# Health economic evaluation of vaccinations

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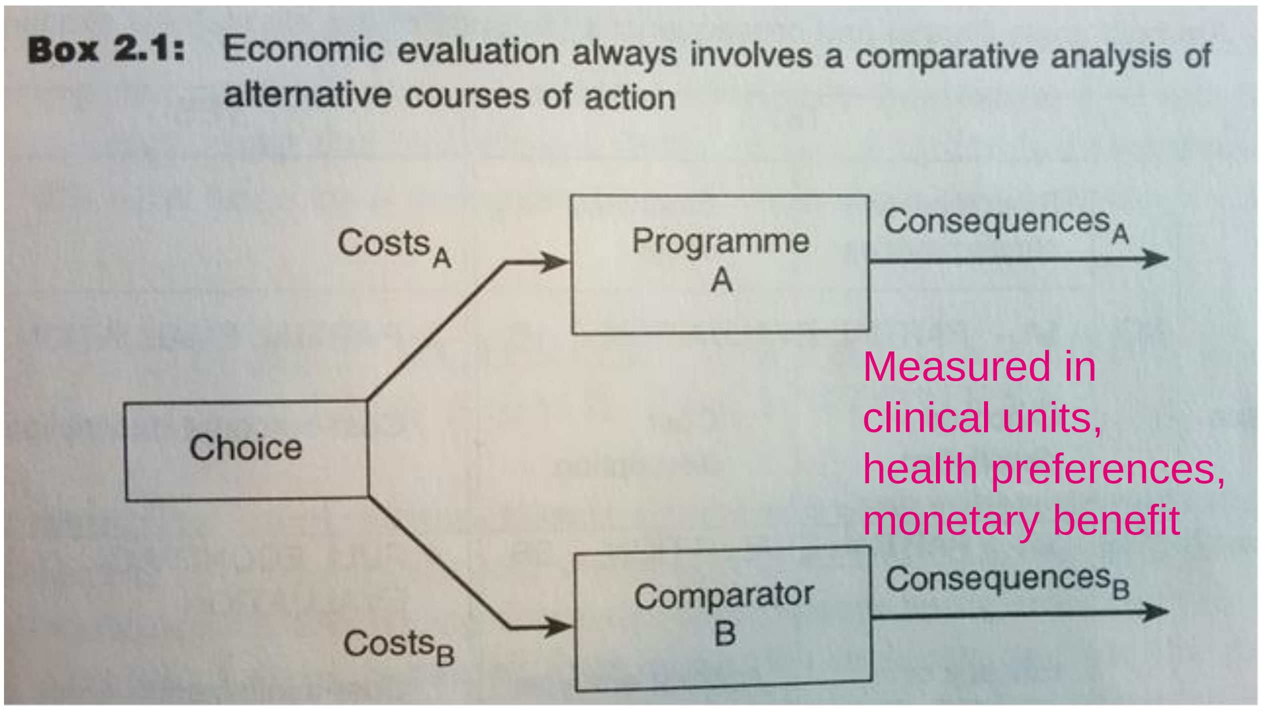
# Health economic evaluation (Drummond 2005)

- A choice between two or more alternatives
- All relevant alternatives are compared in terms of both their costs and consequences.




The comparator could be Programme B or ‘doing nothing’

# The health gains (consequences ) are measured in

**Natural units** in **cost-effectiveness analysis** (CEA)

- Life-years gained, infections prevented, deaths prevented
- Incremental cost-effectiveness ratio: ICER= Δcosts / Δeffects

