against pneumococcal-diseases in Austria

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Objectives

Infection with Streptococcus pneumoniae can cause noninvasive and invasive pneumococcal disease (IPD), leading to about 2 million deaths annually worldwide. Vulnerable groups include adults 60+ and those 18+ with chronic conditions like COPD, diabetes, and cardiovascular disease (CVD), for whom vaccination is recommended. In Austria, around 30,000 adults get pneumococcal infections annually, with 20,000 cases linked to PPV23 and/or PCV15/20 serotypes, and about 340 developing IPD. This budget impact analysis (BIA) compares the effects of vaccinating a portion of older and at-risk adults with PPV23 or PCV15/20 vaccines versus no vaccination, quantifying the positive financial impact.

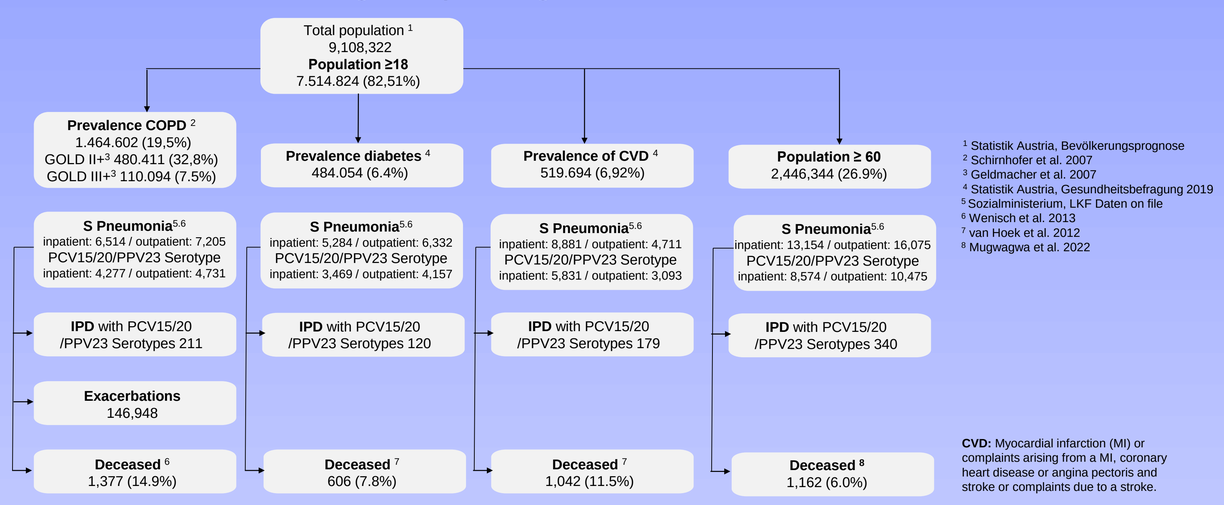
Methods

A 5-year, multi-cohort, population-based model was developed, including states of hospitalized and outpatient pneumococcal diseases (S. pneumoniae), IPD, complications, and mortality. In the vaccination arm, 16% of adults aged 60+ and 20% of at-risk patients are vaccinated in the first year, rising to 20% and 28% by year five. The model accounts for serotype shifts over time. Results show savings for the healthcare-system and society. Vaccination costs are based on the pharmacy selling price and are paid out-of-pocket.

Epidemiology of risk groups

- The current vaccination guidelines recommend immunization for high-risk individuals aged 18 and older, including those with conditions such as cardiovascular diseases (excluding hypertension), respiratory diseases like COPD, and diabetes mellitus. Sequential vaccination with PNC15/20 followed by PPV23 is strongly advised.
- For adults aged 60 and over, sequential vaccination is specifically recommended: one dose of PNC15/20, followed by one dose of PPV23 after a minimum interval of one year.

