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Title: The cost-effectiveness of a universal influenza vaccination program for adults aged 50-64 years in Australia

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ABSTRACT

Currently the Australian government funds universal influenza vaccine for all those aged ≥ 65 years under the National Immunisation Program (NIP). Annual vaccination rates in those aged 50-64 years are significantly lower than vaccination rates in those aged ≥ 65 years, and currently less than half those at high-risk of influenza-related complications aged 50-64 years are immunised. This study used a decision tree model to examine the cost-effectiveness of lowering the age threshold for the influenza NIP in Australia to include those aged 50-64 years. From a healthcare payer perspective, a new influenza vaccination policy would cost \$8,908/QALY gained. From a societal perspective, a new influenza vaccination policy would cost \$8,338/QALY gained. From a governmental perspective, a new influenza vaccination policy would cost \$22,408/QALY gained. The most influential parameters in deterministic sensitivity analysis included: probability of death due to influenza, vaccine efficacy against mortality, vaccine uptake, vaccine cost, and vaccine administration cost. Influenza vaccination for people aged 50-64 years appears highly cost-effective, and should be a strong candidate for funding under the NIP.

INTRODUCTION

Influenza is a common viral infection causing significant morbidity and mortality. It is responsible for 2,886 hospitalisations and 196 deaths annually amongst Australians aged 50-64 years [1]. Those with underlying risk factors, such as diabetes, cardiovascular disease, chronic respiratory disease, or weakened immune systems are particularly susceptible to influenza complications and mortality. Influenza vaccination offers an effective means of preventing much of this morbidity and mortality.

The National Health and Medical Research Council (NHMRC) recommends vaccination of all individuals aged ≥ 65 years, individuals (of any age) at increased risk of influenza-related complications, and contacts of high-risk (HR) patients [2]. However, the Australian government only funds influenza vaccine for those aged ≥ 65 years and Indigenous people aged ≥ 50 years under the National Immunisation Program (NIP) [3]. No government funded NIP exists for the non-Indigenous population aged 50-64 years, even those for whom vaccine is recommended. These people can purchase influenza vaccine privately or at reduced cost via the government-subsidised Pharmaceutical Benefits Scheme (PBS) [3].

A growing body of evidence indicates vaccination of healthy adults is often cost-saving [4-6]. Recently, the cost-effectiveness of universal influenza vaccination in those aged 50-64 years in Europe reported favourable results [7-9].

In the US, the Advisory Committee on Immunization Practices (ACIP) recommends vaccination for all persons aged 50-64 years as a way of increasing vaccination uptake in persons with HR conditions [10]. The ACIP argues that age-based vaccine strategies are more successful than targeting those at HR, and that those without HR conditions still benefit from vaccination [10].

Over one quarter of Australians aged 50-64 years are considered to be at HR of influenza-complications [3]. This age-group achieves annual vaccination rates of approximately 33% (with less than half those at HR being immunised) [3], significantly lower than the 79% influenza vaccination rate achieved under the NIP for Australians aged ≥ 65 years [3]. Similar vaccination coverage could potentially be achieved in the 50-64 year age-group if the NIP was extended to this group. Given the difficulties identifying and targeting those at HR, lowering the age threshold offers a pragmatic approach to increasing coverage levels in Australia [7]. However, the potential benefits of extending the NIP are not without costs. This study examines the cost-effectiveness of universal vaccination funding for Australians aged 50-64 years.

METHODS

A decision tree model (adapted from Aballea et al. [7]) was used to evaluate the cost-effectiveness of extending universal vaccination funding to Australians aged 50-64 years. The model distinguished between those at HR and those at low-risk (LR) of influenza-related complications (Figure 1). HR included those with chronic diseases such as diabetes mellitus, circulatory disease, respiratory disease, and those with weakened immune systems [2;3]. Primary disease was defined as influenza-like illness (ILI), due to the difficulty in determining the true incidence of influenza in the community. For the complications of influenza, ‘influenza-attributable’ hospitalisations and deaths were included. The model was structured so that vaccine efficacy against hospitalisation and mortality was independent of the efficacy against ILI. The principal outcome was quality-adjusted life-years (QALYs). As influenza vaccination is recommended yearly to ensure optimal protection, the model utilised a one-year timeframe.

The perspective for costs was that of the healthcare payer, which includes costs to all parties, including patient co-payments. In scenario analyses, this perspective was augmented by a societal perspective, which additionally included lost production costs, and a governmental perspective which valued only direct costs to Australian governments at federal and state levels. Life-years and QALYs were discounted at 5% in line with the current Australian guidelines [11]. Costs were not discounted as all costs were incurred within a one-year timeframe. All costs are reported in 2005 A\$ (A\$1 ≈ US\$0.8).

Incidence of primary ILI consultations

The Bettering the Evaluation And Care of Health (BEACH) database is a continuous national study of general practitioner (GP) activity in Australia [12]. Records from this database were obtained for the period April 2000 to March 2006 for all those aged 50-64 years where the GP had recorded influenza/ILI [13]. There were an average 45,250 consultations for influenza/ILI annually in Australians aged 50-64 years.

In addition to GP consultations, emergency department (ED) visits coded as influenza were included. Information on ED visits for January 1998 to December 2005 were obtained from the Health Outcomes Information Statistical Toolkit (HOIST) database, which captures about two thirds of all ED visits in the state of New South Wales (NSW). These were scaled up to Australian averages (Table 1).