**Health preferences** in **cost-utility analysis** (CUA)

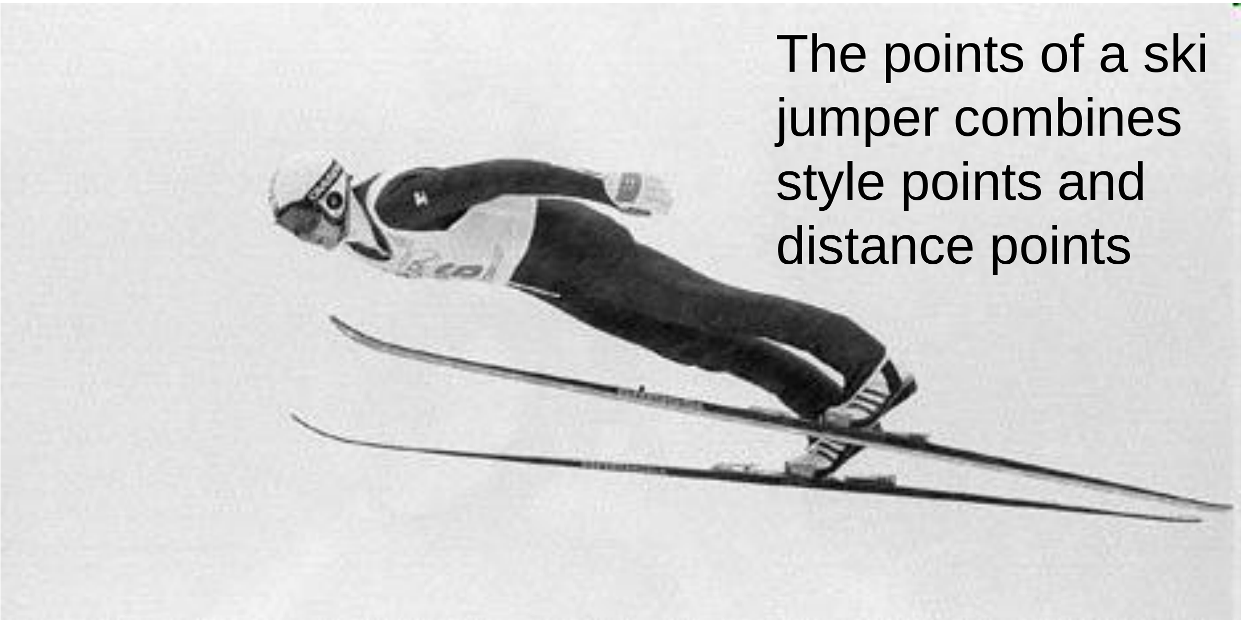
- Combined measure of morbidity and mortality
- Quality-adjusted life-years (QALYs), Disability-adjusted life-years (DALYs)
- Incremental cost-utility ratio ICUR (often ICER): Δcosts / ΔQALYs

**Monetary terms** (€) in **cost-benefit analysis** (CBA)

Types of economic evaluation differ in how benefits are valued

# QALY, Quality-adjusted life-year

- The effect of an intervention on length of life and quality of life combined into a single index number
- The change in utility value induced by the vaccination programme is multiplied by the duration of the effect to provide the number of QALYs gained



# QALY, Quality-adjusted life-year

- A generic measure which sums years spent in different health states using weights
- Scale for each health state from 0 (dead) to 1 (perfectly healthy)

Intervention A:

- 4 years in health state 0.75 = 3 QALYs

Intervention B:

- 4 years in health state 0.5 = 2 QALYs

**->**

1 QALY gained by intervention A

# Economic evaluation of vaccinations

Special characteristics

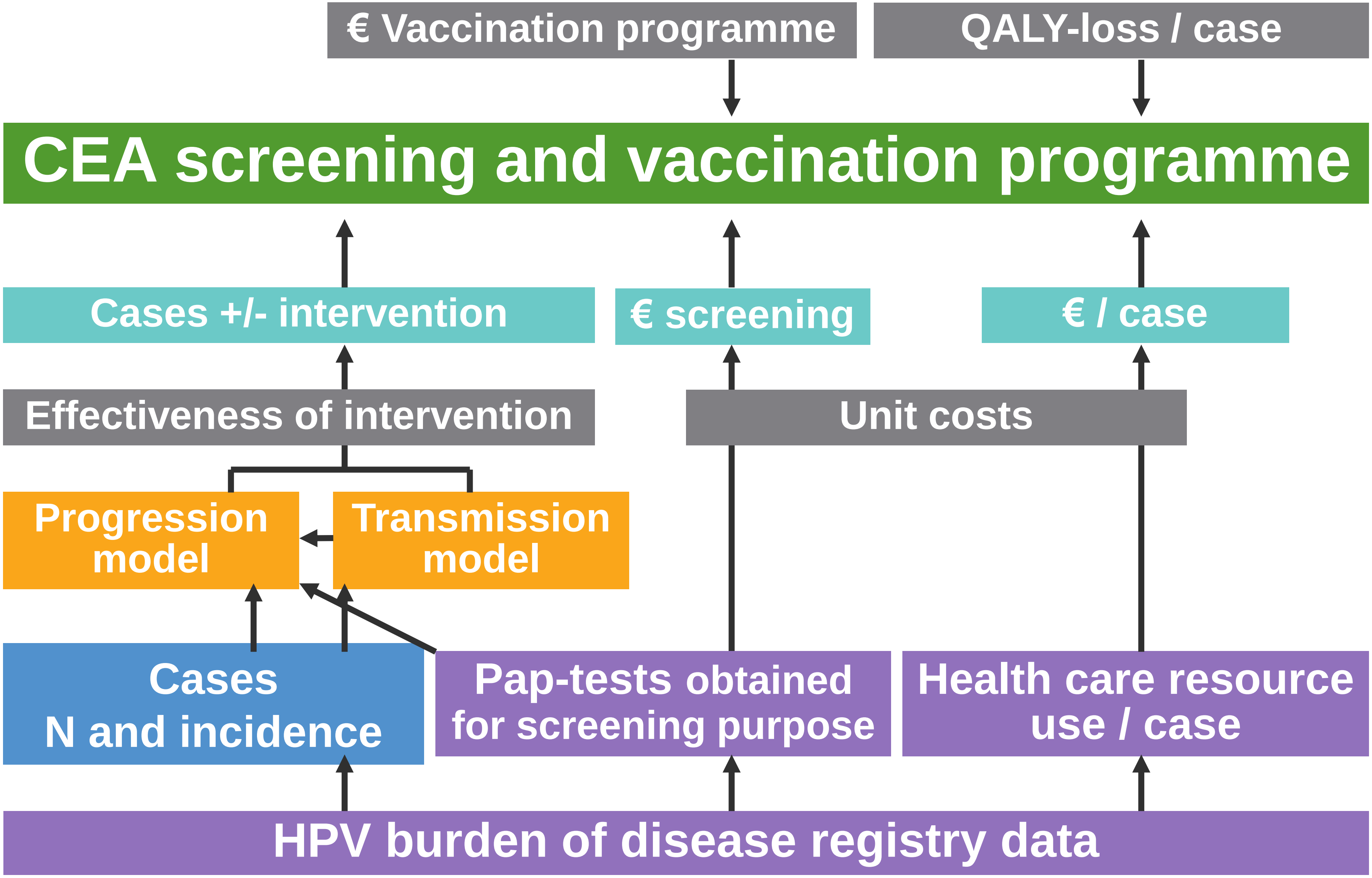
- Primary prevention of infectious diseases in healthy people
- Possibility of adverse events
- The indirect effect of vaccinations in an unvaccinated individual: e.g. herd effect, serotype replacement, increase in the average age at infection
- Discounting future benefits and costs
- Some infections eradicable

Beutels et al. Lancet Infect Dis 2008

# Steps in health economic evaluation

1. The perspective(s) of the study
   - Is a vaccination programme worth it from the health care provider / societal perspective?
2. Estimate the current disease burden
3. Define all alternatives for the intervention
4. Identify the outcomes for each alternative
   - E.g. LYs / QALYs gained
   - Estimate their probabilities and values
5. Estimate relevant costs for each alternative
   - Assign values for the consumed resources
6. Compare costs and benefits of the alternatives
7. Sensitivity analyses
8. Reporting and interpreting the results

