The cost of seasonal respiratory illnesses in Australian children: the dominance of patient and family costs and implications for vaccine use

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Abstract

Respiratory viral infections are one of the next group of diseases likely to be targeted for prevention in childhood by the use of vaccines. To begin collecting necessary epidemiology and cost information about the illnesses caused by these viruses, we conducted a prospective cohort study in 118 Melbourne children between 12 and 71 months of age during winter and spring 2001. We were interested in calculating an average cost per episode of community-managed acute respiratory disease, in identifying the key cost drivers of such illness, and to identify the proportion of costs borne by the patient and family. There were 202 community-managed influenza-like illnesses identified between July and December 2001, generating 89 general practitioner visits, and 42 antibiotic prescriptions. The average cost of community-managed episodes (without hospitalisation) was $241 (95% CI $191 to $291), with the key cost drivers being carer time away from usual activities caring for the ill child (70% of costs), use of non-prescription medications (5.4%), and general practice visits (5.0%). The patient and family met 87 per cent of total costs. The lowest average cost occurred in households from the highest income bracket. Acute respiratory illness managed in the community is common, with the responsibility for meeting the cost of episodes predominantly borne by the patient and family in the form of lost productivity. These findings have implications for preventive strategies in children, such as the individual use of, or implementation of public programs using, currently available vaccines against influenza and vaccines under development against other viral respiratory pathogens. *Commun Dis Intell* 2004;28:509–516.

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Introduction

For some time now there has been a divergence between what vaccines the National Health and Medical Research Council (NHMRC), more recently on the advice of the Australian Technical Advisory Group on Immunisation (ATAGI), recommends Australians should receive, and what is paid for by the National Immunisation Program (NIP). The NIP is a Commonwealth, State and Territory Governments' initiative that provides certain vaccines free of charge to Australians.

This divergence previously only applied to recommendations for older Australians, in particular, influenza and 23-valent polysaccharide pneumococcal vaccines. Influenza vaccine was first recommended for older Australians in the third edition of, what is now called, the *Australian Immunisation Handbook* in 1986[1] but was only funded nationally in 1999.[2] A general recommendation for use of polysaccharide pneumococcal vaccine in older Australians was first made in the fifth edition of the immunisation handbook (1994),[3] and the Commonwealth Government has announced funding for a national program to commence in 2005.[4]

But as Burgess and McIntyre reported recently,[5] the release of the eighth edition of the handbook[6] has seen this divergence between recommended and funded vaccines extend to children. Varicella vaccine is on the Australian Standard Vaccination Schedule at 18 months of age; there is a universal recommendation for a primary course of the relatively expensive seven-valent conjugate pneumococcal vaccine; and inactivated poliomyelitis vaccine is recommended when appropriate combination vaccines become available. An infant program and a catch-up program for children under the age of two years for pneumococcal vaccine commenced at the beginning of 2005,[4] but there is currently no provision to fund either universal childhood varicella vaccination or a transition to inactivated poliomyelitis vaccine.

This emerging discrepancy between recommended and funded vaccines is only likely to widen. One of the next major groups of diseases preventable by use of vaccines is likely to be the respiratory viral infections of childhood. Injectable influenza vaccines are currently licensed for Australian children down to the age of six months, but are currently recommended only for children in high-risk groups.[6] A trivalent, cold-adapted, influenza vaccine (CAIV-T), containing live-attenuated virus and delivered intranasally, was licensed in the United States of America (USA) in 2003 for healthy five to 49-year-olds,[7] with the likelihood of younger and older age indications in the future. Other vaccines against respiratory viral infections, including respiratory syncytial virus and parainfluenza viruses, are currently under development. Information about the epidemiology and costs of acute community-based respiratory illness in children, particularly those costs borne by the patient and family, are required to guide future vaccine use and other control measures. Given the circulation patterns of these viruses, particularly respiratory syncytial virus and influenza virus, we collected information about respiratory illness in winter and spring.

We report here burden information for community-based respiratory illnesses in urban Australian children, and use these to calculate an average cost for these episodes.

