Application of Optimization Model in Vaccine Evaluation

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GSK VACCINES

Disclaimer

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OM: Knapsack Problem & Analogy in Health Care

A knapsack: a weight limitation

Several items in the knapsack with different weight and value (being useful and/or essential)
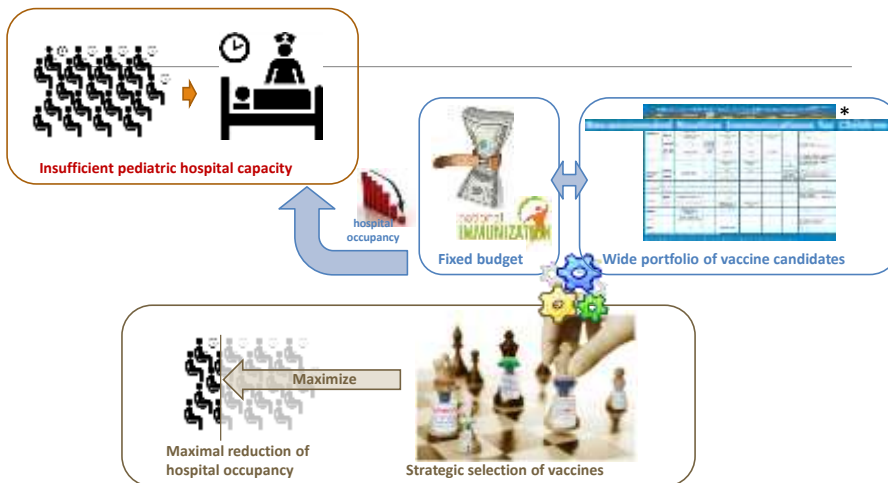
Select those items for which:
◦ total weight not > weight limitation
◦ maximize value of the knapsack

Analogy with health care: budget limitation, different options to select and maximize value (QALY-gain or MCDA)

Sarker, R & Newton Ch. Optimization Modelling, a practical approach, 2008, CRC Press, Taylor & Francis Group, p 154.
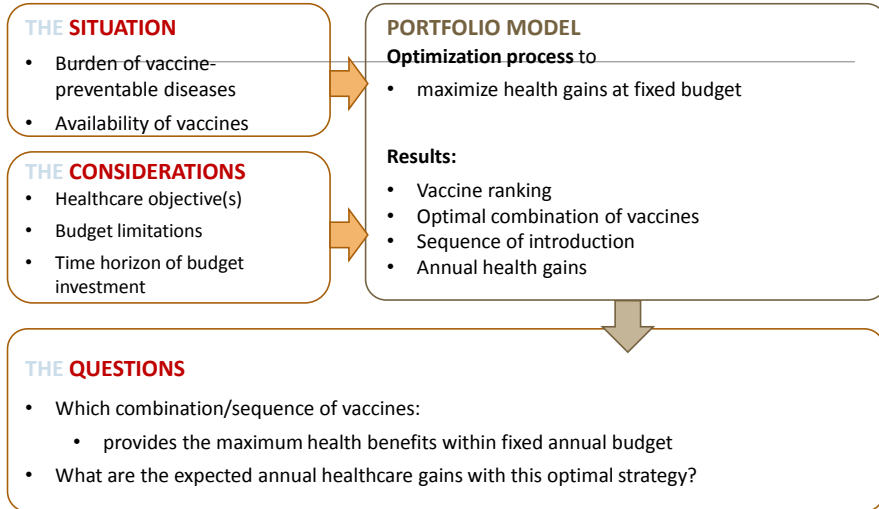
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Optimization: Health Goal and Constraint

Insufficient pediatric hospital capacity

hospital occupancy

Fixed budget

Wide portfolio of vaccine candidates

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Maximize

Maximal reduction of hospital occupancy
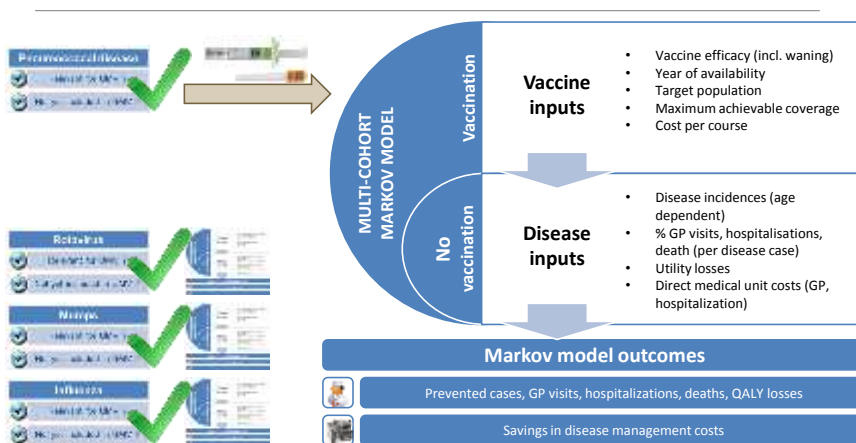
Strategic selection of vaccines