Probability of hospitalisation or mortality

In Australia, as elsewhere, there are relatively few hospitalisations or deaths specifically coded as influenza-related. Several methods have been used to estimate the proportion of hospital admissions and deaths are attributable to influenza [14-21]. In the accompanying article [1], using regression models, it was estimated that the annual excess hospitalisations attributable to influenza were 33.3 (95% CI: 23.2-43.4) per 100,000 for influenza and pneumonia (International Classification of Diseases 10th Revision (ICD-10); J10-18) and 57.6 (95% CI: 32.5-82.8) per 100,000 for other respiratory disorders (ICD-10; J excluding J10-18). The annual excess all-cause mortality attributable to influenza was 6.4 (95% CI: 2.6-10.2) per 100,000 [1].

The proportion of these hospitalisations that occur in HR individuals compared to LR individuals could not be obtained from Australian data. Therefore,

this ratio was based upon a US cohort study of women aged 45-64, which found a risk ratio in HR individuals of 9.67 for hospitalisation and 90.9 for mortality [14].

Vaccine parameters

A Cochrane review of influenza vaccines in healthy adults found that influenza-inactivated parenteral vaccines (the only vaccines currently available in Australia) had an efficacy of 16% (95%CI: 9%-23%) against ILI [22]. This efficacy figure was utilised in the model for ILI not medically attended, ILI GP visits, and influenza ED visits. For hospitalisations/mortality, the model used only the excess disease burden directly attributable to influenza, therefore a vaccine efficacy against laboratory-confirmed influenza was used (74%, 95%CI: 45%-87%) [22].

From AIHW data, it was estimated that 45.5% of the HR and 26.8 % of the LR were vaccinated against influenza in the 50-64 year age-group [3]. It was assumed that the overall uptake of vaccination would be higher than current levels (32.6% overall) in this age-group but lower than the 79% uptake in those aged ≥ 65 years [3]. For the base-case, it was estimated that 60% of 50-64 year olds would be vaccinated under a new universal program. A higher uptake in the HR compared with the LR was assumed, at a ratio of 1.6:1 [23;24].

Antiviral use

The use of antiviral medications (neuraminidase inhibitors) for the treatment of ILI (4%) was derived from BEACH data [13]. A recent review of antivirals for the treatment of ILI reported that neuraminidase inhibitors reduced complications of ILI by 51% compared with placebo [25]. Workdays lost from ILI were also reduced by 13.4% in those receiving antivirals [26].

Utility weights

A conservative approach was taken by not applying lower utility weights to the period of illness that individuals may experience for ILI and its complications. Survival was quality-adjusted, using utility weights, into QALYs. Individuals (particularly those in older age-groups) have, on average, less than perfect health (i.e. they have a mean utility score < 1). Utility weight estimates in five year age-bands were taken from an Australian study [27].

Lost production

Productivity costs were valued using the human capital approach [28]. Lost production due to mortality was ignored to avoid double counting as this cost was valued through QALYs. Australian workforce participation rates were obtained from Australian Bureau of Statistics (ABS) data [29]. ILI cases who sought primary care were assumed to have 2.6 days absent from work [30]. No Australian data were available on absenteeism for influenza cases not medically attended. Data from a French prospective survey was utilised, which found that working adults with influenza not medically attended missed an average of 0.3 days from work [31]. It was assumed that 50% of those with ILI seek medical care [32]. Therefore, ILI incidence was double the ILI consultation rate, giving an average of 1.45 $([2.6+0.3]/2)$ days for an individual with ILI. This value was varied in a sensitivity analysis from 1.3 days [33] to 2.8 days [34].

Further details of all probability estimates and sensitivity ranges are shown in Table 1.

Cost Estimates

The true cost negotiated by the Australian government for vaccines issued as part of the NIP is confidential and is approximated by the 2003 ex-manufacturer PBS fixed price (\$10.69). Currently, 13.3% of those aged 50-64 years who receive an influenza vaccine are vaccinated as part of the NIP (i.e. via 'leakage' from the program targeted at those aged ≥ 65 years) [3], 63.5% are vaccinated privately (and pay the full vaccine cost), and 23.2% are concession card holders and are subsidised [35]. In the new program, the model assumed all those vaccinated receive their vaccine as part of the new NIP at a cost of \$10.69.

It was assumed that in current practice, 70% of those vaccinated are vaccinated by GPs and 30% by practice nurses. Data on influenza vaccination consultations stratified by the type of consultation and the number of problems managed in that consultation was obtained from the BEACH database [36]. All visits where only one problem was managed (i.e. influenza vaccination) were assigned the full consultation cost. For encounters where influenza vaccination was delivered in combination with another problem managed, the cost of the visit was divided by the number of problems managed. The cost of practice nurse-administered vaccines was taken from the MBS. In the new program it was assumed that a larger proportion of vaccines would be given by practice nurses (50%). Further details of vaccination costs can be seen in Table 2.

Health care unit costs

Hospitalisation costs were determined from Australian Refined Diagnosis Related Group (AR-DRG) (version 5.1) data recorded for each patient hospitalised under the appropriate ICD category (i.e. influenza/pneumonia or other respiratory) in

the period July 1998 to June 2005. Unit record data were supplied by the AIHW. The appropriate AR-DRG cost for each of these hospitalisations was then applied, taking into account whether the patient was in a public [37] or a private hospital [38]. Costs for ED visits for influenza (that do not require hospitalisation) were obtained using the same method.

The average cost per GP consultation was determined by the 2006 Medicare Benefits Scheme (MBS) consultation cost for the appropriate level of consultation as reported in the BEACH database [13]. Prescription drug and diagnostic test utilisation were obtained from the BEACH database [13]. Costs for prescription drugs were taken from the PBS Dispensed Price for Maximum Quantity (DPMQ). Diagnostic test costs were taken from the relevant MBS items (85% rebate was utilised for governmental perspective). Further details of health unit costs can be seen in Table 2.