Method

We conducted a prospective cohort study of healthy children in metropolitan Melbourne, Victoria, between 1 July and 1 December 2001. The Royal Children's Hospital Ethics in Human Research Committee approved the study and written informed consent was obtained from parents/guardians. Methods for this study have been described elsewhere.[8] Eligible children were between 12 and 71 months of age at enrolment without pre-existing chronic respiratory or other medical problems. Children aged between 12 and 23 months were recruited largely via maternal and child health nurses (MCHNs) and immunisation providers in 23 local council areas across greater Melbourne. We invited participation from families with older children who had previously participated in a (non-respiratory pathogen) vaccine study conducted by our group, and also distributed flyers and posters through childcare centres. More than one child per family could be enrolled. We collected household demographic features at enrolment. Gross household income was collected in four brackets: bracket 1, ≤ $21,000; bracket 2, $21,101 to $33,000; bracket 3, $33,001 to $56,000; and bracket 4, > $56,000.

Parents/guardians completed a symptom diary card for each day the child was on the study. We designated an important respiratory illness to be an influenza-like illness (ILI) using the criteria described by Belshe *et al* in the CAIV-T efficacy study conducted in the USA during 1996 and 1997.[9] An ILI was defined as having occurred if a child had at least one category A symptom or at least two category B symptoms (Table 1). All information about symptoms was from parental report only. Individual episodes began on the first day on which there were sufficient symptoms to meet the definition of an ILI, and finished on the final day there were any documented symptoms associated with the ILI. A new episode was deemed to have commenced if there were three or more symptom-free days since the last day with any symptoms of the previous episode. Number and duration of ILIs was ascertained;

Table 1. Defining symptoms of an influenza-like illness

Category A symptoms	Category B symptoms
• fever (either identified without measurement or a measured temperature of 37.6°C or higher by axillary thermometer) • wheezing • shortness of breath • pulmonary congestion (moist cough) • pneumonia (diagnosed by a healthcare provider) • ear infection (suspected by parent/guardian or diagnosed by healthcare provider)	• runny nose/nasal congestion • sore throat • cough • muscle aches • chills • headache • irritability • decreased activity (lethargy/weakness) • vomiting

incidence rates were calculated using child-months (person-time) as the denominator, and 95 per cent confidence intervals (CI) were produced using the standard method for incidence rate data.[10]

We used incident-based costing to derive an average cost of community-managed episodes (not including illnesses in which there was a hospitalisation). Once a child developed an ILI we asked parents to complete a burden diary on healthcare use, travel costs seeking healthcare (including car used and kilometres travelled), medication usage, investigations performed, time spent seeking healthcare during the episode, and excess time spent caring for a sick child—that is, time over and above that normally required for the care of the child when well.

Cost data were calculated from a societal perspective using 2001–2002 financial year Australian dollar values (Table 2). Discounting is not relevant as costs were collected in a single year. Direct and indirect costs were included, and we allocated costs as being borne either by the patient and family, the healthcare sector, or by another sector.[11] Details of sources for all costs are provided (Tables 2 and 3). An average cost per episode was calculated using the total number of illnesses, not just those where burden information was available, as the denominator.

Carer time spent seeking healthcare and excess time spent caring for an ill child were collected in three categories: time away from work with pay lost; time away from work with no pay lost; and time away from usual activities. We applied a sex-weighted hourly rate derived from the Australian Bureau of Statistics average weekly earnings (females: $19.69 per hour; males: $22.44 per hour) for reported times.[12] For time away from work with pay lost and time away from usual activities we allocated the cost to the patient and family sector; and for time away from work with no pay lost, we allocated the cost to the employer (other sector), who was paying for working hours not performed.

We identified the key cost drivers for illness, and calculated an average resource unit used per episode and 95 per cent confidence intervals (95% CI) using standard methods.[13] Where information was not available for an illness, we applied a zero value for missing data when calculating means and CIs. One-way sensitivity analyses were undertaken by using the 95 per cent confidence limits for these key cost drivers, and we calculated an average cost for all episodes, by including those illnesses where there was a hospitalisation. We also used the confidence limits to perform multi-way sensitivity analyses, with a least expensive and most expensive scenario for community-managed episodes.

Calculations were performed using Microsoft Excel.

