The economics of routine childhood hepatitis A immunization in the United States: the impact of herd immunity

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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
The study examined routine childhood hepatitis A vaccination. The programme covered all children aged between 12 and 23 months and was compared with no vaccination.

Note: this paper was published as a companion paper to Rein et al 2007 (see 'Other Publications of Related Interest' below for bibliographic details) and, notwithstanding the fact that this abstract treats the present paper in isolation, it is strongly recommended that the two papers are read in conjunction with one another. In instances where this abstract refers to information or data that are not presented in the present paper the reader should refer to Rein et al 2007.

Type of intervention
Primary prevention (vaccination).

Economic study type
Cost-effectiveness analysis and cost-utility analysis.

Study population
The study population comprised children aged one year.

Setting
The setting was primary care. The economic study was carried out in the USA.

Dates to which data relate
Much of the clinical and economic data used in the study were derived from the previous model published in 2007. Clinical data on herd immunity were derived from on a study published in 2004. The price year was 2005.

Source of effectiveness data
The authors did not report the full list of model inputs that had been evaluated in the previous model but further detail will be found in Rein et al 2007. The clinical data used in the current model were the effects of herd immunity, the estimated proportion of infections prevented by herd immunity, and the proportion of hepatitis A infection acquired abroad by US adults.

Modelling
A published decision model was used to simulate the natural history of disease (no vaccination) and the subsequent impact of vaccination in the first 10 birth cohorts starting in 2005 and ending in 2014. The model was run both with and without the assumption of herd immunity. Each cohort was followed from birth through age 95 years, during which time members of the cohort were subject to mortality rates equal to the US age-specific mortality rates and also to acute
hepatitis A and its associated complications. Other details of the model were not given in this study, but readers are referred to Rein et al 2007 for further information.

**Sources searched to identify primary studies**
Little information on the sources of the clinical data was provided, but readers are referred to Rein et al 2007 for this information. Most of the clinical data came from the National Notifiable Disease Surveillance System.

**Methods used to judge relevance and validity, and for extracting data**
No details of the approach used to identify the published studies were given but further detail will be found in Rein et al 2007. The algorithm used to estimate the proportion of infections prevented by herd immunity was reported in detail and a justification was given.

**Measure of benefits used in the economic analysis**
The summary benefit measures used were the life-years (LYs) and quality-adjusted life-years (QALYs). These were estimated using the decision model. No information on the sources of utility weights used to derive the QALYs was provided. The benefits were discounted at an annual rate of 3%.

**Direct costs**
The analysis was carried out from a societal perspective. It included the direct costs associated with vaccination and treatment of the disease. A breakdown of the cost items was not provided. The unit costs and the resource quantities were not presented separately. The costs and quantities were derived from the published decision model. The costs were incurred over a long time period and an annual discount rate of 3% was used. The price year was 2005.

**Statistical analysis of costs**
The costs appear to have been treated deterministically.

**Indirect Costs**
The analysis appropriately considered productivity costs given that a societal perspective was adopted. The three main categories of productivity losses considered were the productivity loss after death from hepatitis A, the productivity loss while ill with hepatitis A, and the productivity loss by parents caring for children with acute hepatitis A. The costs in the cost-utility analysis included all of these costs except productivity loss while ill with hepatitis A, which was taken into account as a component of QALYs. No information on the sources of these costs was provided. As in the analysis of the direct costs, the price year was 2005 and an annual discount rate of 3% was used.

**Currency**
US dollars ($).

**Sensitivity analysis**
A univariate sensitivity analysis was performed to assess the robustness of the cost-effectiveness and cost-utility ratios to variations in the herd-immunity parameters, vaccination costs, discount rate, incidence and rate of decline in incidence of hepatitis A, duration of immunity from hepatitis A vaccine, immunisation coverage, and quality of life lost during acute hepatitis A. The sources of the alternative ranges of values were not reported.

**Estimated benefits used in the economic analysis**
The expected LYs gained with the vaccination strategy over no vaccination were 206 in the direct-effects model and 675 in the full model where the indirect effects of herd immunity were considered (462 out-of-cohort and 7 within-
The expected QALYs gained with the vaccination strategy over no vaccination were 1,792 in the direct-effects model and 3,684 in the full model where the indirect effects of herd immunity were considered (1,773 out-of-cohort and 119 within-cohort herd-immunity QALYs gained).

