Use of models to identify cost-effective interventions: pertussis vaccination for pediatric health care workers

Greer AL, Fisman DN

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.

CRD summary
The study evaluated the cost-effectiveness of pertussis (whooping cough) booster vaccination programmes for neonatal intensive care unit health care workers. The authors concluded that booster vaccination of health care workers in newborn baby intensive care units was cost-saving or highly cost-effective. However, reporting was generally poor. It was also unclear whether appropriate model inputs were chosen or how they were applied within the model. Lack of transparency makes assessing the validity of the authors’ conclusions difficult.

Type of economic evaluation
Cost-effectiveness analysis, cost-utility analysis

Study objective
The study estimated the cost-effectiveness of diphtheria-tetanus-acellular pertussis booster vaccination programmes for health care workers in a neonatal intensive care unit.

Interventions
Diphtheria-tetanus-acellular pertussis booster vaccination programmes (to achieve coverage levels varying from 25% to 95%) were compared with no vaccination programme in neonatal intensive care unit healthcare workers. Staff were assumed to receive the booster at baseline. As staff were lost and replaced, they received the vaccination according to the coverage in the baseline vaccine programme.

Location/setting
Canada/secondary care

Methods
Analytical approach:
The authors used a 10 year Markov model with one month cycles to simulate transmission of nosocomial pertussis in a neonatal intensive care unit environment. The authors stated that the model perspective was a modified societal perspective.

Effectiveness data:
The clinical evidence came from a selection of studies from the published literature, and the results of an agent-based model of pertussis transmission (Greer 2009, see Other publications of related interest) in a neonatal intensive care unit. The key clinical effectiveness estimates were the transmission rates of pertussis from a staff member with pertussis and the consequences of infection. These estimates came from the agent-based model.

Monetary benefit and utility valuations:
Utility values were estimated for parents and children from published literature. Maternal and paternal utilities decreased if a child died and were further decreased if a child survived but had a neurologic disability. Utilities for children were estimated using average Canadian life expectancies modified by level of neurologic disability.

Measure of benefit:
Quality-adjusted life-years (QALYs) were the summary measure of benefit. Future benefits were discounted at a rate of 3% per year.
Cost data:
The costs included vaccination and those incurred by anyone as a consequence of pertussis infection, including the cost of anaphylaxis related to vaccination, testing and diagnostics, healthcare labour, prolonged hospital stay, and the cost of disability related to pertussis infection. The source of costs was the published literature. All cost figures were in 2008 US $. Future costs were discounted at a rate of 3% per year. Costs were adjusted to 2008 US $ using the medical services component of the consumer price index.

Analysis of uncertainty:
One-way sensitivity analyses were conducted. Univariate threshold analyses were also used to identify variable thresholds that changed cost-effectiveness decisions. Interactions between parameters were analysed in two-way sensitivity analyses. Probabilistic sensitivity analysis was conducted with the results reported as cost-effectiveness acceptability curves.

Results
All vaccination strategies were found to be beneficial compared with no vaccination, resulting in an incremental QALY gain that ranged from 0.0083 for vaccination with 25% coverage to 0.0018 for vaccination with 95% coverage.

The cost of alternatives ranged from $984 for a vaccination strategy with 25% coverage to $1,554 for a vaccination strategy with 95% coverage compared with $1123 for no vaccination. A vaccination strategy with 25% coverage was cost saving (-$139) compared with no vaccination.

The incremental cost-effectiveness ratio (ICER) for a vaccination strategy with 25% coverage compared with no vaccination was -$16,718 (cost-saving). The ICER for 50% coverage compared with no vaccination was $35,658, so the strategy was considered highly cost-effective. All vaccination strategies were considered cost-effective (the ICER ranged from one to three times gross national product). No vaccination was more costly and less effective than any vaccination strategy (dominated). The results were robust to plausible variations in model inputs.

Authors’ conclusions
The authors concluded that booster vaccination of healthcare workers in neonatal intensive care units was a cost-saving or highly cost-effective strategy, even at low levels of coverage.

CRD commentary
Interventions:
The level of reporting of the interventions was sufficient; the intervention appeared to be relevant to the study setting and covered a range of options, but it was not clear that all options were reasonable. It seemed unlikely that an employer would require vaccination of its neonatal intensive care unit workers and then accept only 25% of them being vaccinated. The most cost-effective option, 25% vaccine coverage, was not likely a realistic option. The different levels of vaccination may be more appropriate as sensitivity analyses rather than different interventions, but this was not how the authors analysed them. The results may be generalisable to other study settings.

Effectiveness/benefits:
The level of reporting of the effectiveness data was poor. There was no description of how studies were identified and selected; justifications for selections were absent. It was unclear whether the best available evidence was used. The key effectiveness data, transmission rates and the effects of infection, came from a published model, but there was no reference to where that model derived these data. The authors reported a utility value source but did not describe the instrument used or state whose preferences were estimated. The utility estimates came from a Herpes simplex study; no justification was provided for this choice. Length of child life was assumed to be the same as a child with cerebral palsy; no justification was provided for this choice.

Costs:
The authors described their stated perspective in sufficient detail and appeared to include costs relevant to a societal perspective. The authors defined which costs were omitted from the analysis. The method of cost studies identification and selection was not described. It was unclear whether the best available evidence was selected.

Costs came from a number of sources from Canada and the USA, but it was not clear whether any currency conversions
were calculated or whether costs from one setting were applicable to the other. It may not have been appropriate to use USA consumer price indices for cost reflation if the cost units were not derived from the USA, as the healthcare system contexts do not match. It was not clear that cost data had been appropriately derived or used. No justifications were provided for cost data choices.

**Analysis and results:**
The use of an incremental approach to compare vaccination at different levels of coverage with no vaccination was appropriate. The authors did not discuss limitations of the model beyond assessing that some underlying rates in the model may vary.

The authors used cost-effectiveness thresholds derived from World Health Organization (WHO) guidelines on cost-effectiveness. The incremental cost-effectiveness ratios defined by the WHO used costs per disability-adjusted life-year (DALY), a different quality of life implement than QALYs. Using willingness-to-pay thresholds designed for DALYs may have been inappropriate for QALYs. As indicated by the references cited, Canada had a proposed cost-effectiveness threshold range.

The distributions used for the probabilistic sensitivity analysis were not well reported and some, such as triangular distributions for length of stay, appeared inappropriate. It was not clear whether the referenced agent model provided these, as QALYs and costs were not the outcomes of interest in the original model.

**Concluding remarks:**
Reporting was generally poor. It was also not clear whether appropriate model inputs were chosen or how they were applied within the model. Lack of transparency makes assessing the validity of the authors’ conclusions difficult.

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