Results

One hundred and twenty-one children from 80 households were enrolled; complete individual and household demographic data about 118 children (98%)—52 females and 66 males—from 78 households (97.5%) were available and these are included in this analysis. These 118 children provided 14,430 child-days (477.3 child-months) of follow-up between 1 July and 1 December 2001. Most study households came from the highest annual income bracket: 73 per cent from bracket 4 (income > $56,000); 15 per cent from bracket 3; 6 per cent from bracket 2; and 5 per cent from bracket 1. There were 15 households with a couple and one child, 41 with a couple and two children, 17 with a couple and three children, three with a couple and four children, one household with a single parent and two children, and one household with a single parent and three children. Eight children (7%) were one year of age at enrolment, 62 (53%) were two years of age, 19 (16%) were three years of age, 18 (15%) were four years of age, and 11 (9%) were five years of age.

Table 2. Summary of resources consumed during 202 influenza-like illnesses in 118 Melbourne children during winter and spring 2001

Resource	Units consumed	Patient and family sector	Healthcare sector	Other sectors	% ILI cost
General practice visits*	89	$255.43	$2,174.94	–	5.0%
Other healthcare provider visits†	10	$156.42	$115.00	–	0.2%
Hospital emergency department visit (no admission)‡	4	–	$160.00	–	0.3%
Diagnostic tests§	1	$5.00	$28.31	–	0.1%
Antibiotics‖	42	$579.47	–	–	1.2%
Other prescription medication‖	24	$336.92	–	–	0.7%
Over-the-counter and other medication¶	244	$2,617.40	–	–	5.4%
Paid childcare for other children**	11 episodes	$133.00	–	–	0.3%
Travel costs seeking healthcare††					
Car	460.6 kms	$209.96	–	–	0.4%
Parking	3 episodes	$13.00	–	–	0.0%
Time seeking healthcare‡‡					
Time away from work, pay lost	34.5 hours	$679.31	–	–	1.4%
Time away from work, no pay lost	22.25 hours	–	–	$438.10	0.9%
Time away from usual activities	67.04 hours	$1,329.18	–	–	2.7%
Excess time caring for ill child‡‡					
Time away from work, pay lost	81.50 hours	$1,604.74	–	–	3.3%
Time away from work, no pay lost	178.60 hours	–	–	$3,609.03	7.4%
Time away from usual activities	1682.54 hours	$34,212.06	–	–	70.3%
Sector total§§		$42,131.87	$2,478.24	$4,047.14	100%
Sector cost per ILI		$208.57	$12.27	$20.04	
Sector per cent		86.6%	5.1%	8.3%	
Total		$48,657.25	**Total cost per ILI**	$240.88	

* Based on 2001 Medicare Benefits Schedule rates for healthcare sector costs[28] (85% of code 23—$28.75) and mean patient cost per GP/vocationally registered GP visit for 2001 ($2.87) for patient and family cost.[2]

† Based on parent-reported costs for visits to naturopaths (2 visits) and chiropractors (6 visits), and 2001 Medicare Benefits Schedule[28] fee rates for 2 specialist visits (85% of MBS code 104—$57.50) and mean patient cost per specialist visit for 2001 ($15.71) for patient and family cost.[29]

‡ Hospital emergency department (ED) visits based on the cost for emergency department presentation for the Australian Ambulatory Classes group 23: Other respiratory diseases without procedure ($40).[14]

§ Actual cost paid by parent charged not uniformly available. Government cost based on 85% of 2001 Medicare Benefits Schedule[28] fees for one chest x-ray (MBS code 58500—$33.30). The cost allocated to patient and family was the difference between the Medicare rebate and the schedule fee (15% of the Medicare Benefits Schedule Fee).[28]

‖ Given the high proportion of households in the study from the highest income bracket, we have costed all prescription medication for general PBS beneficiaries (no concessional beneficiaries); we have also assumed they were purchased without a Safety Net Entitlement Card. Prescription medication costs were the maximum recordable value for the Safety Net from the Schedule of Pharmaceutical Benefits for Approved Pharmacists and Medical Practitioners.[30] None of these individual costs exceed the maximum cost for a pharmaceutical benefit item ($21.90), so all costs were allocated to the patient and family sector.