**Cost results**

When LYs gained were considered, the net costs (total costs minus total savings in both direct and indirect costs) with the vaccination strategy over no vaccination were $47.1 million in the direct-effects model. Cost-savings of $19.8 million were observed in the full model with herd immunity. The savings were mainly attributable to the reduction in medical cost for hepatitis A treatment and the reduction in productivity losses by caregivers of ill children.

When QALYs were considered, the net costs (total costs minus total savings in both direct and indirect costs) with the vaccination strategy over no vaccination were $56.8 million in the direct-effects model and $5.1 million in the full model with herd immunity.

**Synthesis of costs and benefits**

Incremental cost-effectiveness and cost-utility ratios were calculated to combine the costs and benefits of the alternative strategies.

The incremental cost per QALY gained with vaccination over no vaccination was $32,000 in the direct-effects model and $1,000 in the full model with herd immunity.

The incremental cost per LY gained with vaccination over no vaccination was $228,000 in the direct-effects model, while vaccination was dominant (less expensive and more beneficial) in the full model.

The results of the sensitivity analysis showed that hepatitis A vaccination was most sensitive to vaccine acquisition and administration costs. For example, decreasing these costs to 50% of their base value, or increasing them to 150% of their base value, resulted in vaccination being either cost-saving or costing $17,000 per QALY gained. Variations in other model inputs did not substantially alter the base-case results. Interestingly, the results of the analysis were not sensitive to variations in the herd-immunity parameters. However, the expected benefits from immunisation, including savings from direct medical costs, public health costs and productivity losses, decreased with each cohort immunised in the model.

**Authors’ conclusions**

The indirect effects of herd immunity enhance the economic and clinical benefits of routine vaccination against hepatitis A in children. The immunisation programme is therefore highly cost-effective in all circumstances and cost-saving under some conditions.

**CRD COMMENTARY - Selection of comparators**

The rationale for the choice of the comparator (no vaccination) was clear, although it was not explicitly justified. Other vaccination strategies (e.g. vaccination only to children in high-risk regions) were not considered in this study. You should decide whether this is a valid comparator in your own setting.

**Validity of estimate of measure of effectiveness**

The clinical data used to populate the decision model were derived from a published economic evaluation, thus there was no information about the approach used to derive the effectiveness estimates. Only limited details of the additional data on herd immunity, together with a description of the algorithm used to separate direct from indirect immunisation effects, were given. Overall, it was not possible to assess the validity of the primary estimates.
Validity of estimate of measure of benefit
Both benefit measures used in the economic analysis were appropriate as LYs and QALYs capture two relevant dimensions of health (i.e. length of survival and quality of life). Discounting was appropriately performed. No information on the source of the utility weights was reported.

Validity of estimate of costs
The analysis included all the cost categories relevant to the societal perspective adopted in the study. The price year and the discount rate were reported. However, an objective assessment of the cost analysis is difficult due to the lack of information presented in this paper.

Other issues
The authors stated that their findings were similar to those observed in a previous study that had evaluated the effect of herd immunity, despite some differences in the methods used to estimate it. The issue of the generalisability of the study results to other settings was implicitly addressed in the sensitivity analysis, in which all key model inputs were varied across plausible ranges. The authors stated that their analysis shared some of the limitations of the published decision model. Further, there were few data about the magnitude of herd-immunity effects under real-life circumstances. Often data on herd immunity are based on a single source. However, the analysis was robust to variations in the majority of model inputs.

Although herd immunity is an important issue, it is also one that is frequently overlooked in economic evaluations of vaccination. The authors of this paper have taken the unusual step of using the results from a previous (Rein et al 2007) and estimating the effect on those results of taking herd immunity into account. This approach serves to demonstrate the degree to which classic economic evaluation methodology is likely to underestimate the economic benefits of vaccination, at least in the case of vaccination against hepatitis A.

Implications of the study
The study results support the implementation of a routine, nationwide vaccination programme against hepatitis A in children. Therefore, the current analysis provided further support to the 2005 decision made by ACIP, which recommended extending infant hepatitis A immunisation to all children born in the USA.

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Other publications of related interest
Because readers are likely to encounter and assess individual publications, NHS EED abstracts reflect the original publication as it is written, as a stand-alone paper. Where NHS EED abstractors are able to identify positively that a publication is significantly linked to or informed by other publications, these will be referenced in the text of the abstract and their bibliographic details recorded here for information.

Rein DB, Hicks KA, Wirth BA, et al. Cost-effectiveness of routine childhood vaccination for hepatitis A in the United


Indexing Status
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MeSH
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