

Estimated Human and Economic Burden of 4 Major Adult Vaccine-Preventable Diseases in Nebraska, 2013



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INTRODUCTION

- Childhood immunization programs in the United States have been one of the most cost-effective and successful public health programs and have considerably reduced the incidence of vaccine-preventable diseases (VPDs) in children.¹
- In contrast, adult immunization programs have been slow to evolve.
- According to the Centers for Disease Control and Prevention, low uptake of routinely recommended adult immunizations remains an area of public health practice that has been insufficiently addressed at local, state, and national levels.²
- Understanding the human and economic value of disease prevention is paramount to increasing adult vaccination.

OBJECTIVE

- To develop a customizable model to estimate the human and economic burden caused by 4 major adult VPDs in Nebraska in 2013

METHODS

- We derived burden of disease estimates for 4 major adult VPDs: (1) influenza, (2) pneumococcal disease (both invasive pneumococcal disease and nonbacteremic pneumococcal pneumonia), (3) herpes zoster (shingles), and (4) pertussis (whooping cough).
- We obtained estimates of adult VPD incidence and associated costs from the literature (eg, national disease surveillance programs or large US administrative claims databases) for each of the 4 diseases.^{3,10}
- To estimate the number of cases for each adult VPD for a given population, we multiplied age-specific incidence rates obtained from the literature by age-specific population data obtained from the 2013 Census (most recent complete US census data). We then multiplied the estimated number of cases for a given population by age-specific estimated medical and indirect (nonmedical) costs per case.

Adult VPD Model Equation

$$[\# \text{ of persons}] \times [\text{est. incidence rate}] \times [(\text{est. medical cost per case}) + (\text{est. nonmedical cost per case})] = \text{est. total cost}$$

- Medical costs represent estimated costs for diagnostic and treatment services linked to a diagnosis of 1 of the 4 adult VPDs.¹¹⁻¹⁴
- We derived indirect cost estimates by combining work-loss data with economic productivity data, including wages, fringe benefits/supplements, and household productivity.¹⁵⁻¹⁷
- All costs were adjusted to 2013 US dollars using the Consumer Price Index.
- Sensitivity analyses were conducted to evaluate the effect of increasing or decreasing each individual base-case model parameter by 20%.

RESULTS

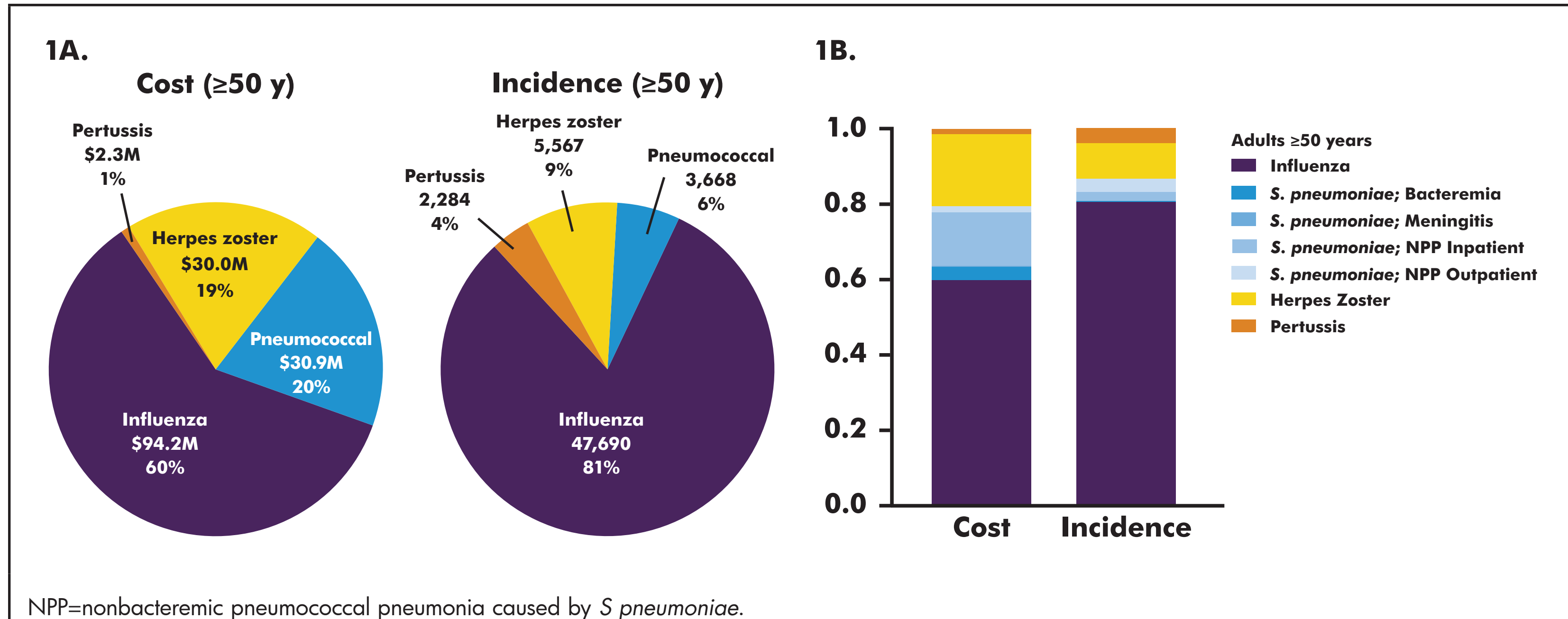
- The estimated annual cost for the 4 VPDs was \$157.5 million (M) for adults 50 years of age and older (Table 1).
 - Direct costs accounted for \$115.3M (73%), and indirect costs accounted for \$42.1M (27%).