Societal costs

The cost attached to lost work days was based on August 2005 average weekly earnings in Australia for a full-time adult (seasonal adjusted) [39]. This produced a cost of \$215 per day (\$1072/5 days) which was applied to all sick days taken as a result of ILI. Full-time adult total earnings were utilised to fully value the opportunity cost to part-time employees.

Sensitivity Analysis

One-way sensitivity analyses were performed on parameters likely to be influential. In addition to those parameters in Table 1, the costs of vaccine leakage (to those below 50 years of age) and wastage (i.e. excess vaccine purchased by

government but not administered) of up to 10% were examined. The vaccine campaign costs were not included in base-case analysis but a \$1 million initial campaign cost was included in the sensitivity analysis.

Probabilistic sensitivity analyses were also performed. Distributions were attached to the range of values seen as plausible for each parameter (Table 1). For each scenario 10,000 simulations were conducted. In each simulation, parameter values were sampled based on the distributions attached to the parameter. Through this approach it was possible to generate cost-effectiveness acceptability curves to illustrate the probability of a new intervention falling under a given threshold (e.g. \$50,000/QALY gained).

RESULTS

Health outcomes

A vaccination program targeted at 50-64 year-olds would reduce the annual number of ILI cases (medically attended and non-attended) by 3,124, a 0.09% reduction in the incidence of ILI, from 1.90% to 1.81%. The new policy would also prevent 1,172 hospitalisations, 89 deaths and 2,805 work days lost (Table 3).

Costs

From a healthcare payer perspective, a new influenza vaccination policy would cost an additional \$15.5 million (or an additional \$4.40 per person aged 50-64 years). A total of \$0.1 million would be saved on primary care for ILI GP visits and influenza ED visits. A total of \$6.0 million would be saved on hospitalisation costs attributable to influenza. Overall, the net cost of the new influenza vaccination policy would be \$9.4 million (Table 4). From a societal perspective, direct costs were

identical to those from a healthcare payer perspective; however, an additional saving of \$0.6 million was made from reduced work absenteeism. Therefore, overall the net cost of the new influenza vaccination policy to society would be \$8.8 million.

From a governmental perspective, a new influenza vaccination policy would cost the Australian government \$29.8 million (\$8.44 per individual aged 50-64 years). The Australian government would save \$0.1 million on primary care for ILI GP visits and influenza ED visits. It would save \$6.0 million on hospitalisation costs attributable to influenza. Overall the net cost to the Australian government for the new influenza vaccination policy would be \$23.7 million (Table 5).

Cost-effectiveness

From all the perspectives considered, a new influenza vaccination policy was more costly and more effective than current practice (Table 6). From a healthcare payer perspective, a new influenza vaccination policy resulted in an Incremental Cost-Effectiveness Ratio (ICER) of \$8,908/QALY gained. From a societal perspective, a new influenza vaccination policy resulted in an ICER of \$8,338/QALY gained. From a governmental perspective, a new influenza vaccination policy resulted in an ICER of \$22,408/QALY gained.

Deterministic sensitivity analyses

Details of deterministic sensitivity analyses are presented in a tornado graph (Figure 2). In all scenarios for the healthcare payer perspective/societal perspective, ICERs were below \$18,000/QALY gained (and governmental perspective below \$50,000), except when considering variation in the probability of death due to influenza. Figure 3 shows a sensitivity analysis around the NIP cost of the vaccine.

Probabilistic sensitivity analyses

Assuming a maximum cost-effectiveness threshold of \$50,000/QALY gained, over 99% of simulations from all perspectives show a publicly funded influenza vaccine for those aged 50-64 years to be cost-effective (Figure 4). The most influential variables in probabilistic sensitivity analysis were the probability of death due to influenza and the proportion of those at HR.

DISCUSSION

The incremental cost per QALY gained was less than \$9,000 from the healthcare payer perspective. This is well below the implied threshold for cost-effectiveness based on past PBAC funding decisions [40]. In the healthcare payer perspective 99% of all simulations were below a cost-effectiveness acceptability threshold of \$50,000/QALY gained.

No previously published Australian study has examined the cost-effectiveness of public funding of influenza vaccine in people aged 50-64 years. The Aballea et al. study [7], which applied the same basic model structure to three European countries, used approximately four times the rate of primary disease and approximately double the rate of hospitalisation and mortality attributable to influenza, compared to the estimates used in this study. Consequently, the ICERs for Europe were lower than those found for Australia, except in Germany, where from a governmental perspective they found a higher ICER, largely due to the low increase in vaccine uptake expected in HR individuals. Days of work lost due to ILI in Australia were relatively low given the lower ILI incidence rate estimated for Australia compared with Europe [7]. Recent cost-effectiveness analyses of vaccination in 50-64 year olds from the UK and the US have found similar results to this study [8;9].

The governmental perspective is useful for assessing the impact that a new vaccination program will have on a government's budget. However, in the case of influenza vaccination, where the comparator for the proposed intervention is not 'no intervention' but rather current practice, this perspective may be misleading. While there is no current national public funding of influenza vaccine for those aged 50-64 years, a significant proportion (approximately 30%) of this age-group is already

being vaccinated. For vaccines obtained privately an individual (or employer) pays the full cost of vaccination, or in the case of healthcare card holders, they pay a co-payment towards the cost. In the existing system, from a governmental perspective those vaccinated privately (70% of those currently vaccinated) are attributed no cost, whereas from a healthcare payer perspective and societal perspective the whole cost is attributed.