¶ Over-the-counter medication from pharmacies is the MIMS Australia cited cost,[31] and other medication (for example, natural therapies) based on parent-report.

** Parent-reported childcare costs for other children whilst seeking care for ill child.

†† Car running costs per kilometre (business cost) from the Royal Automobile Club of Victoria (RACV) based on type, age, and engine size of car used.[32] Parking costs as reported by parents in seeking healthcare.

‡‡ All time based on parent-reported hours. Cost applied from sex-weighted Australian Bureau of Statistics (ABS) average weekly earnings, November 2001:[12] male ($852.70 per 38 hour week) and female ($748.20 per 38 hour week). Cost allocated to the employer (other sector) for time away from work, no pay lost, and to patient and family sector for time away from work, pay lost and time away from usual activities.

§§ Columns do not add exactly to total due to rounding.

There were 202 ILI community-managed episodes identified, giving an incidence rate of 0.42 ILIs per child-month (95% CI 0.36 to 0.48). There were three episodes that resulted in hospitalisation,[8] and these were not included in general calculations. During the period, 21 children had no episodes of ILI, 35 children had one episode, 30 children had two episodes, 24 children had three episodes, five children had four episodes, and three children had five episodes. We received costing information for 180 (89%) of these illnesses (Table 2). The illnesses where we did not receive burden data were shorter (median duration: 2.5 days versus 5 days) and less likely to have parent-reported fever or ear infection[8] (proportion with uncomplicated illness: 77% versus 48%), compared to those illnesses where burden data were available. Parents may have been less likely to report burden information for illnesses they felt were trivial, or resulted in no excess resource consumption.

Using the costs from these 180 for all 202 illnesses gave an average cost per ILI episode of $241 (95% CI $191 to $291). The average cost using only those illnesses we had information on was $270. The key cost driver for ILI in children was carer time spent caring for the ill child away from usual activities, making up 70 per cent of total costs. Females spent an average of 6.38 hours per episode (95% CI 4.61 to 8.15) caring for the ill child away from their usual activities, and males an average of 1.95 hours per episode (95% CI 1.05 to 2.84). The next most important non-carer time related drivers were use of non-prescription medication (5.4% of total costs, 244 episodes of use, 95% CI 215 to 273), and general practitioner visits (5.0% of total costs, 89 visits, 95% CI 68 to 110 visits).

The average cost per episode was lowest for those illnesses occurring in households from the highest income bracket: bracket 4, $208; bracket 2, $290; bracket 1, $377; and bracket 3, $449. These rankings remained the same when illnesses where there was no information available were removed from average calculations (bracket 4, $235; bracket 2, $327; bracket 1, $431; and bracket 3, $474).

Funding the resource use during illness was predominantly the responsibility of the patient and family, with this sector being responsible for meeting 87 per cent of total costs. The healthcare sector met five per cent of costs, and other sectors met eight per cent of costs.

As key costs drivers, carer time away from usual activities, non-prescription medication, and general practice visits were individually varied in one-way sensitivity analyses, according to the upper and lower 95 per cent confidence limits. The average cost per episode varied little for the sensitivity analyses involving non-prescription medication and general practice visits (Table 3), but ranged from $186 to $296 when carer time away from usual activities was varied. The one-way sensitivity analysis which included the three illnesses with hospitalisations increased average cost per episode to $287 (Table 3). Two scenarios were tested producing a least expensive average cost per episode of $177, and a most expensive average cost per episode of $304 (Table 3). Unsurprisingly, these values varied little from those generated in the one-way analyses of carer time away from usual activities.

Discussion

As demonstrated by our findings, acute respiratory illness in healthy, urban children during winter and spring is common, with the costs borne largely by the patient and family. These findings have implications for preventive strategies in Australian children, particularly vaccine use. The impact carer time away from usual activities has on the average cost per episode can be seen in a number of ways: the proportion of total costs made up by this single variable (70%); and in the multi-way sensitivity analyses producing least and most expensive cost per episode scenarios varying little from the one-way sensitivity analysis of this variable alone. Not including carer time away from usual activities, as recommended for submissions to have drugs listed on the Pharmaceutical Benefits Scheme,[14] would substantially under-estimate the true impact of community-managed disease of this nature. In this regard, these illnesses may be similar to chickenpox, being common and usually community-managed, with the direct costs of a proposed infant vaccination program in Australia outweighing the direct costs associated with not implementing such a program.[15]