Disease	Adults Aged 50 Years and Older						
	Cases	Direct Cost (per Case)	Indirect Cost (per Case)	Total Cost (per Case)	Direct Cost (all Cases)	Indirect Cost (all Cases)	Total Cost (all Cases)
Influenza ^{2,15}	47,690	1,573	403	1,976	75,025,666	19,219,557	94,245,223
Pneumococcal ¹³	3,668				28,256,838	2,660,440	30,917,278
Bacteremia	191	27,627	1,545	29,172	5,276,680	295,064	5,571,744
Meningitis	12	33,409	1,537	34,946	405,588	18,661	424,249
NPP (inpatient)	1,383	15,296	862	16,159	21,159,829	1,192,984	22,352,813
NPP (outpatient)	2,081	680	554	1,234	1,414,741	1,153,732	2,568,473
Herpes zoster ^{9,14,16}	5,567	1,984	3,398	5,382	11,044,529	18,913,677	29,958,207
Pertussis ^{5,11}	2,284	432	593	1,026	987,467	1,354,957	2,342,424
Total	59,209				115,314,500	42,148,632	157,463,132

NPP=nonbacteremic pneumococcal pneumonia caused by *S. pneumoniae*. All costs were adjusted to 2013 US dollars using the medical component of the Consumer Price Index.

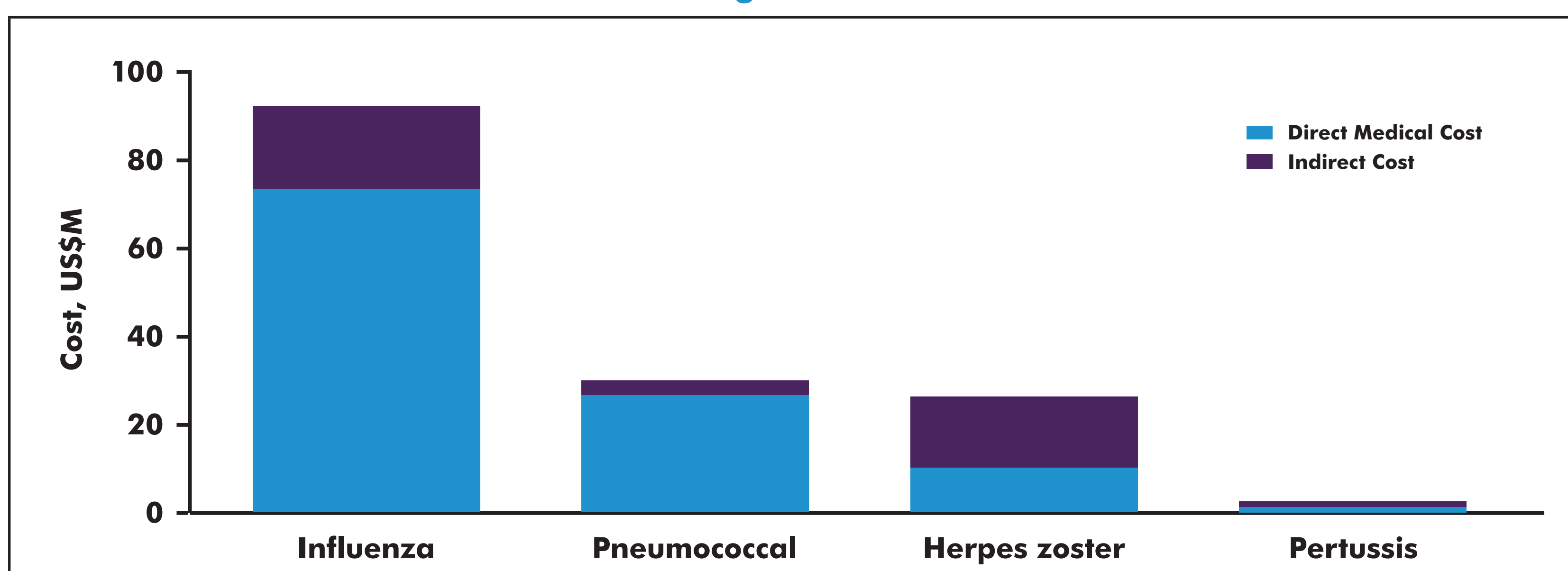
- Among adults 50 years of age and older, influenza, pneumococcal disease, herpes zoster, and pertussis made up \$94.2M (60%), \$30.9M (20%), \$30.0M (19%), and \$2.3M (1%) of the cost, respectively, compared with 81%, 6%, 9%, and 4% of the total number of cases (Figure 1A).
- Most (>80%) pneumococcal cost stemmed from nonbacteremic pneumococcal pneumonia (Figure 1B).