The variation in vaccine uptake under a new vaccination program is an influential variable parameter. How variation in vaccine uptake influences the cost-effectiveness of a new vaccination program is dependent on the perspective considered. From a governmental perspective, if a 10% increase in vaccination uptake (e.g. from the current 30% to 40%) is assumed, the ICER increases to \$41,181/QALY gained. However, this increase is the result of existing vaccine costs being shifted from the consumer to the government. When the same scenario is considered from a healthcare payer perspective, there is a net saving of \$4.4 million from a new vaccination program, with individuals no longer purchasing higher cost vaccines privately, but rather being vaccinated at the cheaper Australian government negotiated price.

The incidence of mortality attributed to influenza is the most influential parameter in the model. This is because, in this model, QALYs are lost through mortality only. While there is significant debate around the various modelling approaches to determine excess influenza-related hospital admissions and mortality [41-43], these differing approaches can produce similar estimates when applied to the same time-period/population [42]. The Australian mortality estimates were lower than rates estimated using similar models in other countries [15;17;21]. For example, in the US, Thompson et al. estimated approximately double the incidence of deaths

attributable to influenza at 12.5 per 100,000 (in those aged 50-64 years [17]) compared to 6.4 deaths per 100,000 in Australia [1]. If the rate estimated for the US had been used in the Australian model, the ICER would have been reduced to \$4,571/QALY gained (healthcare payer perspective).

Recent studies in the elderly focusing on the reduction in mortality have reported a vaccine efficacy of approximately 50% against all-cause mortality in winter months [44;45]. However, in the US it was estimated that influenza is responsible for less than 10% of all-cause winter mortality among the elderly [46]. The inconsistency between these two figures has been widely noted, and the methodological problems associated with cohort studies suggested as the primary explanation [46-51]. This analysis has taken a conservative approach and used a vaccine efficacy for laboratory-confirmed influenza (74% [22]) against only excess hospitalisation and excess mortality attributable to influenza. Previous cost-effectiveness studies have utilised the same approach [9]. In Australia, the excess deaths attributable to influenza represent only 1.3% of all deaths [1]. Therefore, in our approach a maximum of 1% (i.e. $1.3\% \times 0.74$) of all deaths could be prevented in a fully vaccinated population. This approach is the equivalent to an efficacy against all-cause mortality of 1%; or, assuming a quarter of all deaths occur in winter, a 4% efficacy against all-cause winter mortality.

Where there were data limitations a conservative approach was taken to parameter estimation. For example, in the case of ED visits, where the data source was poor, only estimates of ED coded specifically as influenza were included. As with hospitalisation/mortality, it is likely that ED visits coded as influenza are only a small proportion of the true number attributable to influenza. Unlike some other

studies of influenza prevention [52], QALY loss for ILI and its related complications were not included.

Based on current Australian guidelines it appears that the healthcare payer perspective is preferred for decision making [11]. From a healthcare payer perspective, an influenza NIP results in an ICER of \$6,873 per life-year saved and \$8,908/QALY gained. Uncertainty in the estimate of excess mortality (attributable to influenza) appears likely to be the main impediment to public funding. However, in sensitivity analyses (even for mortality), the upper limit of the ICERs were below \$50,000/QALY gained. Influenza vaccination for people aged 50-64 years appears highly cost-effective.

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Table 1. Model parameters: base-case values and sensitivity values

Parameter	Base-case	Deterministic sensitivity range	Probabilistic distribution	Source
Population size	50-54: 1,334,942 55-59: 1,245,336 60-64: 944,942 Total: 3,525,220	–	–	[29]
Proportion at high-risk (HR) of influenza-related complications	50-54: 26.1% 55-59: 34.1% 60-64: 29.8% 50-64: 29.92% ¹	25%–34.8%	Triangular - min: 25%; mode: 30%; max: 35%	[3;53]
Vaccination uptake -Existing policy	HR: 45.54% LR: 26.8 %	–	–	[3]
Vaccination uptake -New policy	HR: 81.44% LR: 50.90%	Overall: 40%–80%	–	[3]
HR/LR ratio	1.6	1.3–1.6	–	[23;24]
Vaccination administration -Existing policy	GP: 70% Nurse: 30%	GP: 50%–90%	Uniform - min: 50%; max: 90%	²
Vaccination administration -New policy	GP: 50% Nurse: 50%	GP: 30%–70%	Uniform - min: 30%; max: 70%	²
Probability of prescription of antiviral	3.94%	–	–	[13]
Workforce participation rates	50-54: 72.2% 55-59: 66.0% 60-64: 43.8%	–	–	[29]
Life-expectancy	50-54: 31.1 yrs 55-59: 26.6 yrs 60-64: 22.3 yrs	–	–	[29]