Drummond 2005

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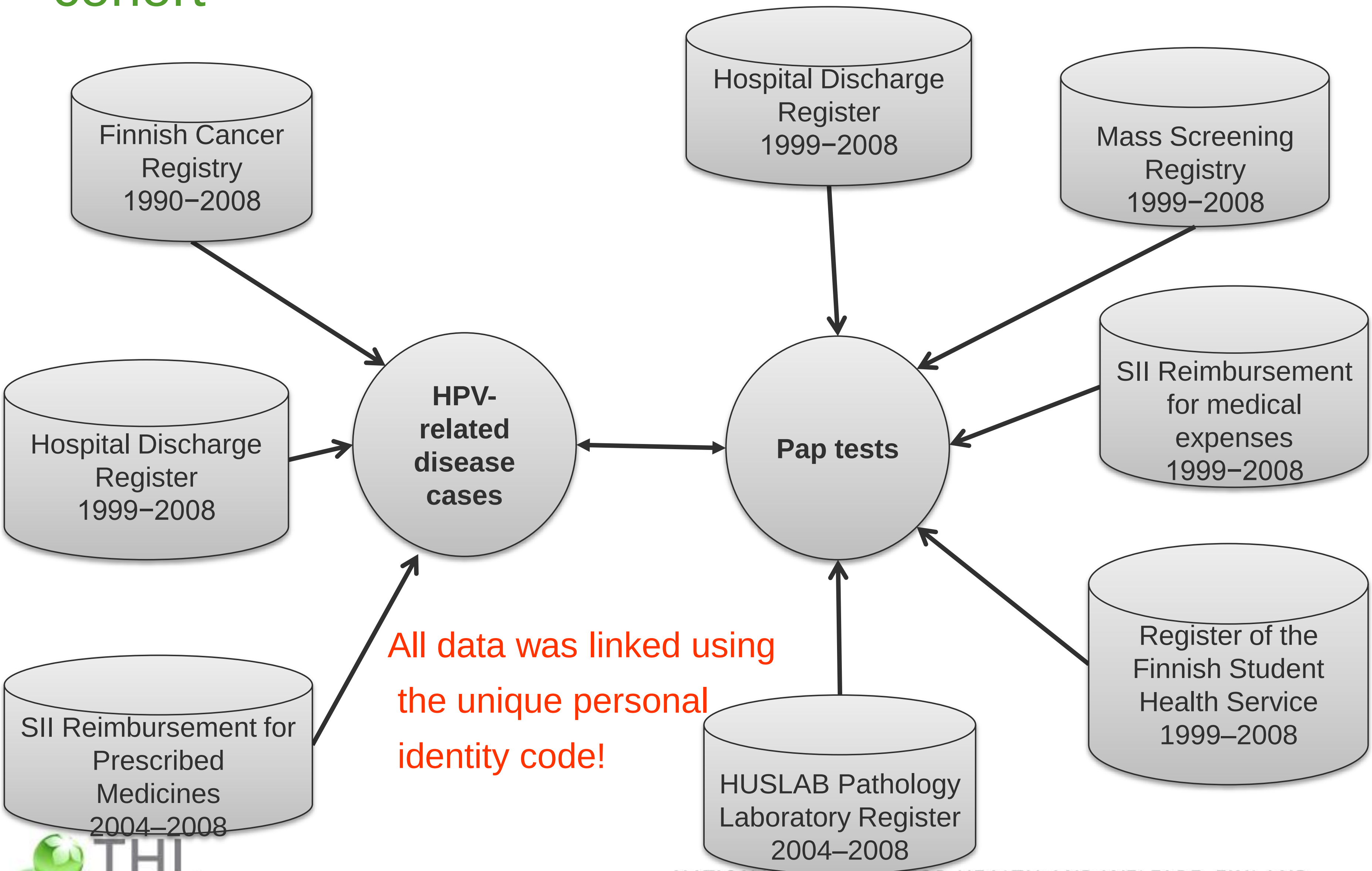
# Costing in economic evaluations

- **Resource changes** associated with disease and intervention
  - Identify, measure and value (registry data if possible)
  - Within and outside the health care sector (perspective)
- The burden of disease and costs reflect always the national (health care) system

**Direct costs:**
- ✓ Medical resources (treatment of disease, intervention)
- ✓ Non-medical resources, directly needed (e.g. transport)

**Productivity costs (Indirect costs)**:
- ✓ Patient time including productivity changes
- ✓ Time of informal caregivers

# Identification of the HPV-burden of disease study cohort




All data was linked using the unique personal identity code!