A significant proportion of the illnesses identified in this study are likely to have been caused by respiratory viral infections, including respiratory syncytial virus, influenza virus, parainfluenza viruses, human metapneumovirus, coronaviruses, adenoviruses, and rhinoviruses. The Victorian Infectious Diseases Reference Laboratory identifies 2001 as a year of normal seasonal activity for influenza from the collaborative sentinel influenza surveillance scheme.[16] Injectable influenza vaccine is licensed in Australia for children down to six months of age. The recent licensing in the USA of the intranasal CAIV-T vaccine provides the possibility of better access, acceptability, and delivery of public influenza vaccination programs, especially if the license for use extends to a lower age-group. The current price of the vaccine, though set to fall to USA$23.50 for the 2004/2005 influenza season in the United States of America,[17] will remain an impediment to its wider use. Vaccines against other respiratory viruses are

Table 3. One-way and multi-way sensitivity analyses for average cost of episodes

Sensitivity analyses	Modification	Values used		Average cost per episode
One-way analyses				
General practice visits	Number of general practice visits and dependent variables*	Lower value: Upper value:	68 visits 110 visits	$233.55 $247.94
Over-the-counter and other medication	Number of episodes of over-the-counter and other medication use	Lower value: Upper value:	215 episodes 273 episodes	$239.34 $242.42
Carer time away from usual activities	Time spent caring from ill child away from usual activities	Lower value: Upper value:	5.67 hours (4.61 female, 1.05 male) 10.99 hours (8.15 female, 2.84 male)	$186.03 $295.73
Hospitalisation	Addition of three ILIs with a hospitalisation	All costs for these ILIs added to total costs†		$287.03
Multi-way analyses				
Least expensive scenario	General practice visits* Over-the-counter and other medication Carer time from usual activities	68 visits 215 episodes of use Female carers: Male carers:	 4.61 hours per episode 1.05 hours per episode	$177.17
Most expensive scenario	General practice visits* Over-the-counter and other medication Carer time from usual activities	110 visits 273 episodes of use Female carers: Male carers:	 8.15 hours per episode 2.84 hours per episode	$304.33

* Changes in the number of general practice visits included proportionate changes in the cost of other variables that rely on a general practice visit: diagnostic tests, antibiotics and other prescription medication, travel seeking healthcare, parking, and time seeking healthcare.

† Costing for non-hospital related costs in three additional ILIs as per Table 1. Extra diagnostic tests performed outside of hospital: urine microscopy, culture, and sensitivity (MBS code 69312—$33.00—with 2 performed), full blood evaluation (MBS code 65070—$16.70—with 2 performed), and serum biochemistry (MBS code 66515—$19.20—with 2 performed). Healthcare sector cost based on 85% of 2001 Medicare Benefits Schedule;[28] the cost allocated to patient and family for diagnostic tests was the difference between the Medicare rebate and the schedule fee (15% of the Medicare Benefits Schedule Fee).[28] Ambulance cost from Victorian Ambulance Service for emergency transport to hospital less than 10kms away (one transfer). Public hospital admission National Hospital Cost Data Collection code E62C ($2,395).[33] Private hospital admission costs as reported by the two private hospitals: overnight admission for respiratory infection $228 paid by patient and family to private hospital; overnight admission for febrile convulsion $400 paid by health insurance company (other sector cost), and $222 paid by patient and family to private hospital. Private health insurance fees not included.

under development, but still likely to be some way off; the possibility for preventing such illnesses at present is limited to influenza. Beginning in 2004 the Advisory Committee on Immunisation Practices (ACIP) in the USA have made injectable influenza vaccine part of the routine childhood immunisation schedule—for children from six months up to two years of age. This recommendation extends to household contacts (including older children) and out-of-home caregivers of all children less than two years of age.[7] Interest in this recommendation was driven by the USA Centers for Disease Control and Prevention initiating national surveillance for paediatric influenza-associated deaths.[18] It is also possible that use of vaccine in this age group may lead to reduced incidence of disease in other age-groups due to herd protection, similar to effects seen from vaccinating school-aged children against influenza,[19,20] and more recently, seen in vaccinating USA infants with conjugate pneumococcal vaccine.[21]