Parameter	Base-case	Deterministic sensitivity range	Probabilistic distribution	Source
Utilities	50-59: 0.80 60-69: 0.79 70-79: 0.75 80+: 0.66	Base-case -1	-	[27]
Discounting rate: life-years/QALYs	5%	0%-5%	-	[11]
<i>Disease estimates:</i> ³				
Probability of influenza-like illness (ILI) general practitioner (GP) visit ⁴	0.93%	0.82%–1.09%	Empirical distribution of incidences from 2000-2006	[13]
Probability of influenza emergency department (ED) visit	0.02%	-	-	⁵
Percentage of individuals with ILI seeking medical care (GP/ED care) ⁶	50%	25%–75%	Beta (50%,3%) ⁷	[32]
Probability of hospitalisation	Influenza/Pneumonia: 33.3 per 100,000 Other respiratory: 57.6 per 100,000	Overall: 55.7–126.2 per 100,000	Beta - Influenza/Pneumonia: (33.3, 5.3) ⁷ Beta - Other respiratory: (57.6, 14.2) ⁷	[1]
HR/LR ratio	9.67:1	2:1–9.67:1	-	[14;54]
Probability of death	6.4 per 100,000	2.6–10.2 per 100,000	Beta (6.4,2.3) ⁷	[1]
HR/LR ratio	90.9:1	20:1–90.9:1	-	[14;55]
Number of workdays lost- cases seeking medical care	2.6	Overall workdays lost: 1.3–2.8	Normal (2.6,0.15) ⁷ ; min 0	[30;33;34]
Number of workdays lost- cases not seeking medical care	0.3	See above	Probability absence: Beta (0.45,0.06) ⁷ Mean number of days: Lognormal (0.68,0.15) ⁷	[31]

Parameter	Base-case	Deterministic sensitivity range	Probabilistic distribution	Source
<i>Vaccine efficacy:</i>				
ILI ⁸	16%	9%–23%	Lognormal (16%,5.4%) ⁷	[22]
Hospitalisations	74%	45%–87%	Lognormal (74%,56.8%) ⁷	[22]
Deaths	74%	45%–87%	Lognormal (74%,56.8%) ⁷	[22]
<i>Antiviral efficacy:</i>				
Lost workdays	13.4%	–	–	[26]
Complications	51%	–	–	[25]

¹Weighted

²Expert opinion

³In the model probability of disease was adjusted for the proportion of the 50-64 year population currently immunised

⁴To obtain the ILI consultation incidence, the annual number of ILI encounters (45,250) were divided by the average Australian population (aged 50-64 years) during the period of review ($45,250/3279532 = 1.38\%$), and then restricted this to new ILI consultations ($1.38\% * 67\% = 0.93\%$). To account for the cost of the 33% ILI encounters listed as follow-up, each new ILI case was given the cost of approximately 1.5 GP visits (i.e. an additional 0.5 visits, $0.33/0.67 = 0.5$).

⁵To estimate the number of ED visits for Australia, HOIST data was first scaled these to represent the NSW total ($201.1 * 3/2 = 301.7$), and then scaled again to represent Australia, based on the proportion of Australian influenza hospitalisations from NSW (50-64 years = 28.7%), giving a total of 1050 annually ($1/28.7\% * 301.7 = 1050$).

⁶This figure of 50% was used (in conjunction with the ILI consultation rate) to estimate the number of individuals who develop ILI but who do not seek medical attention.

⁷(mean, standard deviation)

⁸This efficacy figure was utilised in the model for ILI not medically attended, ILI GP visits, and influenza ED visits.

Table 2. Model costs: base-case values

	Average cost per patient	
	Healthcare payer perspective/societal perspective	Governmental perspective
<i>ILI GP visit</i>		
GP fee	\$38.68 ¹	\$34.83
Medication costs	\$6.48 ²	\$6.11
Diagnostic test costs	\$1.68	\$1.43
<i>Influenza ED visit cost</i>	\$281	\$281
<i>Hospitalisation costs</i>		
Influenza/pneumonia	\$5,788	\$5,788
Other respiratory ³	\$4,669	\$4,669
<i>Administration costs</i>		
GP	\$20.18 ⁴	\$18.01
Nurse	\$10.69 ⁵	\$10.60
<i>Current program vaccine dose costs</i>		
Concession card holders	\$17.79 ⁶	\$12.98 ⁷
Privately	\$18.78 ⁸	\$0
Leakage	\$10.69	\$10.69
<i>Current average vaccine cost</i>	\$17.47	\$4.44

¹ In the healthcare payer perspective/societal perspective an average patient contribution of \$3.85 was added.

² In the healthcare payer perspective/societal perspective, drug premium and non-PBS listed drug costs were included [56].

³ All other respiratory disorders excluding influenza and pneumonia

⁴ In the healthcare payer perspective/societal perspective an average patient contribution of \$3.85 was added before calculation.

⁵ In the healthcare payer perspective/societal perspective an average patient contribution of \$0.09 was added.

⁶ PBS cost

⁷ \$12.98 = \$17.79 - \$4.81, where \$4.81 is the average patient co-payment.

⁸ \$18.78 = \$17.79 PBS + \$0.99 allowance for safety net card.

Table 3. Base-case health outcomes

	Individual level			Population level		
	New policy	Existing policy	Difference	New policy	Existing policy	Difference
Probability of illness ¹	1.81%	1.90%	-0.09%	63,945	67,068	-3,124
Probability of hospitalisation	0.06%	0.09%	-0.03%	2,035	3,207	-1,172
Probability of death	0.004%	0.006%	-0.003%	137	226	-89
Number of workdays lost ²	0.016	0.017	-0.008	57,451	60,256	-2,805
Life-years ³	15.3266	15.3262	0.0004	54,029,605	54,028,234	1,371
QALYs ³	11.8254	11.8251	0.0003	41,686,994	41,685,936	1,058

¹GP/ED and non-consulting

²Societal perspective

³Discounted at 5% annually

Table 4. Base-case costs (healthcare payer perspective)

Type of cost	Individual level (A\$)			Population level (A\$,000)		
	New policy	Existing policy	Difference	New policy	Existing policy	Difference
Vaccination	15.67	11.28	4.40	55,247	39,754	15,494
Primary care ¹	0.68	0.72	-0.03	2,403	2,521	-117
Hospitalisation	2.93	4.62	-1.69	10,336	16,288	-5,952
Total	19.29	16.61	2.67	67,987	58,563	9,424