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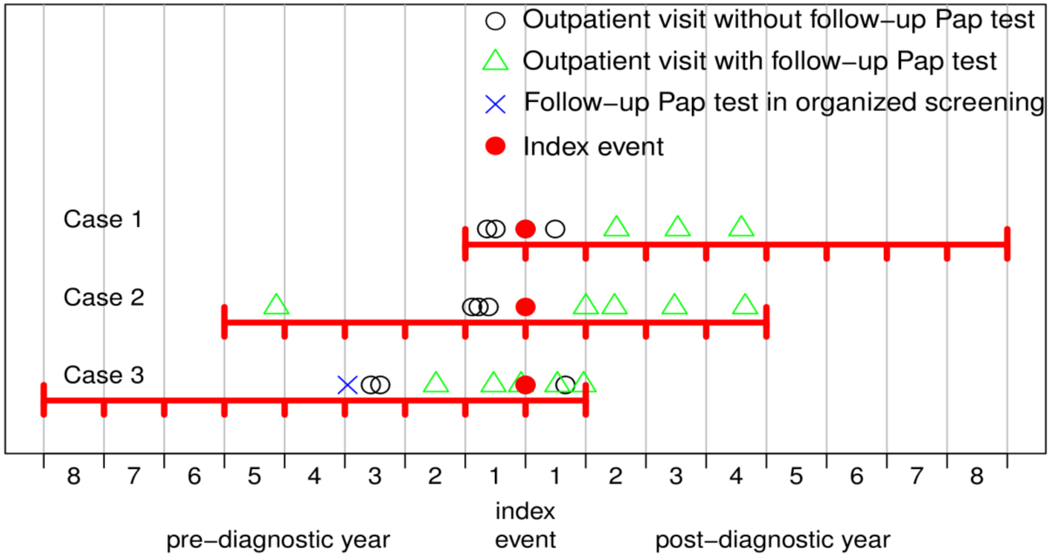
# Constructing an episode of care (CIN3)

- By linking events of a woman retrieved from different registers:
  - outpatient visits, inpatient hospitalisations, gynaecological procedures by private providers, follow-up Pap tests and Cancer Registry notifications
- The index event: the first event with a diagnosis (here CIN3) corresponding to the final classification of the episode of care



