Costs of Childhood Hospitalisation for Asthma

Alexandra C Carswell[1]**, Niamh F Hammond[1]**, Wan N Ab-Halim[1], Olivia P Badcock[1], Georgia TA Brownlee[1], Sarah MJ Bush[1], Samuel CD Clark[1], Shaun G Collings[1], Sarah AL Cox[1], Jhanvi A Dholakia[1], Amelia A Eddowes[1], Timothy J Foster[1]*, Auzita Irani[1], Tom A Judd[1], Georgina LE Kioa[1], Nick Preval[1], Anna Hamer-Adams[1], Nevil Pierse[1]

Abstract

Asthma hospitalisations in children have major economic, as well as health, effects in this country, costing New Zealand $7.6 million in healthcare costs in 2013. However, little research has been done to estimate non-healthcare costs of these hospitalisations including parents' expenses, time off work and intangible costs, such as stress and anxiety. Therefore, we set out to estimate these costs through expenditure and willingness-to-pay surveys of parents of hospitalised children.

We estimated the median non-healthcare cost of these hospitalisations to be $380.74 per night, effectively adding 30% to current estimates of costs. This could have a considerable impact when assessing the cost-benefit ratios of strategies to prevent hospitalisations of children for asthma.

Keywords

Asthma — Cost — Willingness to pay — Paediatrics

[1] *Department of Public Health, University of Otago, Wellington, New Zealand*

***Corresponding author**: fosti213@student.otago.ac.nz, ****Equal contributor**

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1. Introduction

Respiratory disease among children accounts for a major burden of disease in New Zealand, with 128,597 hospitalisations recorded between 2009-2013 for respiratory diseases among under-15s; indeed, this group has the highest frequency of hospitalisation for respiratory disease of any age group in this country [1]. Respiratory hospitalisations in all age groups make up 1 in 8 New Zealand hospital admissions and display strong disparities by ethnicity and deprivation, with Māori, Pacific and deprived adults and children disproportionately affected by all measures of respiratory disease burden [1].

Some effort has previously been made to estimate the costs of such hospitalisations in this country; Holt & Beasley (2002), for example, calculated the cost of (childhood and adult) asthma in New Zealand and estimated that Asthma hospitalisations

cost $11.6 million with a wider total cost to the economy of $699 million annually during the late 1990s [2]. An alternative analysis by Wilson (2001) estimated the cost of Asthma to the New Zealand Economy to be $349 million in 2000 [3]. More recently, Telfar-Barnard et al. (2015) estimated the total cost of asthma to be $799 million and cost of all respiratory disease to be $5.7 billion for the 2011 calendar year [1]. However, these New Zealand analyses (as well as many overseas studies) only considered direct healthcare costs of hospitalisation, prescriptions and GP visits as well as time off school, patient time off work and years of life lost [1, 2, 3, 4]. As such, other costs of hospitalisation of a child are ignored, including priced costs to parents such as transport, parent time off work, food and childcare as well as intangibles, such as stress, anxiety and lack of sleep (for the child and parents).

These indirect and intangible costs are important; firstly, they allow for a more accurate assessment of the costs of asthma allowing for more informed cost benefit analyses when assessing programmes designed to improve respiratory health, such as indoor mould removal [5]. Additionally, these are likely to be the major costs incurred by patients and parents, as opposed to direct medical costs (mostly paid for by the government) and time off work (often a cost to employers through sick-leave). Given that hospitalisations of under-15s disproportionately affect Māori, Pacific and deprived New Zealanders, these groups are likely to shoulder a disproportionate amount of these costs, contributing to existing disparities in the burden of respiratory disease in this country [1]. As such, interventions that can prevent or reduce the impact of respiratory disease are attractive from a public health and equity point-of-view; however, failing to measure all the costs associated with respiratory disease may lead to the benefits of such programmes being under-estimated [6].

Efforts have been made overseas to attempt to more accurately estimate the costs of respiratory diseases. Priced costs, such as time off work, travel and food, can be estimated by patient surveys of expenditure [7]. However, intangible costs such as quality-of-life, stress, sleep loss and anxiety are harder to measure. One option is to estimate these costs with a willingness-to-pay (WTP) approach; that is, the cost that a patient or parent might be willing to pay to ameliorate the situation. This method has been shown to be theoretically consistent with the true change in utility a person experiences as a result of a health-care event [8], and has previously been used in the health literature to estimate the true value of health services that are not directly priced in a market [7, 9, 10, 11, 12]. This method has been used to evaluate the costs to asthma patients in Korea [7] and the US [9], where it was found that costs determined by WTP were associated with objective and subjective disease severity, with a mean monthly cost of US$331 for severe asthma. Our study aimed to use this technique, in addition to expenditure surveys, to more accurately determine the cost of a paediatric hospitalisation for a respiratory condition.