¹GP/ED visits

Table 5. Base-case costs (governmental perspective)

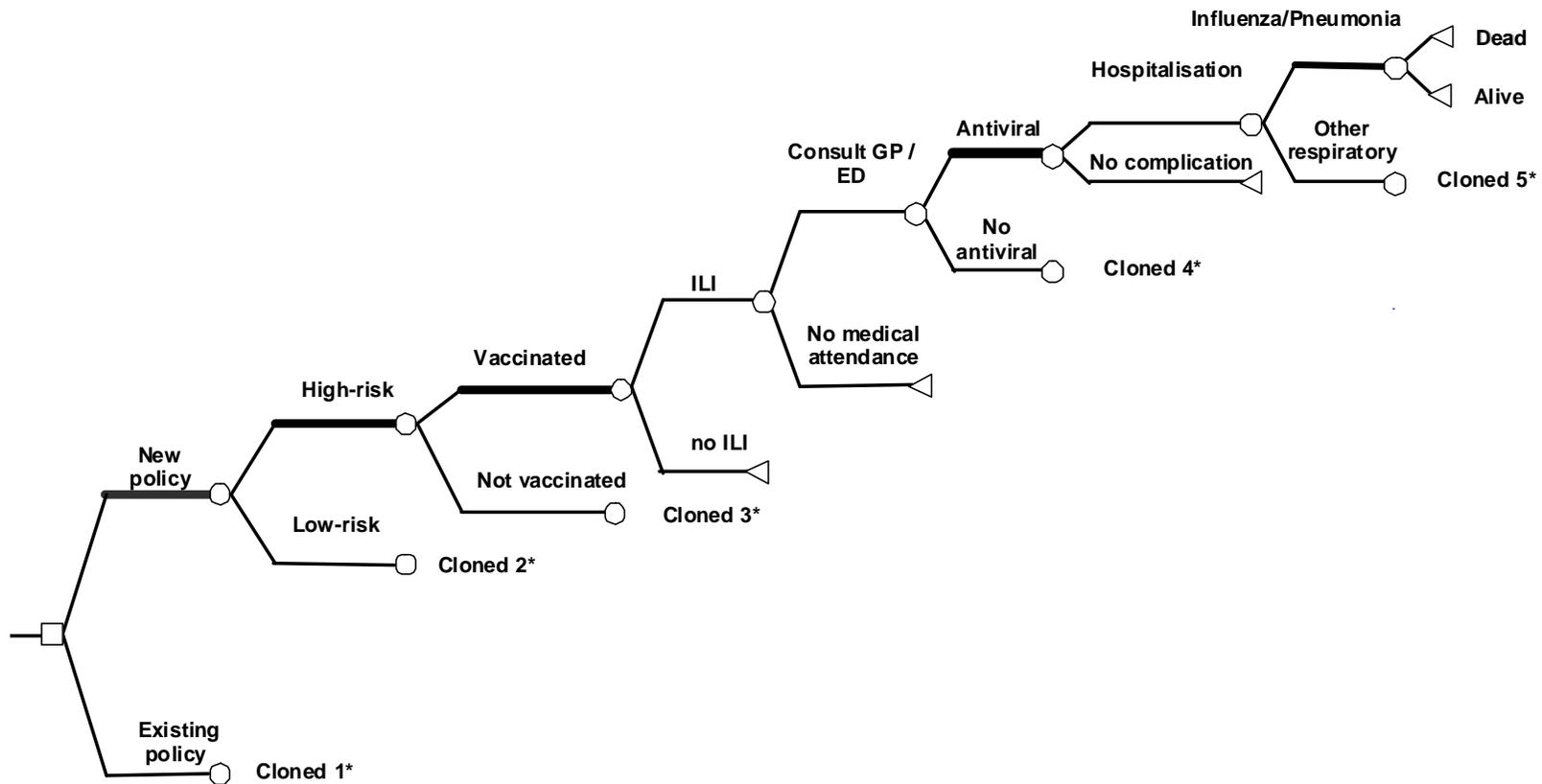
Type of cost	Individual level (A\$)			Population level (A\$,000)		
	New policy	Existing policy	Difference	New policy	Existing policy	Difference
Vaccination	15.00	6.55	8.44	52,878	23,102	29,766
Primary care ¹	0.62	0.65	-0.03	2,201	2,309	-108
Hospitalisation	2.93	4.62	-1.69	10,336	16,288	-5,952
Total	18.55	11.83	6.72	65,405	41,699	23,706

¹GP/ED visits

Table 6. Incremental cost-effectiveness

	Healthcare payer perspective	Societal perspective	Governmental perspective
Cost per case of ILI averted	\$3,017	\$2,824	\$7,589
Cost per hospitalisation averted	\$8,041	\$7,527	\$20,228
Cost per death averted	\$105,343	\$98,602	\$264,992
Cost per life-year saved	\$6,873	\$6,433	\$17,289
Cost per QALY gained	\$8,908	\$8,338	\$22,408

Figure 1. Decision tree



*Cloned subtrees are identical copies from bold branches. Decision tree model adapted from Aballea et al. [7].