Figure 1: Epidemiological situation

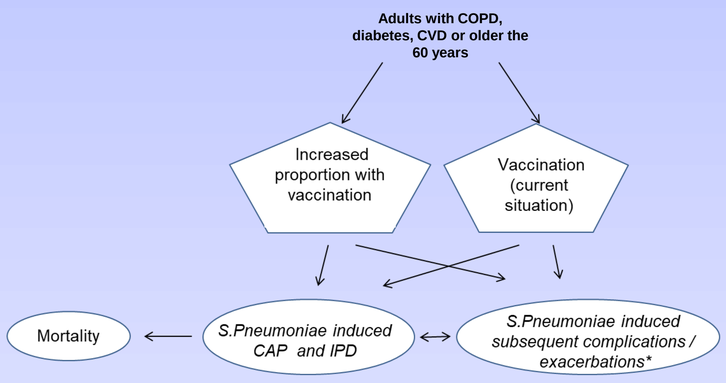


[1] Statistik Austria, Bevölkerungsprognose
[2] Schirnhofer et al. 2007
[3] Geldmacher et al. 2007
[4] Statistik Austria, Gesundheitsbefragung 2019
[5] Sozialministerium, LKF Daten on file
[6] Wenisch et al. 2013
[7] van Hoek et al. 2012
[8] Mugwagwa et al. 2022

CVD: Myocardial infarction (MI) or complaints arising from a MI, coronary heart disease or angina pectoris and stroke or complaints due to a stroke.

Modeling approach

Figure 2: Model Design



CAP = Community acquired pneumonia; IPD = Invasive pneumococcal disease

Source: own developed

Cohorts were stratified among age and risk groups:

- Different transition probabilities were used for the following age groups: 18-34, 35-49, 50-64 and ≥ 65.
- The following transition probabilities were included:
  - Pneumonia hospitalized
  - Pneumonia outpatient treated
  - IPD Pneumonia
  - IPD Pneumonia and Sepsis
  - IPD Sepsis
  - IPD Meningitis
  - IPD Meningitis and Sepsis
  - IPD Meningitis, Pneumonia and Sepsis
  - IPD Meningitis and Pneumonia
  - Subsequent complications after IPD (neurological problems and deafness)
  - Exacerbations in case of COPD patients*
  - Mortality rate

Vaccine effectiveness

- The analysis considers the vaccine effectiveness (VE) of the sequential vaccination: 1 x PCV15 or PCV20 (conjugated pneumococcal vaccines) and after ≥ 1 year 1 x PPV23 (23-valent polysaccharide vaccines).
- The VE were derived from the CAPTA study and a current budget impact analysis (BIA) of the PCV20 vaccination.
- According to the BIA we assumed an analogous VE for the seven additional serotypes of PCV20 of those recorded in PCV13 (Mugwagwa et al. 2022).
- In the "world without vaccination", the presence of childhood vaccination is taken into account.

Table 1: Vaccine effectiveness (VE) against Vaccine-type (VT)-IPD and VT-CAP

Age groups	VE IPD	VE CAP
Age 18-49	73.5%	50.1%
Age 50-64	71.3%	46.2%
Age 65+	67.5%	40.5%

Source: CAPITA, Mugwagwa et al. 2022

Serotype shift

- Extrapolation for PCV15/20 and PPV23 serotype coverage was determined based on an observation period from 2019 to 2021 for the respective population. A serotype shift is considered in the model.
- For the population over 60 years of age, only the reported serotypes of the age group were used.

Table 2: PCV15/20 and PPC23 serotypes over time in % of pneumococcal isolates of IPD cases in patients age ≥ 18

Age groups	Year 1 (2023)	Year 2 (2024)	Year 3 (2025)	Year 4 (2026)	Year 5 (2027)
PCV15/20	61.8%	61.6%	61.3%	61.1%	60.9%
PPV23	69.5%	67.3%	65.1%	62.8%	60.6%

Source: estimated based on the Pneumococcal annual report 2019 and 2021

Immunization rate

The vaccination rate was estimated based on an Austrian market research. 25% of those vaccinated follow the combined vaccination recommendation.

