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A national estimate of the hospitalisation costs for the influenza (H1N1) pandemic in 2009

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Abstract

Aim To estimate the hospitalisation costs borne by the New Zealand Government for the influenza pandemic in 2009 (with uncertainty).

Methods Data were derived from national and local New Zealand studies, and from a combined Australia and New Zealand study on intensive care unit (ICU) use and costs. Probabilistic sensitivity analysis was performed (2000 iterations).

Results We estimated the total mean cost to the hospital sector in New Zealand of NZ$30.5 million (95% uncertainty interval (UI): 22.3 to 39.5 million) [US$14.8 to 26.3 million]. The mean cost per capita was NZ$7.01. In an additional cost-effectiveness analysis (using a hypothetical counterfactual relating to no hospital care), the results were suggestive that hospital care was likely to be a relatively cost-effective means of preventing death from pandemic influenza.

Conclusions These high hospitalisation costs for a relatively non-severe pandemic indicate the potential value of preventive measures (e.g., vaccination) and of investing in pandemic planning and other control measures to reduce person-to-person spread.

The 2009 influenza pandemic in New Zealand had a significant nation-wide impact[1 2] including on the hospital sector.[3] One Australasian study,[4] considered the impact of the 2009 pandemic on intensive care unit (ICU) admissions and a related study costed these admissions at over A$65 million, for both Australia and New Zealand collectively.[5] This costing study did not, however, separate out the cost estimates for New Zealand and did not calculate costs for hospitalised cases not admitted to ICUs.

We therefore aimed to expand on this work to provide best estimates of such hospitalisation costs for the New Zealand setting for the 2009 pandemic.

Methods

We took a healthcare provider perspective, i.e., that of the New Zealand Government which fully funds public hospitals. New Zealand data for the year 2009 included 1508 hospitalisations for influenza, a four-fold increase on the number in the preceding year.[3] Most of these people (n=1122) were admitted to hospital with a primary diagnosis of “pandemic influenza A(H1N1) 2009”. The dominant role of the pandemic strain in 2009 in causing influenza in this year also comes from virological surveillance data,[6] and from two local hospital studies.[7,8]

Other national data used were on intensive care unit (ICU) admissions from an inception-cohort study by the ANZIC Influenza Investigators which collected data on all ICU admissions for pandemic influenza A (H1N1) cases in both Australia and New Zealand.[5] A Wellington based study was used to provide additional data on length-of-stay in hospital.[7]

We explored the use of national costing data from the Ministry of Health, but this did not allow for clear enough separation of ICU and non-ICU costs. Therefore we used the Australasian cost estimates,[5] along with the New Zealand length-of-stay data (see Table 1).

We applied gamma distributions for length-of-stay and for mean cost-per-person-per-day in ICU and non-ICU settings, and conducted probabilistic sensitivity analysis using the software "@Risk for Excel" (version 5.7 Palisade, Sydney). We applied purchasing power parity adjustments to produce cost results in NZ$ for 2009.[9]

Results

We estimated the mean total ICU cost to be NZ$9.9 million and the mean total non-ICU hospitalisation cost to be NZ$20.6 million for the 2009 pandemic (Table 1). That is, a total mean cost to the hospital sector of NZ$30.5 million (95% uncertainty interval (UI): 22.3 to 39.5 million). The mean cost per capita was NZ$7.01.

While we have focused on performing a cost-of-illness study, a simplistic and hypothetical cost-effectiveness analysis can also be considered. That is, we assumed the counterfactual of "no hospital care" (e.g., as if hospital services were completely overwhelmed during a pandemic) and that this lack of care resulted in 100% of the year 2009 ICU cases dying and 10% of non-ICU hospitalised cases dying.

Given such assumptions, this would suggest that hospital care has a relatively high cost-effectiveness in the order of NZ$155,000 per life saved from pandemic influenza [i.e., NZ$30.5 million / ((102 in ICU – 16 [who died based on the ANZIC Influenza Investigators data]) + (1122 – 11 [who died[3]]) × 10%)].

Given that the median age of hospitalised cases was 26.7 years and only 2.0% (5/49) of all pandemic-attributable deaths were among those under age 65 years,[3] the cost-effectiveness of hospital care in preventing years-of-life-lost, would probably be very favourable. However, this benefit is hard to calculate precisely in the population hospitalised with pandemic influenza given the relatively high levels of co-morbidity in this population,[3] and hence lower than average life expectancy.

Table 1. Details of input parameters and results of the probabilistic sensitivity analysis for estimating hospitalisation costs in New Zealand attributable to the 2009 influenza pandemic (n=2000 iterations using @Risk)

Key parameter (2009 influenza pandemic related)	Data inputs	Details and approaches to modelling uncertainty
Input data – ICU admissions		
Number of ICU admissions in NZ in the period 1 June 1 to 31 August 2009 (ANZIC Influenza Investigators database)	N=102*	–
Days stay in ICU in NZ (ANZIC Influenza Investigators database)	Median=5 days Mean=12.41 days (standard deviation [SD]=14.80)	To provide for population level variation we calculated the standard error (SE) of the mean (SE=1.47) and used this in our analysis. Based on the distributional pattern for both Australia and NZ data (Figure 1 in Higgins et al[5]), we applied the distribution with the best fit (gamma) for length-of-stay in ICU (alpha=71.74, beta=0.17).
Mean cost-per-person-per-day in ICU for H1N1 cases (2009 Australian dollars)[5] [A$63,298 / mean days (8.4)=A$7,535].	A$7,535 per day (NZ$7,787)	We used a gamma distribution with a SD of approximately ± 20% of the mean (i.e., alpha=25.00, beta=311.50).