Vaccination programs against illnesses that are largely managed in the community may not appear cost-effective if the impact of lost productivity is ignored. Vaccines against influenza and other viral respiratory pathogens may be recommended for young children in the near future, but may not pass the cost-effectiveness hurdle for public funding. There are few published studies looking at the cost-effectiveness of influenza vaccine specifically in children. Given the findings of our study, it will not be surprising that a childhood influenza vaccine program could be potentially cost-saving if indirect costs are included.[22] The reduction in indirect costs is central to the economic benefits of vaccination,[23–25] with previous studies showing that these benefits are greatest when parents are prevented from missing work to care for an ill child.[24]

The majority of households (73%) in our study came from the highest income bracket. This compares with approximately 40 per cent of Victorian family households being in this income range, according to 2001 Census data.[26] This may have had a number of impacts: members of lower income households have been shown to have a higher incidence of respiratory viral infections, thought to be due to the impact of crowding;[27] but in this study we did not find a lower rate of illness in children from high income families.[8] It could be argued that parents from relatively higher income households might be more likely to expend more resources in caring for a sick child, as compared with those from a lower income household; but we found that the average cost per episode was lowest in households from the highest income bracket. In our study, high-income households were more likely to have both parents spending some time working outside the home. Parents in these households might have different thresholds for seeking medical attention or using medication for illnesses that are perceived to be mild or of minor significance. If anything, due to the lower average cost per episode in higher income households, the over-representation of such households in our study may have made our cost estimate conservative.

Costing studies such as this, together with studies that measure the relative role of specific pathogens, will not only inform local cost-effectiveness studies, but failing public funding of programs, will provide important information for vaccine providers and parents about the likely benefits of paying for available vaccines themselves.

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References

1. National Health and Medical Research Council. Immunisation Procedures. 3rd edition. Canberra: Australian Government Publishing Service, 1986.
2. Taylor A, Wilson D, Dal Grande E, Gill T. National Influenza Survey - a population survey of vaccination uptake in Australia, October 2000. Adelaide: South Australian Department of Human Services, 2001.
3. National Health and Medical Research Council. *The Australian Immunisation Procedures Handbook*. 5th edition. Canberra: Australian Government Publishing Service, 1994.
4. The Hon Tony Abbott MHR. Media Release: Commonwealth Government toprovide pneumococcal vaccine for both young and old. Commonwealth Department of Health and Ageing, 2004. Available from: http://www.health.gov.au/mediarel/yr2004/ta/abb078.htm Accessed 22 October 2004.
5. Burgess MA, McIntyre PB. Vaccines: the new Australian best-practice schedule. *Med J Aust* 2004;180:494–496.
6. National Health and Medical Research Council. *The Australian Immunisation Handbook*. 8th edition. Canberra: Australian Government Publishing Service, 2003.
7. Centers for Disease Control and Prevention. Prevention and control of influenza - recommendations of the Advisory Committee on Immunisation Practices (ACIP). *MMWR Morb Mortal Wkly Rep* 2004;53 (no. RR–6):1–40.
8. Lambert SB, O'Grady KF, Gabriel SH, Nolan TM. Respiratory illness during winter: a cohort study of urban children from temperate Australia. *J Paediatr Child Health* 2004 (in press).
9. Belshe RB, Mendelman PM, Treanor J, *et al*. The efficacy of live attenuated, cold-adapted, trivalent, intranasal influenzavirus vaccine in children. *N Engl J Med* 1998;338:1405–1412.
10. Rothman KJ. Epidemiology: an introduction. New York: Oxford University Press, Inc, 2002.
11. Drummond MF. Methods for the economic evaluation of health care programmes. 2nd edition. Oxford: Oxford University Press, 1997.
12. Australian Bureau of Statistics. Average weekly earnings Australia: November 2001. Volume 6302.0. Canberra: Australian Bureau of Statistics, 2002.