- Population ≥ 60 years: 16% (1st year) to 20% (5th year)
- Risk groups: 20% (1st year) to 28% (5th year)

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Funding: This study was funded by a grant from ÖVIH - Austrian Association of Vaccine Manufacturers

Direct costs

The analysis includes costs of inpatient and outpatient pneumonia treatment, IPD treatment (Pneumonia, Meningitis and Sepsis) including treatment of subsequent complications (neurological problems and deafness). The costs are assessed with reimbursement tariffs. The costs of pneumococcal vaccination are borne by vaccinated people (44.23 € for PPV23, 110.95 € for PCV15 and 119.75 € for PCV20 ; pharmacy selling price).

Indirect costs

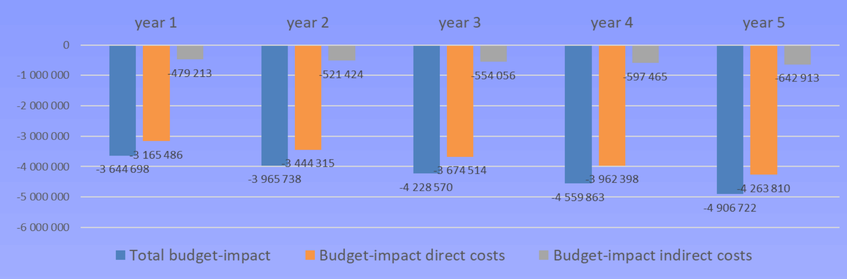
Indirect costs include sick leave. Indirect costs are calculated on the basis of the employment rate by age group (share of the working-age population). The duration of work loss is calculated based on ICD-10 for the pneumococcal diseases and for the subsequent complications.

Results

Budget-Impact

At the current vaccination rate for those 60+, pneumococcal vaccination saves € 21.3 million over 5 years. The highest savings are in the CVD risk-group (€ 15.6 million), followed by COPD GOLD II+ patients (€ 13.6 million). The highest return-on-investment exhibits for COPD GOLD III+ patients, every € 1 privately invested in vaccination saves society € 5.62 and the healthcare-system € 5.34 (Figure 5). The higher the vaccination coverage, the higher the savings.

Figure 3: Total budget-impact (€) population ≥ 60 years



- Direct costs account for € 18.5 million or 87% of the savings.
- The savings due to indirect costs amount to € 2.8 million (13%).

Source: own calculations

Figure 4: Budget Impact; cumulative (5 years) of risk groups

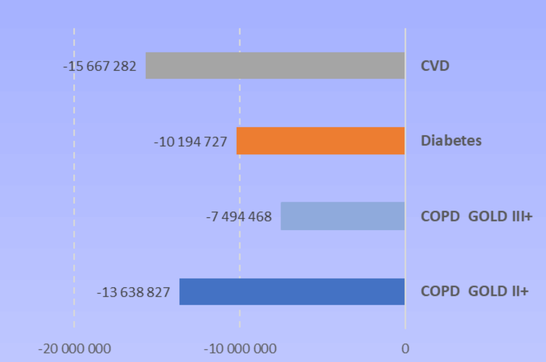
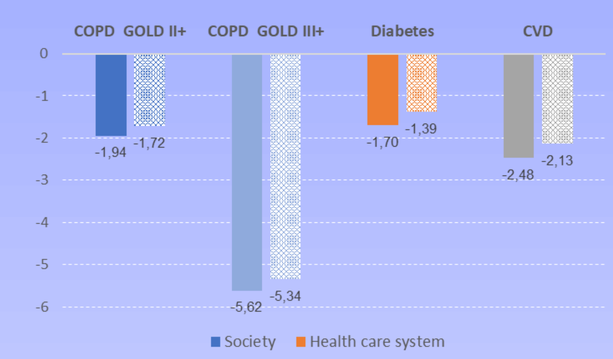