*WHO recommendations for routine immunization: *http://www.who.int/immunization/policy/Immunization_routine_table2.pdf*
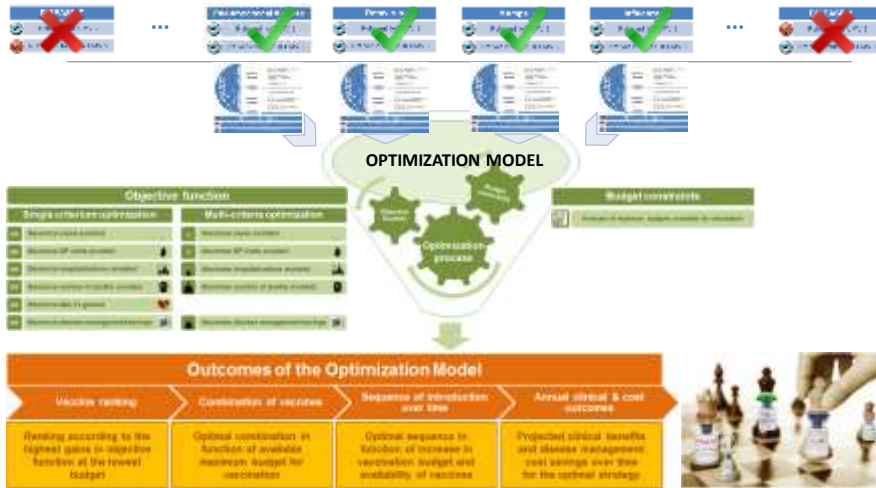
Running the PMV-model

THE SITUATION
- Burden of vaccine-preventable diseases
- Availability of vaccines

THE CONSIDERATIONS
- Healthcare objective(s)
- Budget limitations
- Time horizon of budget investment

PORTFOLIO MODEL

Optimization process to
- maximize health gains at fixed budget

Results:
- Vaccine ranking
- Optimal combination of vaccines
- Sequence of introduction
- Annual health gains

THE QUESTIONS
- Which combination/sequence of vaccines:
  - provides the maximum health benefits within fixed annual budget
- What are the expected annual healthcare gains with this optimal strategy?

Data inputs (illustration only)

MULTI-COHORT MARKOV MODEL

Vaccination

Vaccine inputs
- Vaccine efficacy (incl. waning)
- Year of availability
- Target population
- Maximum achievable coverage
- Cost per course

No vaccination

Disease inputs
- Disease incidences (age dependent)
- % GP visits, hospitalisations, death (per disease case)
- Utility losses
- Direct medical unit costs (GP, hospitalization)

Markov model outcomes

Prevented cases, GP visits, hospitalizations, deaths, QALY losses

Savings in disease management costs

Running the PMV

OPTIMIZATION MODEL

Example 1*: Optimize pediatric vaccine introduction in Japan based on health gains.

Ranking according to highest health gains in the objective function

Rank	Single criterium					
	Cases	Medical visits	Hospital bed occupancy	Deaths avoided	DMC savings	QALYs
1st	Mumps	Mumps	Rotavirus	Influenza	Mumps	Mumps
2nd	Influenza	Rotavirus	Mumps	Pneumo	Rotavirus	Influenza
3rd	Rotavirus	Pneumo	Influenza	Rotavirus	Pneumo	Rotavirus
4th	Pneumo	Influenza	Pneumo	NA	Influenza	Pneumo

Outcomes of PMV: combination and sequence of vaccines with increasing budget*
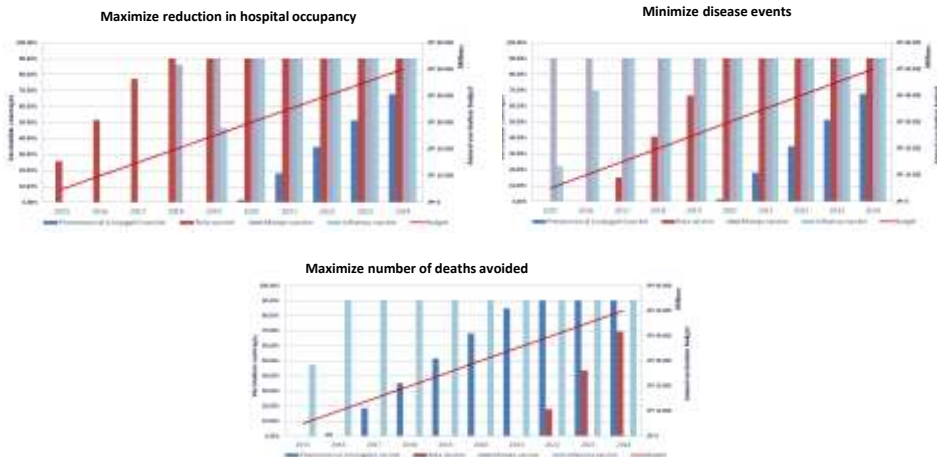
Maximize reduction in hospital occupancy