13. Kirkwood BR, Sterne JAC. Essential medical statistics. Second edition. Oxford: Blackwell Science, 2003.

14. Commonwealth Department of Health and Ageing. Manual of Resource Items and their associated costs for use in major submissions to the Pharmaceutical Benefits Advisory Committee involving economic analyses. Canberra: Australian Government, 2002.

15. Scuffham PA, Lowin AV, Burgess MA. The cost-effectiveness of varicella vaccine programs for Australia. *Vaccine* 1999;18:407–415.

16. Victorian Infectious Diseases Reference Laboratory. Sentinel Influenza Surveillance. Victorian Infectious Diseases Reference Laboratory, 2004. Available from: http://www.vidrl.org.au/surveillance/flureports/fluidx.htm Accessed 22 October 2004.

17. Medimmune Inc. MedImmune Selects Henry Schein as Exclusive Distributor of FluMist™, MedImmune Substantially Reduces the Vaccine's Price. 2004. Available from: http://investor.medimmune.com/phoenix.zhtml?c=83037&p=IROL-NRText&t=Regular&id=581615& Accessed 22 October 2004.

18. Centers for Disease Control and Prevention. Update: influenza activity — United States, 2003–04 season. *MMWR Morb Mortal Wkly Rep* 2004;53:284, 286–287.

19. Reichert TA, Sugaya N, Fedson DS, Glezen WP, Simonsen L, Tashiro M. The Japanese experience with vaccinating schoolchildren against influenza. *N Engl J Med* 2001;344:889–896.

20. Monto AS, Davenport FM, Napier JA, Francis T, Jr. Modification of an outbreak of influenza in Tecumseh, Michigan by vaccination of schoolchildren. *J Infect Dis* 1970;122:16–25.

21. Whitney CG, Farley MM, Hadler J, *et al*. Decline in invasive pneumococcal disease after the introduction of protein-polysaccharide conjugate vaccine. *N Engl J Med* 2003;348:1737–1746.

22. Nichol KL. The efficacy, effectiveness and cost-effectiveness of inactivated influenza virus vaccines. *Vaccine* 2003;21:1769–1775.

23. White T, Lavoie S, Nettleman MD. Potential cost savings attributable to influenza vaccination of school-aged children. *Pediatrics* 1999;103:e73.

24. Cohen GM, Nettleman MD. Economic impact of influenza vaccination in preschool children. *Pediatrics* 2000;106:973–976.

25. Luce BR, Zangwill KM, Palmer CS, *et al*. Cost-effectiveness analysis of an intranasal influenza vaccine for the prevention of influenza in healthy children. *Pediatrics* 2001;108:E24.

26. Australian Bureau of Statistics. Household and Family Estimates, Australia, Electronic Delivery, June 2001. Catalogue 3236.0.55.001, 2004. Available from: http://www.abs.gov.au/Ausstats/abs@.nsf/Lookup/490EBCFADEE3238DCA256EA8007DF182 Accessed 22 October 2004.

27. Monto AS. Epidemiology of viral respiratory infections. *Am J Med* 2002;112 Suppl 6A:4S–12S.

28. Commonwealth Department of Health and Ageing. Medicare Benefits Schedule, November 2001. Commonwealth Department of Health and Ageing, 2004. Available from: http://www7.health.gov.au/pubs/mbs/archive.htm Accessed 22 October 2004.

29. Commonwealth Department of Health and Ageing. Medicare statistics: average patient contribution per service (patient and bulk billed services out-of-hospital only;table B6) Australian Government, 2001. Available from: http://www.health.gov.au/haf/medstats/table6.pdf Accessed 02 September 2004.

30. Commonwealth Department of Health and Ageing. Schedule of Pharmaceutical Benefits for Approved Pharmacists and Medical Practitioners. Canberra: Australian Government, 2001.

31. MIMS Australia. MIMS annual. 25th edition. Sydney: MediMedia Australia Pty Ltd., 2001.

32. Royal Automobile Club of Victoria. Vehicle operating costs. Melbourne: RACV, 2002.

33. Commonwealth Department of Health and Ageing. National Hospital Cost Data Collection. Hospital Reference Manual, Round 6, for the 2001–202 financial year. Canberra: Australian Government, 2002.