Figure 1. Percentage of Total Cost and Incidence of 4 Major Vaccine-Preventable Diseases in Adults Aged 50 Years and Older, Nebraska, 2013



- Among adults 50 years of age and older, direct medical cost accounted for 91% of the total pneumococcal cost burden and 80% of the total influenza burden but only 37% and 42% of the total economic burden due to herpes zoster and pertussis, respectively (Figure 2).

Figure 2. Comparison of Indirect Costs and Direct Medical Costs for 4 Major Vaccine-Preventable Diseases in Adults Aged 50 Years and Older, Nebraska, 2013



- In adults 65 years of age and older, the estimated cost for the 4 VPDs was \$92.0M (Table 2).
 - Direct costs accounted for \$75.0M (81%), and indirect costs accounted for \$17.0M (19%).

RESULTS CONTINUED

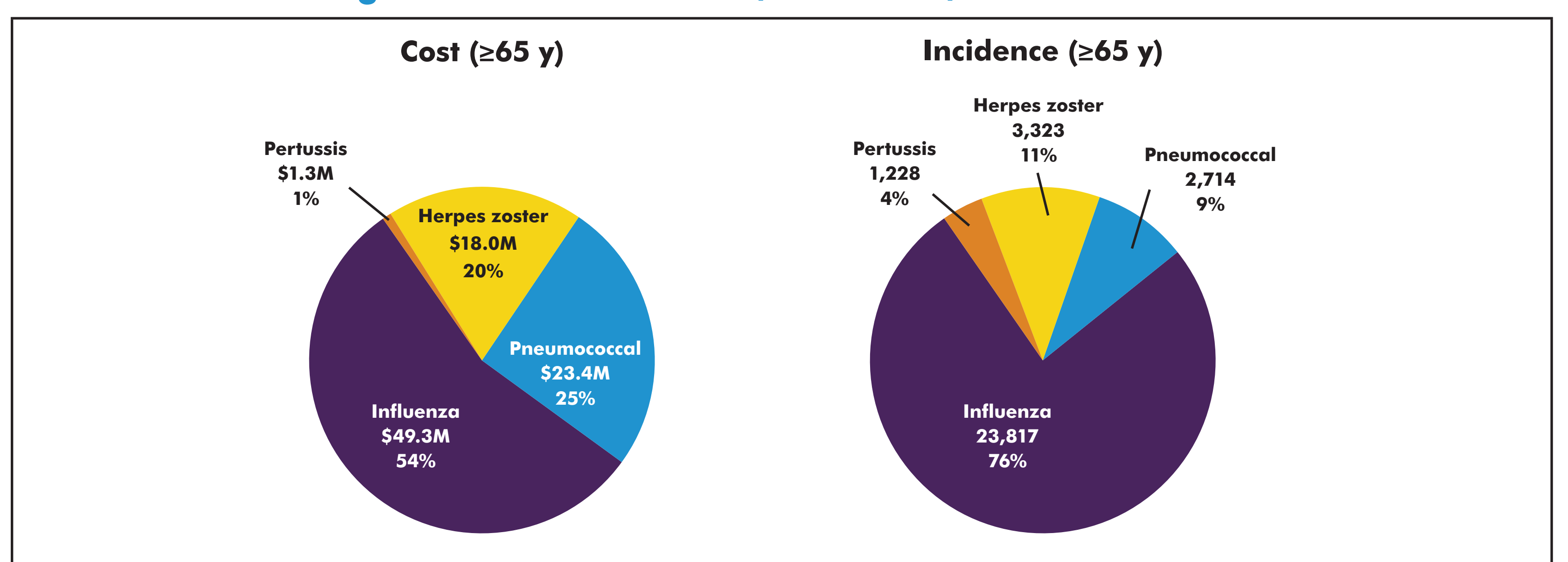
Table 2. Estimated Human and Economic Burden of Vaccine-Preventable Disease in Adults Aged 65 Years and Older in Nebraska in 2013