2. Methods

2.1 Participant Recruitment

Ethics was granted under category B from the Department of Public Health (University of Otago, Wellington) to survey parents among the general public. Participants were approached in public spaces (outside schools, supermarkets, etc. . .) in Wellington, Hutt Valley and Porirua, and verbal consent was attained for survey participation. All participants had to be parents, who had had a child (under 15 at the time of hospitalisation) hospitalised. This allowed us to recruit 173 parents.

2.2 Survey Design and Pricing

Participants were surveyed about the most recent hospitalisation of any one of their children. They were asked to recall direct costs to them of this hospitalisation event; this included time off work, transport, parking, childcare, accommodation, food and miscellaneous costs. Demographic data including age, sex, ethnicity and income (own and partner if applicable) were also collected from participants as well as the age of their child at the time of hospitalisation, reason for hospitalisation, time off school and length of stay.

Income data were collected using a tick box, with options: '$0-20,000', '$20,000-40,000', '$40,000-60,000', . . . , '$100,000+', and were recored as numbered categories (1-6). The income value for cost of 1 day lost work was assumed to be $(20,000n - 10,000)/250$, where n is income category number (we assumed 250 working days in a year, equivalent to a five day working week for 52 weeks minus the 10 New Zealand public holidays) [13]. The cost of a day off school was conservatively assumed to be the average cost (for 2014) to the Ministry of Education of a day's schooling for a child, which was $37.14 (assuming 380 half days, the Ministry's minimum) [14, 15]. To get schooling costs per day of hospitalisation, we multiplied the days off school by $37.14 and divided by the length of hospitalisation. For ethnicity, our analysis was only powered to explore comparisons between Māori and non-Māori; for these analyses, participants were deemed to be 'Ever Māori' if they self-identified as Māori regardless of other self-identified ethnicities. This was done in order to give maximum consistency with the 'Ever Māori' method of ethnicity assignment used in Māori epidemiology [16].

In addition to asking for recall of direct costs, participants were asked how much they might pay to avoid intangible costs (such as stress and anxiety) associated with a 24 hour hospitalisation of their child for asthma. We opted for an open ended WTP question format as we didn't wish to bias responses by indicating a range of possible responses. However, there have been reported difficulties with open-ended format; in particular, that participants may find such a question difficult to comprehend

and answer [11, 12]. Nevertheless, we opted to persist with an open ended format, and invited participants to leave this question blank if they felt that they were unwilling to answer.

2.3 Data Analysis

The primary outcome of interest was an estimate of the median total cost to parents for a hospitalisation event. The median costs were estimated based on a sum of the market-priced costs incurred by parents, and separately based on WTP. Confidence limits (95%) of the median were approximated by the bootstrap percentile method (10,000 replications), to minimise distributional assumptions about cost data [17].

Unadjusted relationships between continuous variables were also determined non-parametrically, by calculating Kendall's Tau-B rank correlation coefficient (τ_B), as rank ties were present in the data. Hypothesis testing on Kendall's τ_B was done by computing an approximate Wald statistic, with the null hypothesis of no correlation. Differences between two groups (e.g. Māori vs non Māori) were tested by the Mann-Whitney U test, with the null hypothesis of no difference. For hypothesis testing involving income, participant and partner (if applicable) incomes were added to give a household income.

Where there was evidence to reject a null hypothesis, sensitivity analyses were subsequently carried out to test for the effect of potentially confounding variables on the relationship. This took the form of a linear model of the log expected value with 95% confidence intervals of the regression coefficients estimated by the bootstrap. All data analyses were carried out in R [18].

3. Results

As is shown in Table 1, we recruited 173 participants, of whom 79% were female and 23% were Māori. The median child age at the time of hospitalisation was 4 years and the median length of stay was 2 days. Of our 173 participants, 13 did not answer the WTP question for intangible costs, 19 did not answer the income questions to value time off work and 1 did not answer the direct expenses questions.

Table 1. Basic demographic and hospital stay data.

Variable	Value
Number	173
Median Combined Income	$80,000
Ever Māori	40 (23%)
Female	137 (79%)
Median Child Age (years)	4
Median Length of Hospitalisation (days)	2
Median Number of Children	2

Table 2 shows the daily estimated median costs (and 95% confidence intervals for the median) for days of lost work, priced expenses, intangible costs (estimated by WTP method) and days off school. Total costs were estimated by adding the value of these for components for each study participant. There was no significant correlation in the data between intangible costs and daily expenses, suggesting that we successfully separated these costs when asking our WTP questions (see Table 3).

Table 2. Estimates for median costs (in NZ$ per day) of hospitalisation events with lower and upper boundaries of the 95% confidence interval, estimated by the bootstrap.