Key parameter (2009 influenza pandemic related)	Data inputs	
Time in hospital (outside of the ICU)		
Days stay in hospital before or after ICU, ie, for those (n=88) for whom data were available (ANZIC Influenza Investigators database)	Median=5 days Mean=10.86 days (SD=19.23)	To provide for population level variation we calculated the SE of the mean (SE=1.90) and used this in our analysis. We applied the same type of distribution as for the ICU data (gamma) (albeit different alpha=32.57, beta=0.33).
Mean cost-per-person-per-day (based on data in an Australasian study[5] in 2009; and generated by subtracting the total mean hospital cost for these patients from the total mean cost of the ICU stay and then dividing by the mean days spent in hospital (outside of the ICU)). [(A$85,359 – A$63,298) / (15.5 days – 7 days)=A$2595]	A$2595 per day (NZ$2,682)	We used a gamma distribution with a range of approximately ± 20% of the mean (alpha=25.00, beta=107.27).
Other hospital admissions (non-ICU)		
Number of hospitalisations in NZ (2009)[3] with a primary diagnosis of "pandemic influenza A(H1N1) 2009"	N=1122	–
Mean days stay in hospital (based on published data from a Wellington, NZ study[7] (where mean duration of admission was 6.1 days, for range 0–24 days).**	Mean=6 days, SD=3 days	We derived estimates from the published data (Figure 2 in Verrall et al[7]) to calculate the SE of the mean (SE=0.2). We used a gamma distribution with alpha=916.00 and beta=0.01.
Mean cost-per-person-per-day. Given the absence of NZ data we used the data for hospital cases calculated for the Australasian study[5] above.	A$2,595 per day (as per the above cost-per-day estimate)	Of note is that this cost estimate might be an over-estimate as it is derived from those who had been particularly ill (i.e., had previously been in ICU).
Results	**Median [Mean] (NZ$)**	**95% Uncertainty interval (NZ$)**
ICU – cost-per-person	95,000 [97,000]	59,000 – 146,000
ICU – total costs	9,653,000 [9,857,000]	6,060,000 – 14,923,000
Hospital (not-ICU) – cost-per-person	17,000 [17,000]	11,000 – 23,000
Hospital (not-ICU) – total costs	20,488,000 [20,626,000]	13,890,000 – 28,177,000
Total hospital costs (ICU + non-ICU)	30,204,000 [30,483,000]	22,250,000 – 39,525,000
Total hospital costs (ICU + non-ICU) per capita (NZ population in 2009)[10]	6.95 [7.01] per capita	5.12 – 9.09 per capita
Total hospital costs (ICU + non-ICU) in US$	US$20,124,000 [20,310,000]	US$14,825,000 – 26,335,000

Notes:

* Other work has reported a higher estimate (n=119)[3], but this was for a longer time period. The ANZIC Influenza Investigators dataset involved carefully identifying all transfers (using initials, date-of-birth, day of discharge from one ICU and day of admission to another etc), and only included them as one ICU admission.

** A slight limitation with these NZ data are that they include 19 cases (8% of the total) who were admitted to "intensive care or high dependency units for at least 1 night".

Discussion

These cost estimates are the first we know of for all hospitalisations from the 2009 influenza pandemic at a country-level. They suggest a significant extra cost to the health sector from even a relatively non-severe influenza pandemic (compared to previous influenza pandemics for New Zealand[11–13]). Nevertheless, these estimates are still likely to be underestimates of the true costs to the hospital sector given that the calculations in the Australasian study[5] did not include certain cost items (e.g., "blood products" even though usage of these was relatively high for patients treated with extracorporeal membrane oxygenation [ECMO]).

Furthermore, we have not included the costs associated with disruption to normal hospital operations e.g., as elective surgical procedures were cancelled as ICU space became very constrained in some New Zealand and Australian hospitals.[14]

A more sophisticated analysis would also consider a wider range of locality-specific factors (e.g., actual New Zealand data on hospital costs, national level data on length-of-stay, and correlations between length-of-stay and average daily cost). Nevertheless, at the ICU level, the experience for patients in Australia and New Zealand appeared to be fairly similar, with similar rates of ECMO use (7% in Australia compared with 8% in New Zealand), invasive ventilation (64% compared to 53%) and case-fatality proportions (16% for both groups).

A wider health system perspective would consider costs for emergency departments, primary care, and the public health sector. Societal costing would consider the contribution of morbidity, premature death, absenteeism from work and educational settings, and impacts on the tourism industry. Given the sudden and unpredictable nature of such pandemics, there is a case for further study of these costs – to help determine the appropriate scale of pandemic planning and preventive measures.

In summary, this analysis provides initial estimates (with uncertainty estimates) of the hospitalisation costs to the New Zealand Government during the first wave of the 2009 influenza pandemic. But given the relatively non-severe nature of this pandemic, it is likely to provide only an approximate lower bound cost for this sector from new influenza pandemics in the future.

Much more complete costing studies are probably warranted in this and other countries to guide future decision-making around investment into influenza pandemic planning. Nevertheless, these high cost estimates indicate the potential value of further work on preventive measures (e.g., vaccination) and of investing in pandemic planning and other control measures to reduce person-to-person spread.

Competing interests: Nil.

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