Disease	Adults Aged 65 Years and Older						
	Cases	Direct Cost (per Case)	Indirect Cost (per Case)	Total Cost (per Case)	Direct Cost (all Cases)	Indirect Cost (all Cases)	Total Cost (all Cases)
Influenza ^{2,15}	23,817	1,867	201	2,068	44,455,678	4,796,171	49,251,849
Pneumococcal ¹³	2,714				22,138,914	1,305,351	23,444,265
Bacteremia	120	24,940	863	25,803	3,001,013	103,801	3,104,814
Meningitis	8	32,383	863	33,246	249,389	6646	256,035
NPP (inpatient)	1,177	15,183	630	15,813	17,867,340	741,374	18,608,714
NPP (outpatient)	1,409	725	322	1,047	1,021,173	453,530	1,474,703
Herpes zoster ^{9,14,16}	3,323	2,361	3,061	5,422	7,845,237	10,171,386	18,016,622
Pertussis ^{5,11}	1,228	432	593	1,026	530,834	728,387	1,259,222
Total	31,081				74,970,663	17,001,294	91,971,958

NPP=nonbacteremic pneumococcal pneumonia caused by *S. pneumoniae*. All costs were adjusted to 2013 US dollars using the medical component of the Consumer Price Index.

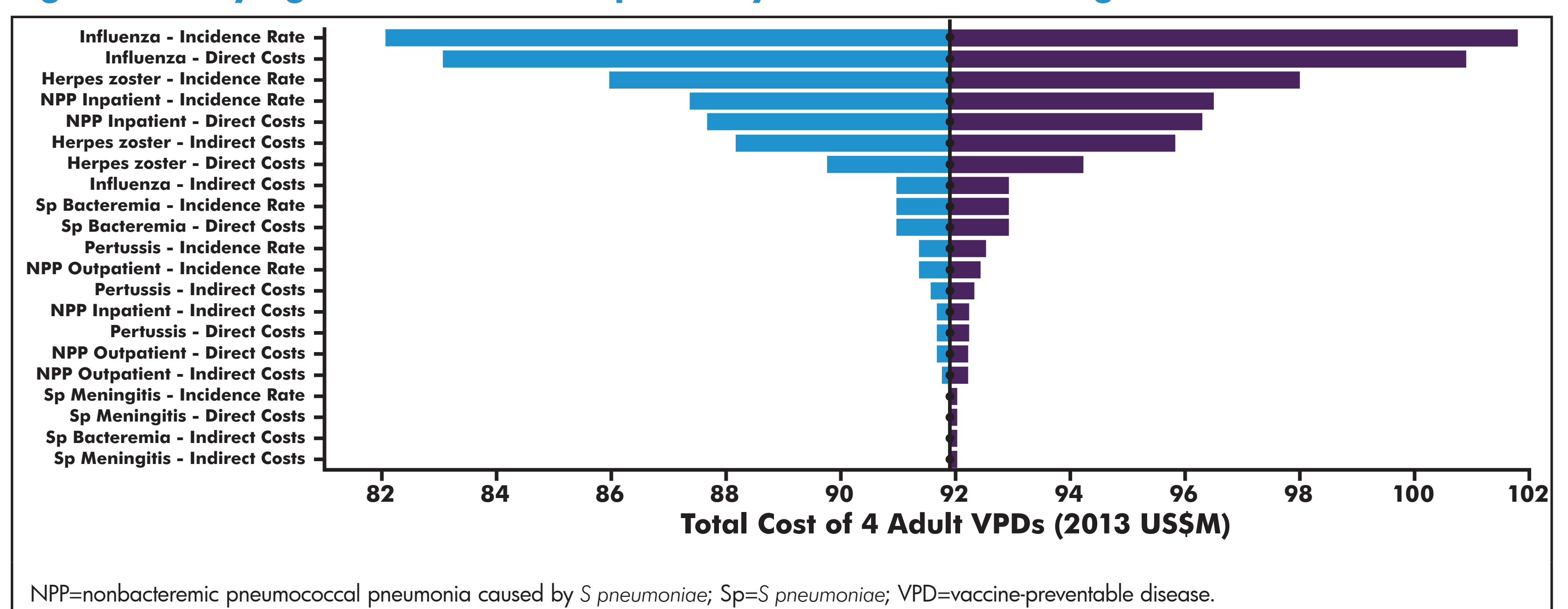
- Among those 65 years of age and older, influenza, pneumococcal disease, herpes zoster, and pertussis made up \$49.3M (54%), \$23.4M (25%), \$18.0M (20%), and 1.3M (1%) of the cost, respectively, compared with 76%, 9%, 11%, and 4% of the total number of cases (Figure 3).