Variables	Median	Lower 95% CI limit	Upper 95% CI limit
Intangible (WTP)	$100.00	$100.0	$200.00
Lost Work	$105.00	$40.00	$155.00
Expenses	$28.45	$22.50	$34.17
Schooling	$0.00	$0.00	$31.80
Total	$380.47	$289.28	$505.70

Table 3 shows the results of raw (unadjusted) tests of correlation/differences for our estimated costs, excluding costs of lost work, and some of the study variables of interest. Costs of lost work were omitted, as we were primarily interested in costs incurred by parents and cost of lost work is commonly incurred by an employer as sick leave. These analyses are purely exploratory, as we were not testing any *a priori* main hypotheses of our project. Therefore, we include them to hypothesise on possible factors associated with hospitalisation costs, on the understanding that such associations will need to be demonstrated by future research.

Table 3. The raw (unadjusted) testing for relationships of interest between pairs of variables (explanatory variable listed first). For differences between two groups (e.g Ever Māori vs Never Māori or Female vs Male) the p value is produced by the Mann-Whitney U test, for other variables, testing is of Kendall's τ_B.

Relationship	Difference of Medians	τ_B	p
Ever Māori/Intangible Costs (WTP)	-$15.00		0.03
Ever Māori/Priced Expenses	$13.79		0.20
Ever Māori/Combined Income	-$20,000.00		0.15
Female/Intangible Costs (WTP)	-$100.00		0.41
Female/Priced Expenses	$11.07		0.17
Combined Income/Intangible Costs (WTP)		0.11	0.07
Combined Income/Priced Expenses		-0.03	0.52
Child Age/Intangible Costs (WTP)		-0.01	0.88
Child Age/Priced Expenses		0.07	0.20
Expenses/Intangible Costs (WTP)		0.06	0.32

As can be seen, only one of these relationships yields a p value less than 0.05, the difference in intangible costs between Ever Māori and Never Māori. A sensitivity analysis was carried out to investigate the confounding effect of income, and the 95% confidence interval of the effect estimate was compatible with no effect.

4. Discussion

4.1 Conclusions

Overall, the estimated non-healthcare costs of childhood hospitalisation are less than one third of the healthcare costs of childhood hospitalisation, estimated at $2,026.04 per hospitalisation or $1,397.24 per day of hospitalisation (with an average length of stay of 1.45 days) [1]. This is in contrast to what we expected from the results of the study of Kim et al (2011) who found that intangible costs of asthma in Korea were greater than direct healthcare costs [7]. However, despite being much lower than expected, these results still indicate that parents incur significant costs associated with the hospitalisation of one of their children. Furthermore, these costs are likely to be highly conservative, as they do not take into account many of the costs incurred by children themselves as a result of hospitalisation (which may have been too emotional for parents to value accurately). Therefore, it is likely that a hospital-based study that could assess effects on parents and children of current hospitalisations would yield higher estimates of costs.

On a national level, given 3,730 asthma hospitalisations of under-15s in 2013 (at 1.45 days average stay), we estimate that asthma cost the New Zealand economy $2.1 million in non-healthcare costs in 2013 (our estimate of $380.47 per day for $[3,730 \times 1.45]$ days of hospitalisation), in addition to $7.6 million in healthcare costs [1]. Therefore, from a purely economic perspective, measures to prevent hospitalisation of children in this country seem imperative, quite apart from the obvious societal benefits of fewer paediatric hospitalisations.

These results emphasise the potential savings of preventing paediatric hospitalisations. As an example, Howden-Chapman and colleagues (2007) showed that retrofitting homes with insulation may reduce hospitalisations (OR = 0.53: 0.22-1.29 95% CI), at a cost of $1,800 per participant [6, 19]. This intervention was shown to be cost-effective overall; however, their estimated benefit to cost ratio of 1.87:1 would be closer to 2.25:1, as we calculate that their cost estimation for an inpatient hospitalisation would increase by 32% by applying our estimate of $380.47 in indirect costs per night [19].

4.2 Limitations

This study was retrospective, asking participants to recall a past hospitalisation event (not necessarily one of asthma), often years prior. Therefore, there is the distinct possibility of recall error and bias (e.g. those who incurred higher costs might have had more accurate recall of costs). Furthermore, our survey's income question was capped at '$100,000+', which was analysed as being equal to $110,000. This is likely to be a highly conservative estimate of mean income in this group, and probably lead to an underestimation of the value of lost work.