Minimize disease events

Maximize number of deaths avoided

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Comparison between PMV and no PMV on QALYs*
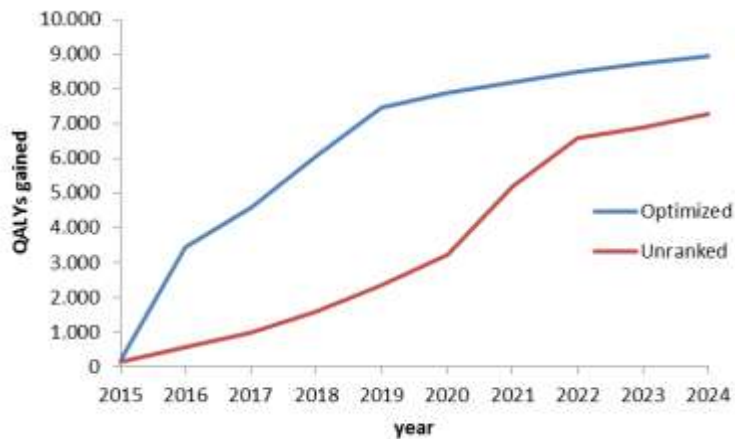
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Example 2:

Selecting a Mix of Prevention Strategies against Cervical Cancer for Maximum Efficiency with an Optimization Program

Nadia Demarteau,[1] Thomas Breuer[2] and Baudouin Standaert[1]

Key points for decision makers:

- Two cervical cancer (CC) prevention strategies exist: secondary (screening) and primary (HPV vaccination)

- Optimization models can be used to determine the optimal mix of primary and secondary prevention strategies minimizing CC burden under budget and logistic constraints

- Extending existing screening intervals while implementing vaccination in both the UK and Brazil could result in a substantial CC reduction while maintaining the current budget

Legend:
■ Vaccination alone
□ Vaccination and screening
▤ Screening alone
□ No prevention strategy
◇ Screening interval vaccinated
△ Screening interval unvaccinated

• UK:
--65% of the women will be vaccinated and screened every 6 years, and 15% would be vaccinated with no screening, and 20% remain unscreened

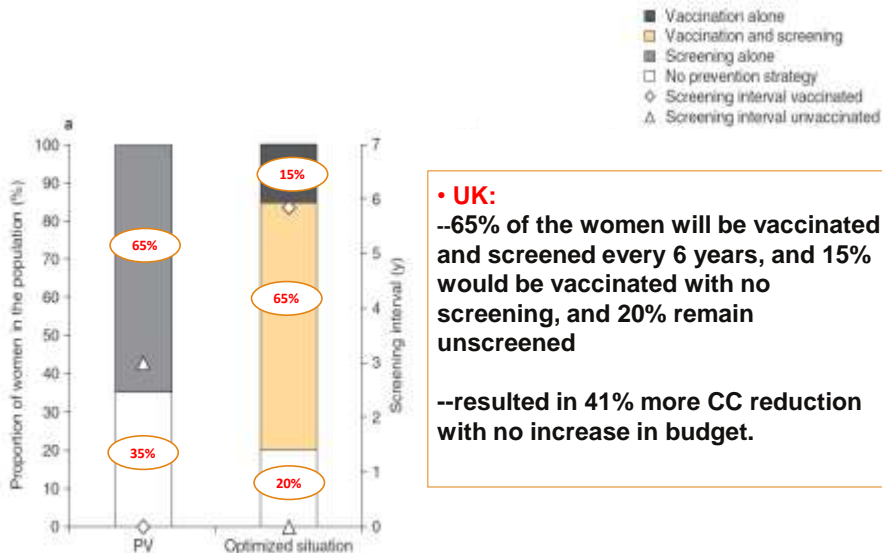**--resulted in 41% more CC reduction with no increase in budget.**

Fig. 2. Pre-vaccination strategy and base-case optimal budget allocation for (a) the UK and (b) Brazil. The left axis refers to the population distribution (bars), and the right to the screening interval (△: screened only; ◇: vaccinated and screened; where ◇ or △ = 0 correspond to having no women under that specific scenario, e.g. screened only or screened and vaccinated). PV = pre-vaccination strategy.

Conclusions

Optimization model is a powerful tool for decision makers with restricted budgets to maximize health gains.

It allows budget planning over time

Support the approach of sustainability in HC

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