Figure 2. Tornado diagram of deterministic sensitivity analysis results (healthcare payer perspective)

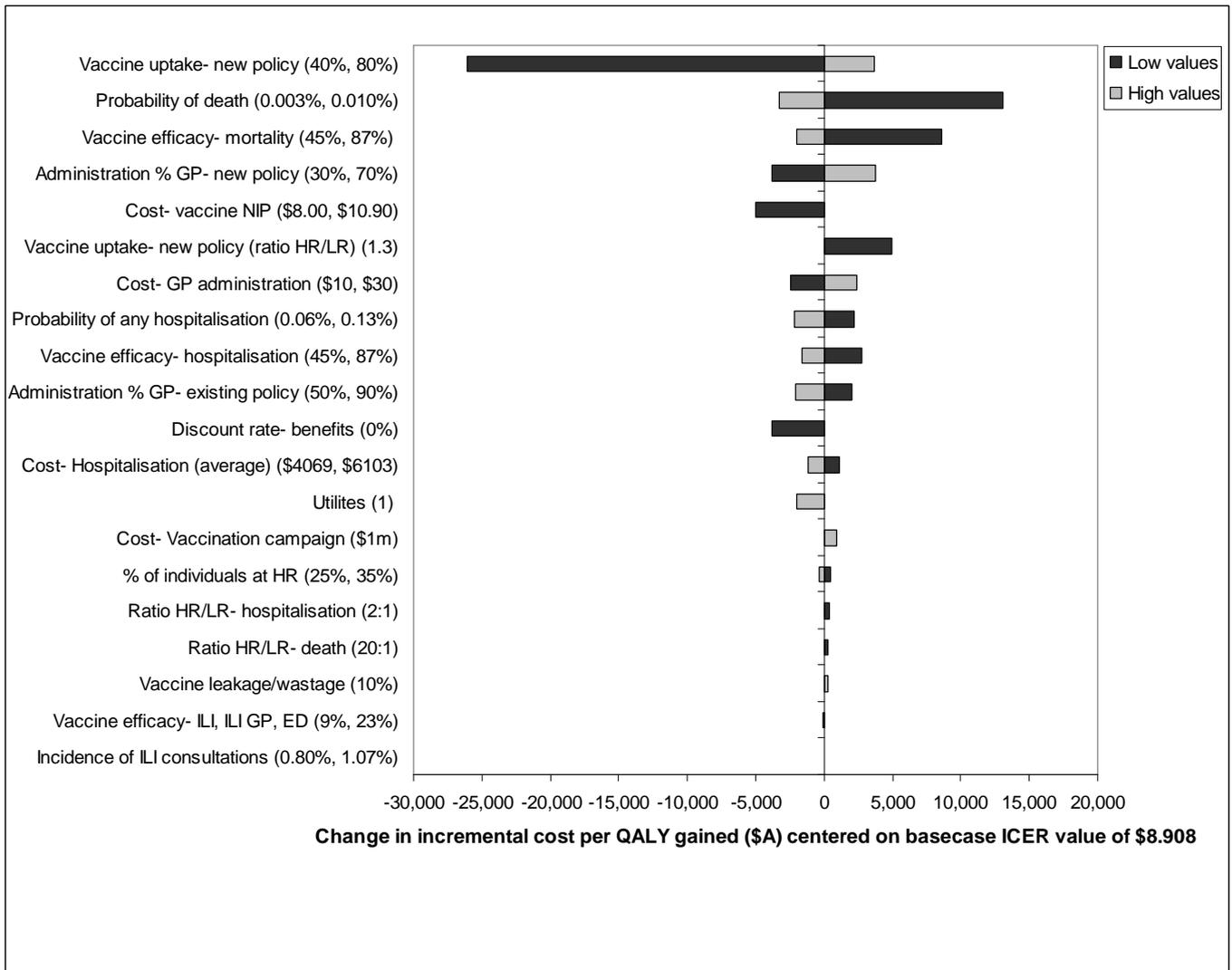


Figure 3. Sensitivity analysis based on variation in vaccination cost: healthcare payer perspective (HP), societal perspective (SP) and governmental perspective (GP). The effect of a change in NIP vaccine purchase cost on the cost-effectiveness of vaccination.