Figure 3. Percentage of Total Cost and Incidence of 4 Major Vaccine-Preventable Diseases in Adults Aged 65 Years and Older, Nebraska, 2013



- Among adults 65 years of age and older, direct medical cost accounted for 94% of the total pneumococcal cost burden and 90% of the total influenza burden but only 44% and 42% of the total economic burden due to herpes zoster and pertussis, respectively.
- Sensitivity analysis revealed that estimated influenza rates and costs per case, nonbacteremic pneumococcal pneumonia incidence and direct costs, and herpes zoster incidence rates and indirect costs had the largest impact on the model (Figure 4).

Figure 4. Varying Base-Case Assumptions by ±20% for Adults Aged 65 Years and Older



LIMITATIONS

- The model relied on the human capital methodology of calculating cost, which does not tend to capture the monetary or nonmonetary value of pain, suffering, and premature death due to disease.
 - In 2013, it was estimated that approximately 54,000 individuals aged 50 and older died from influenza and pneumonia; the large majority of deaths (>48,000; approximately 90%) occurred among adults 65 years of age and older.¹⁸
 - From a societal perspective, this premature death—which we did not capture in this analysis—has an economic value. As such, the output of this model underestimated indirect costs relative to other cost calculation methods.
- It is also important to point out that the methodology and output of the model reflect only the burden of disease attributable to the 4 adult VPDs included in the analysis.
- Because no vaccine is 100% effective or covers all disease strains or serotypes, this model does not reflect the actual amount of disease that would necessarily be prevented with vaccination or by improving vaccination coverage. Instead, the model should be interpreted as the US burden of disease in 2013, among both vaccinated and unvaccinated people, that is attributable to each infectious disease included in the model.

CONCLUSIONS

- Results from the epidemiologic model suggested that the economic impact of 4 adult VPDs (influenza, pneumococcal disease, herpes zoster, and pertussis) is considerable, and that in 2013, the economic impact attributable to adult VPD for adults in Nebraska aged 50 years and older was \$157M (\$115M for those aged 65 years and older).
- This economic burden would be even greater if mortality costs (ie, the value of future income lost by premature death) and leisure time costs (ie, the value of time spent when not working forgone by illness) were included in the analyses.
- Moreover, results of the model showed that although influenza (often the focus of most adult immunization programs) accounted for the majority of cases of adult VPD (81% of adults 50 years of age and older and 76% of adults 65 years of age and older), from a cost perspective, pneumococcal disease and herpes zoster both represent a significant economic burden in addition to influenza.
- Thus, broadening adult immunization efforts beyond only influenza may help reduce the economic burden of disease.
- A pneumococcal vaccination effort primarily focused on reducing the burden of nonbacteremic pneumococcal pneumonia constitutes a logical starting point.

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ACKNOWLEDGMENTS

This study was sponsored by Pfizer Inc. Medical writing support was provided by Susan E. DeRocco, PhD, of Complete Healthcare Communications, Inc., and funded by Pfizer Inc.