Developing automated decision rules based on vaccine cost to identify optimal vaccination strategies

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Background

Where efficiency and value for money are key considerations in health policy decisions, economic evaluations are often conducted to inform such decisions. However, the prices of vaccines in publicly-funded vaccination programmes are typically negotiated with vaccine manufacturers after a policy decision has been made to offer vaccination. Additionally, vaccine prices often remain confidential once agreed. As such, vaccine costs must be assumed in economic analyses. This creates considerable uncertainty in the results of the analysis. Where maximising efficiency for the public purse is a key objective, it therefore leads to challenges for the health care payer when negotiating vaccine prices.

This study aimed to develop automated decision rules as part of an economic evaluation, providing valuable insight to the health care payer and enabling them to identify the optimal vaccination strategy once vaccine prices are known.

Methods

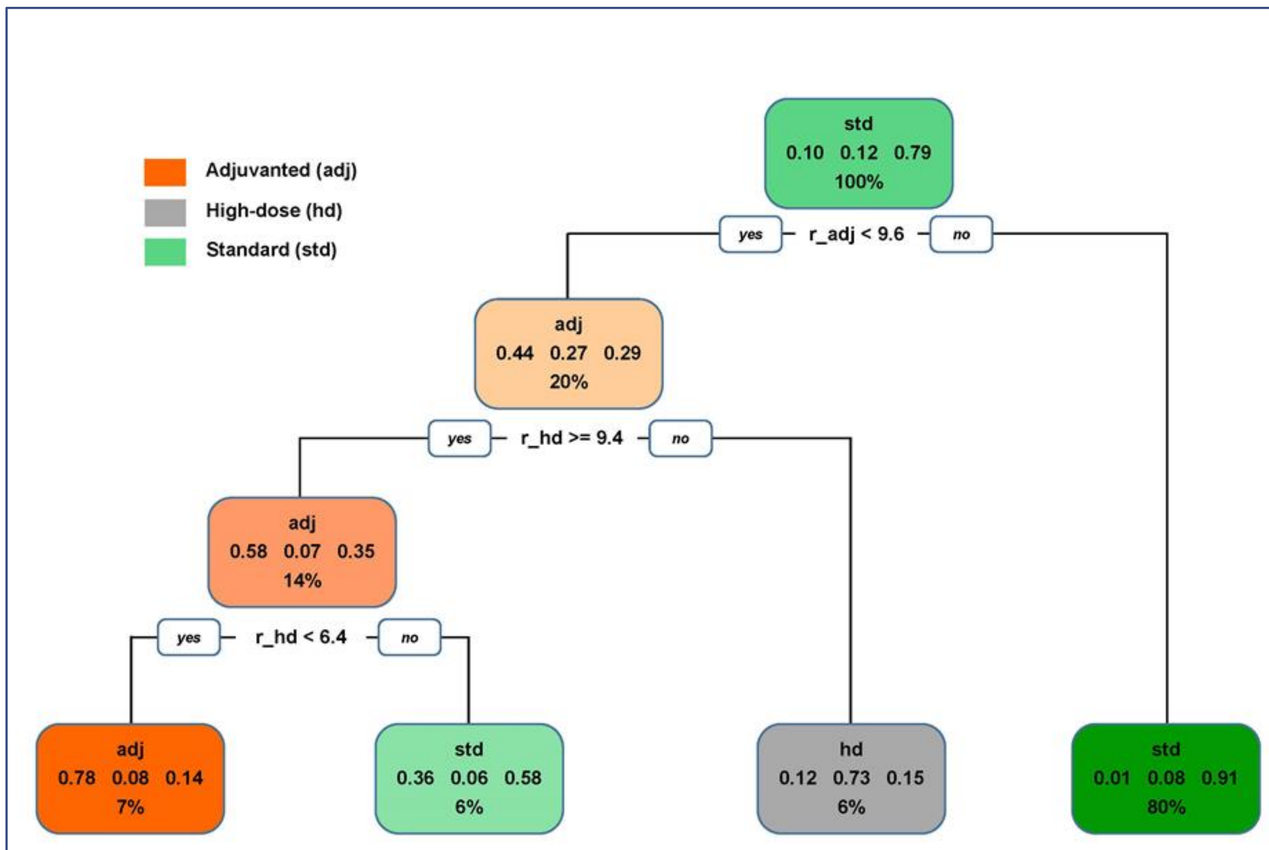
- A cost-utility analysis of the use of an enhanced inactivated influenza vaccine for those aged 65 years and older in the seasonal influenza vaccination programmes in Ireland was used for this study.
- Employing a dynamic transmission model of influenza viruses, three alternative vaccination strategies, using a standard, adjuvanted or high-dose inactivated influenza vaccine were compared.
- The costs for each of the three vaccines were assigned uniform distributions within plausible range and were varied simultaneously in probabilistic simulations.
- Vaccine costs (per dose) were assigned the following ranges:
  - from €5 to €10.99 for the standard vaccine
  - from €10.99 to €25 for the adjuvanted vaccine
  - from €10.99 to €45 for the high-dose vaccine.

  All costs excluded VAT and administration fees were included as a separate model input. There was an additional assumption that the high-dose vaccine was always more costly than the adjuvanted vaccine.
- For each simulation, the net monetary benefit (NMB) was determined for each vaccination strategy at a willingness-to-pay threshold of €20,000 per quality-adjusted life year (QALY).
- Recursive partitioning was used to derive decision rules for identifying the strategy with the largest NMB, that is the optimal strategy, based on the vaccine costs.

Results

- The automated decision rules were developed using a training dataset of 5,000 simulations. Appling the decision rules to a validation dataset achieved correct identification of the optimal strategy in 87% of cases.
- Three separate decision rules, one for each of the enhanced vaccines, were generated for identifying the optimal vaccination strategy.
- The decision rules are centred on the following relative costs of the vaccines:
  - the cost of the adjuvanted vaccine relative to the standard vaccine
  - the cost of the adjuvanted vaccine relative to the high-dose vaccine.
- A decision tree provides a graphical representation of the decision rules identifying the optimal influenza vaccination strategy based on vaccine price (**Figure 1**).

Figure 1 Decision Tree to identify the optimal influenza vaccination strategy based on vaccine price



Key: r_adj – relative cost of adjuvanted; r_hd – relative cost of high-dose.

Explainer: Each box in the plot provides both the probability of a particular vaccination strategy being optimal at that level and the proportion of times each of the three possible strategies (in the order of adjuvanted, high-dose and standard, respectively) is in that box at that level.

Decision Rules for identifying the optimal vaccination strategy

- A strategy using the **high-dose** vaccine is optimal if the vaccine cost is <€9.40 greater than adjuvanted AND adjuvanted is <€9.60 greater than standard.
- A strategy using the **adjuvanted** vaccine is optimal if the vaccine cost is <€6.40 greater than standard AND high-dose is ≥€9.40 more than adjuvanted.
- A strategy using the **standard** vaccine is optimal in all other situations.

Conclusions

- When comparing alternative vaccination strategies in economic evaluations, automated decision rules relating to vaccine costs can be developed using recursive partitioning.
- These rules can enable health care payers to easily identify the optimal vaccination strategy based on net monetary benefit.
- Automated decision rules can be a valuable tool for health care payers when negotiating vaccine prices with manufacturers.

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