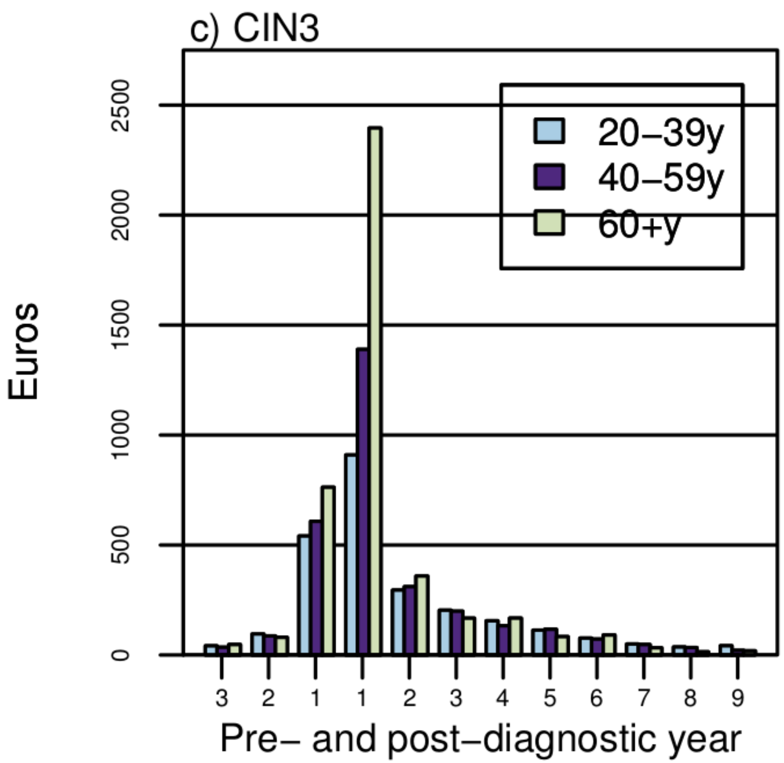

calendar year 1999-2008

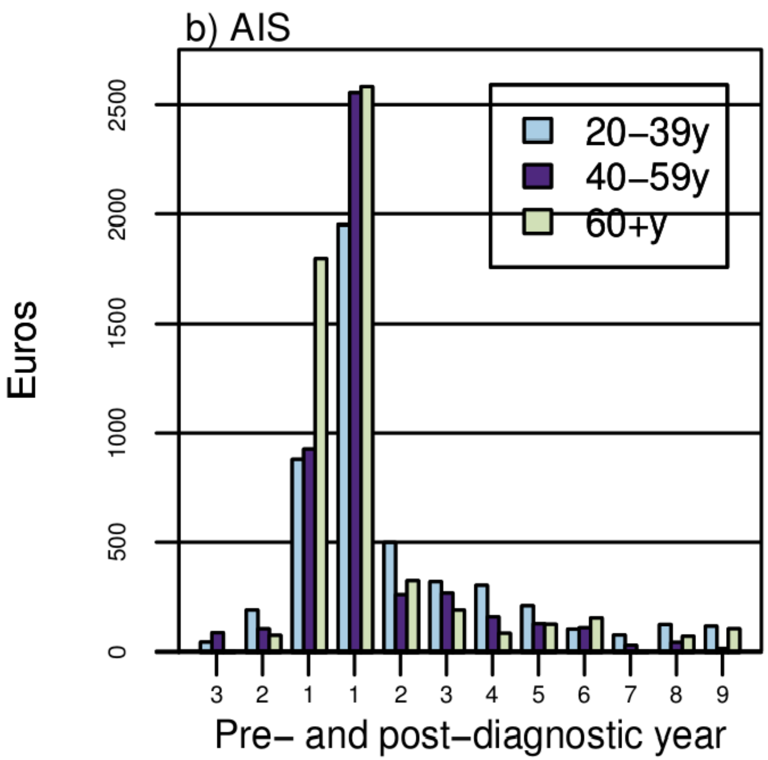
(Salo et al. IJC 2013)

# Health care service use per episode of care

- Each case = one episode of care
- Episode of care was divided into 1-year pre- and post-diagnostic periods
- Pre-diagnostic years (time before the index event)
  - diagnostic tests and procedures (excluding screening)
- Post-diagnostic years (time from the index event onwards)
  - included the index event itself, the acute phase treatment and the follow-up of the HPV outcome
- The average health care use per case was estimated from all episodes of care by outcome and age

# AIS/CIN3: Average undiscounted cost per case per pre-diagnostic and post-diagnostic year and by age-group




The average cost per case for a given HPV-related outcome was derived by summing up the average costs of the consecutive pre- and postdiagnostic years.

Salo et al. IJC 2013

# Discounting

- Adjusting costs and benefits for differential timing
- Comparison of interventions is made at one point in time
- In vaccination programmes different time profiles for costs (now) and benefits (in the future)
- Future costs and benefits are reduced (discounted) to reflect the time preference
- Time preference: we prefer to have 100 euros rather today than tomorrow (interest rates)

# Discounting

$$Present\ value\ (PV) = \sum_{t=0}^{n} \frac{C(t)}{(1+r)^t}$$

r = discount rate

C(t) = costs occuring at time t

Example: Present value of €100 costs occurring at 20 years from now is €55, when the discount rate is 3%

$$PV = \frac{€100}{(1+0.03)^{20}} = €55.4$$

The further in the future and the higher the discount rate the less impact the future events have

# Static and dynamic models

Static model:

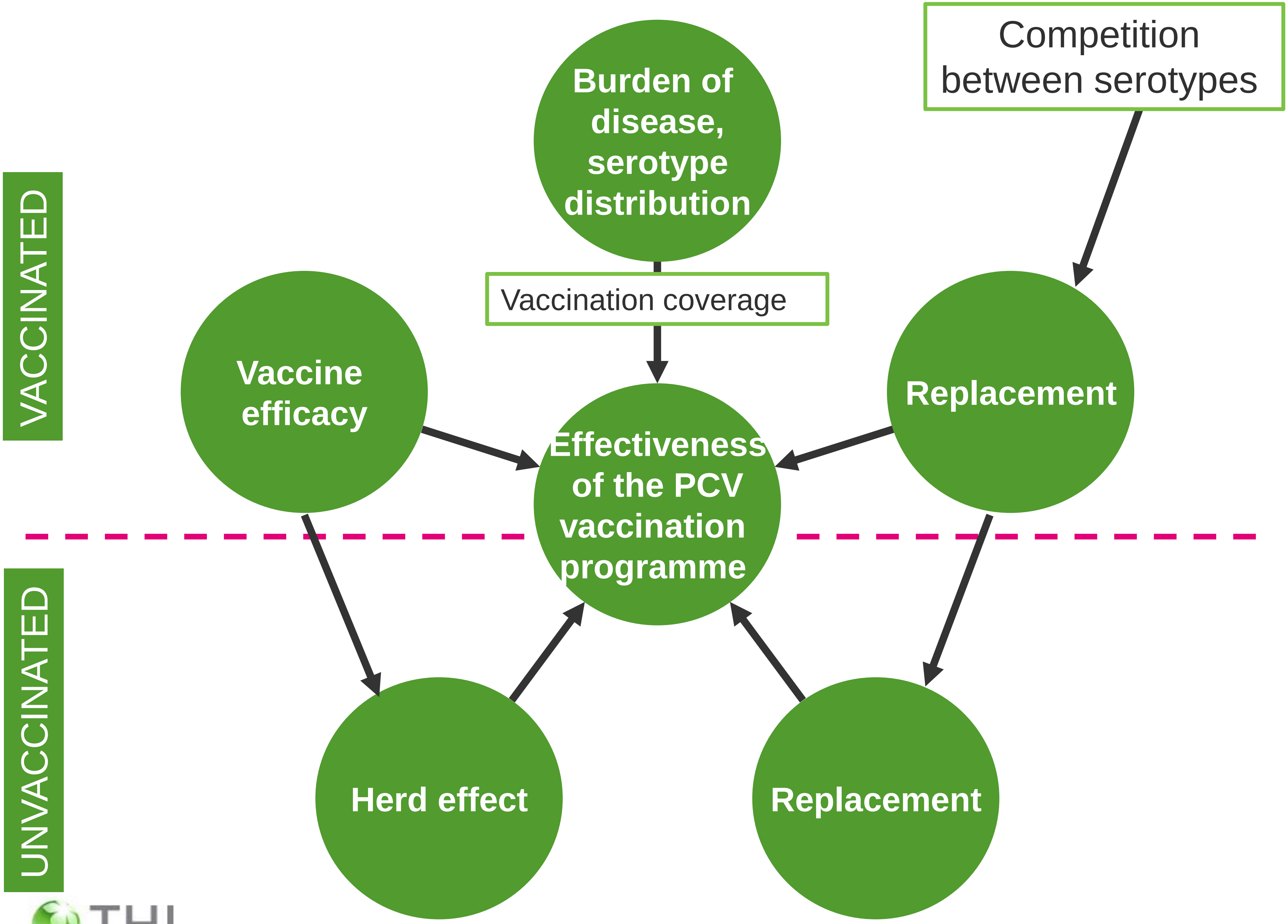
- Force of infection is independent of the proportion of the population who are infectious at each time point
- Markov cohort models
- Decision analysis models

Dynamic model:

- Force of infection is dependent of the proportion of the population who are infectious at each time point
- Herd effect impact is built in the model

# Indirect effect

- Impact on effectiveness and cost-effectiveness
- Herd effect, replacement, increase in the average age at infection due to reduced probability of infection


Competition between serotypes
Burden of disease, serotype distribution
Vaccination coverage
VACCINATED
Vaccine efficacy
Effectiveness of the PCV vaccination programme
Replacement
UNVACCINATED
Herd effect
Replacement

# What is economic evaluation needed for?

”Old” vaccines (no need but would be nice to know)

- Cheap and preventing common and serious diseases
- Obviously cost-saving
- MMR vaccination programme in Finland saves annually 457 life-years and ~€40 million in health care costs

New vaccines

- Expensive
- Not always preventing so common and/or serious diseases
- Economic evaluation needed in adopting a new vaccine and in price negotiations

# Presenting the results

- When one intervention is both more costly and more effective the trade off is made between the additional benefits and additional costs by the ICER
- Usually the situation when adopting a new vaccination programme
- If ICER is less than the maximum acceptable cost-effectiveness ratio then the intervention is considered cost-effective
- For example in UK the maximum acceptable ICER is £20,000 - £30,000 per QALY
- In Finland there is no threshold set

# Estimated cost-effectiveness of vaccination programmes in Finland

| Vaccination programme | Cost (€) / QALY gained |
|---|---|
| PCV7 | |
| No herd effect (< 5 v) | 77 000 |
| Herd effect on IPD | 19 000 |
| Rotavirus | 25 000 |
| Varicella (still pending) | 15 000 |
| Influenza (TIV, healthy children) | Cost-saving |
| HPV | Cost-saving |

Varicella vaccination has not yet been approved in the Government's budget proposal

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- Are you making the most of your resources?
- Do you know that you are choosing the right alternative from the potential options?
- Are you able to convince the decision-makers that the benefits of your program are worth the costs?

Economic evaluation can help to get answers.