Figure 5: Multiplier (1€ invested in vaccination generate –xx savings)

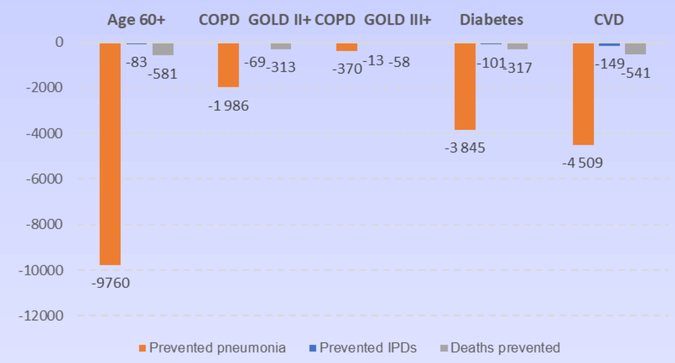


Source: own calculations

Cases prevented

- In the group of ≥ 60-year-olds, 9,760 cases of S pneumonia can be prevented. The absolute number of prevented pneumonias [-4,509] is highest in the risk group with cardiovascular diseases.

Figure 6: Prevented cases



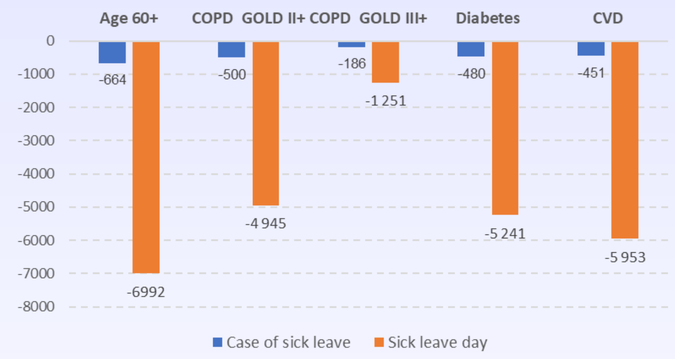
- Furthermore, 83 IPDs can be prevented in the group of ≥ 60-year-olds.
- The prevented deaths in adults old 60-years are 581 cases.
- The absolute deaths avoided are comparable in the group with COPD GOLD II+ [-313] and diabetes [-317] and is higher for patients with CVD [541].

Source: own calculations

Avoided loss of work

- The greatest reduction in lost workdays is among those 60+ (6,992 days) and patients with CVD (5,953 days).

Figure 7: Work absenteeism avoided



- Overall, patients with CVD have fewer sick days than diabetes patients, which is due to a shorter duration of sick leaves.
- Patients with COPD GOLD II+ have 500 sick leaves with 4,945 days.
- Patients with COPD GOLD III+ have 186 sick leaves, corresponds 1,251 days.

Source: own calculations

Variation in vaccination coverage

- Increasing vaccination coverage to 30% in the population aged 60 and older raises the total budget impact from € 21.3 million to € 34.6 million over a 5-year period.
- For patients with COPD at GOLD stage II or higher, elevating vaccination coverage to 40% would raise the total budget impact from € 13.6 million to € 18.1 million over 5 years.
- In patients at GOLD stage III or higher, the total budget impact would increase from € 7.5 million to € 9.3 million over the same timeframe.
- Achieving a 40% vaccination coverage rate in the diabetes population would result in an increase in the total budget impact from € 10.2 million to € 15.3 million over 5 years.
- For the CVD population, this coverage level would increase the total budget impact from € 15.7 million to € 23.5 million over 5 years.

Conclusion

Pneumococcal vaccination saves money for both society and the healthcare system. Including it in a public co-payment program would boost vaccination rates, especially among vulnerable groups, and increase savings.

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Additional literature with the author