Due to time and resource constraints, the survey was only carried out within the Wellington region and results may not be generalisable to other regions of the country, particularly rural areas. Additionally, as with most surveys conducted in public places, there was a very low response rate to our survey ($\sim$ 10%), compared to all eligible participants (all parents in the surveyed locations); therefore, there is the potential for selection bias to affect our results, where the costs for parents that answered our survey differ systematically from those that didn't; furthermore, our general-public respondents may have differed from parents of children currently hospitalised.

Despite these limitations, however, this is the first New Zealand study to directly measure parents' costs incurred during a hospitalisation of a child. Therefore, costings presented here are the first to be estimated empirically, rather than estimated through assumptions.

4.3 Future Directions

Given the limitations above, we recommend future research to give more information on the cost of these hospitalisation events. In particular, we recommend that studies be conducted in a hospital environment, which we believe will reduce recall and selection errors and allow more information to be gathered. Quality-of-life surveys would be possible in this setting, allowing children's quality of life (or reduction in quality of life from disease) to be included in the analysis (a factor that was only peripherally measured by our WTP analysis) [20]. Additionally, we recommend that future studies sample other regions in New Zealand, including rural areas.

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References

[1] Telfar Barnard L, Baker M, Pierse N, Zhang J. The impact of respiratory disease in New Zealand: 2014 update. Wellington: The Asthma Foundation. 2015;.

[2] Holt S, Beasley R. The burden of asthma in New Zealand. Asthma and Respiratory Foundation of New Zealand; 2002.

[3] Wilson N. The cost burden of asthma in New Zealand. New Zealand Medical Journal. 2001;112(1128):146–147.

[4] Hasegawa K, Tsugawa Y, Brown DF, Camargo CA. Childhood asthma hospitalizations in the United States, 2000-2009. The Journal of pediatrics. 2013;163(4):1127–1133.

[5] Burr ML, Matthews IP, Arthur RA, Watson HL, Gregory CJ, Dunstan FDJ, et al. Effects on patients with asthma of eradicating visible indoor mould: a randomised controlled trial. Thorax. 2007;62(9):767–772.

[6] Howden-Chapman P, Matheson A, Crane J, Viggers H, Cunningham M, Blakely T, et al. Effect of insulating existing houses on health inequality: cluster randomised study in the community. BMJ. 2007;334(7591):460.

[7] Kim Cy, Park HW, Ko SK, Chang SI, Moon HB, Kim YY, et al. The financial burden of asthma: a nationwide comprehensive survey conducted in the republic of Korea. Allergy, asthma & immunology research. 2011;3(1):34–38.

[8] Mishan EJ. Evaluation of life and limb: a theoretical approach. The Journal of Political Economy. 1971;p. 687–705.

[9] Zillich AJ, Blumenschein K, Johannesson M, Freeman P. Assessment of the relationship between measures of disease severity, quality of life, and willingness to pay in asthma. Pharmacoeconomics. 2002;20(4):257–265.

[10] Johannesson M, Jönsson B, Borgquist L. Willingness to pay for antihypertensive therapy—results of a Swedish pilot study. Journal of Health Economics. 1991;10(4):461–473.

[11] Van den Berg B, Bleichrodt H, Eeckhoudt L. The economic value of informal care: a study of informal caregivers' and patients' willingness to pay and willingness to accept for informal care. Health economics. 2005;14(4):363–376.

[12] Frew EJ, Wolstenholme JL, Whynes DK. Comparing willingness-to-pay: bidding game format versus open-ended and payment scale formats. Health Policy. 2004;68(3):289–298.

[13] New Zealand Government. Public holidays and anniversary dates; 2015 [cited 5 August 2015]. Available from: https://www.govt.nz/browse/work/public-holidays-and-work/public-holidays-and-anniversary-dates/.

[14] New Zealand Government. Per student funding; 2015. Available from: https://www.educationcounts.govt.nz/statistics/schooling/resourcing/per-student-funding [cited 2 August 2015].

[15] Ministry of Education; 2015 [cited 4 August 2015]. Available from: http://www.education.govt.nz/ministry-of-education/school-terms-and-holidays/.

[16] Simmonds S. The implications of using different methods to measure ethnicity in a cohort study. University of Otago, Wellington; 2010.

[17] Wasserman L. All of statistics: a concise course in statistical inference. Springer Science & Business Media; 2013.

[18] R Core Team. R: A Language and Environment for Statistical Computing. Vienna, Austria; 2015. Available from: http://www.R-project.org/.

[19] Chapman R, Howden-Chapman P, Viggers H, O'dea D, Kennedy M. Retrofitting houses with insulation: a cost–benefit analysis of a randomised community trial. Journal of epidemiology and community health. 2009;63(4):271–277.

[20] Osman I, Godden D, Friend J, Legge J, Douglas J. Quality of life and hospital re-admission in patients with chronic obstructive pulmonary disease. Thorax. 1997;52(1):67–71.