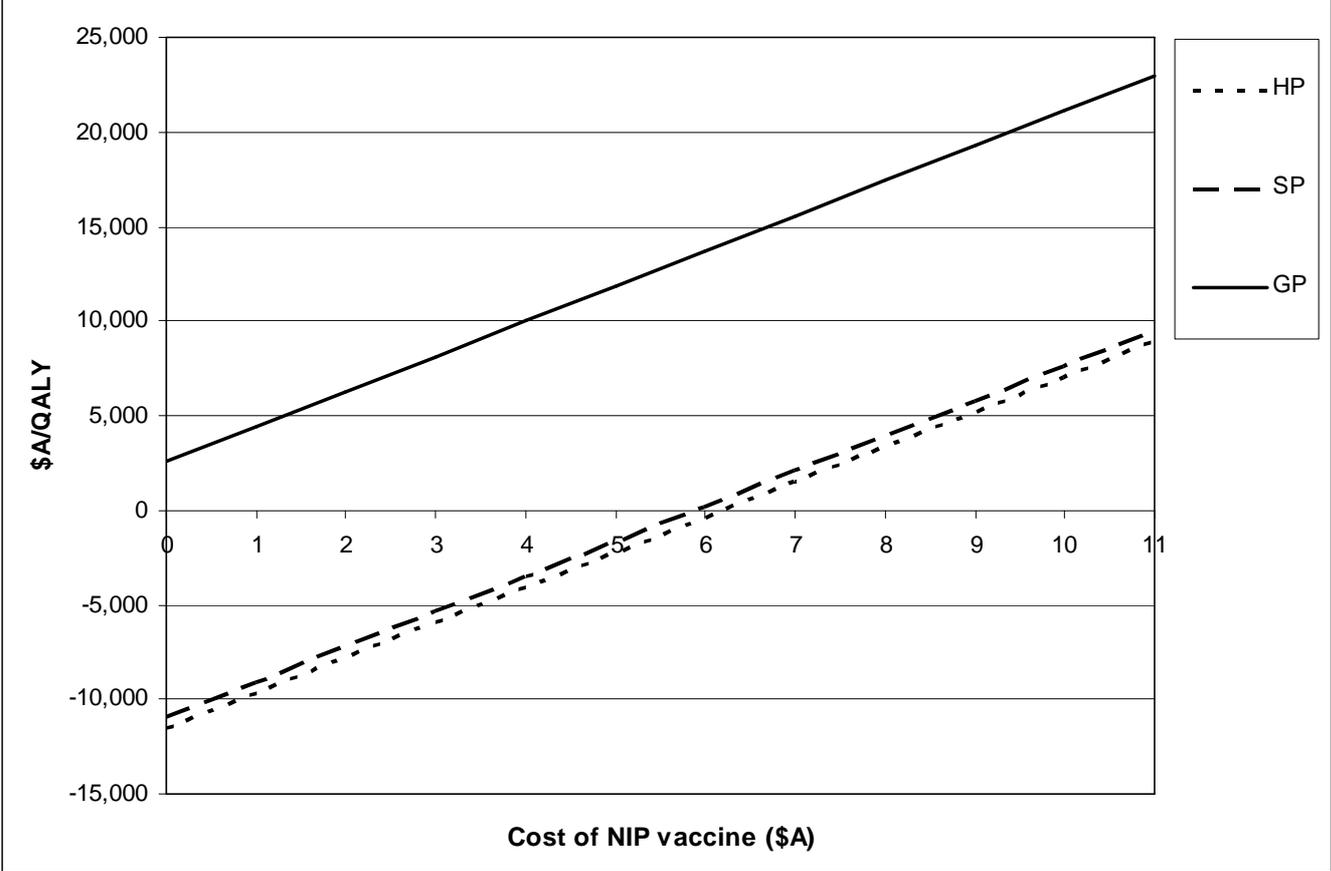
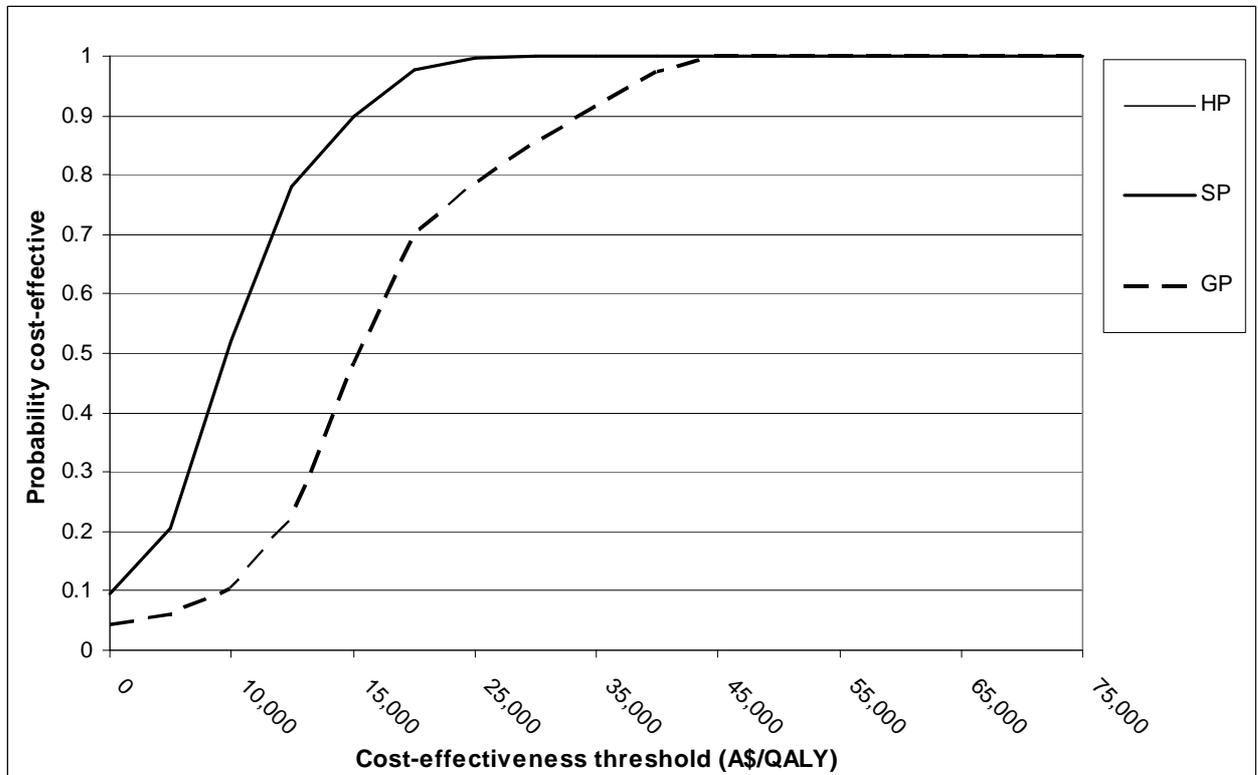


Figure 4. Cost-effectiveness acceptability curves: healthcare payer perspective (HP), societal perspective (SP) and governmental perspective (GP).



*Note that differences in the healthcare payer perspective and societal perspective are minimal and the lines overlay