Rijksinstituut voor Volksgezondheid
en Milieu
Ministerie van Volksgezondheid,
Welzijn en Sport

Risk assessment: van theorie naar beleid

Arie Havelaar en Arno Swart

Symposium
Campylobacter bij pluimvee: Recente inzichten en beleidsmaatregelen
Lelystad, 14 juni 2013

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Inhoud

Human campylobacteriosis in the Netherlands, 2011

- Population 16.7 million
- 8,490 reported cases (51.3 per 100,000)
- 108,000 population cases of gastroenteritis per year (6.5 per 1,000, compare UK 9.3 per 1,000)
- 26,000 GP consultations; 1,100 hospitalizations; 34 deaths
- Sequelae
  - Guillain-Barré syndrome 79 cases
  - Reactive arthritis 1,900 cases
  - Inflammatory Bowel Disease 23 cases
  - Irritable Bowel Syndrome 9,300 cases
- Increasing trend in incidence rate in recent years
- Disease burden 3,600 DALYs (1st among 14 food-related pathogens)
- Cost-of-illness 82 million Euros (2nd to norovirus)

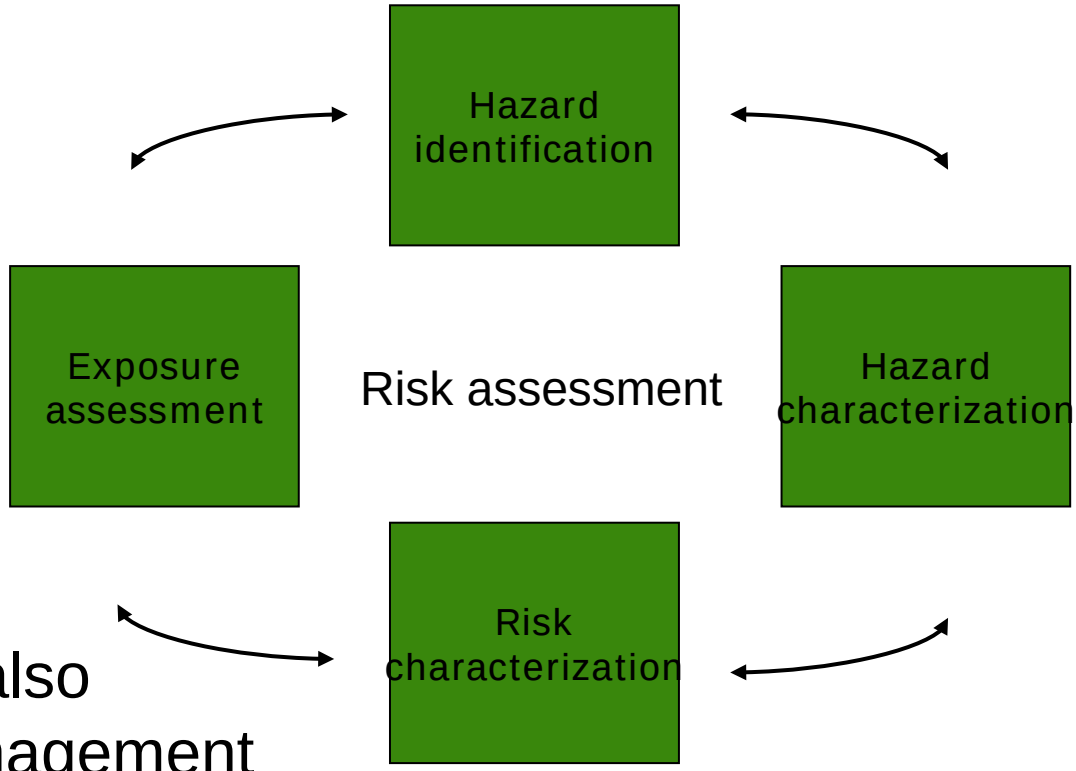
Choosing between interventions

- **Effectiveness**: a positive impact on public health?
  →Risk assessment
- **Efficiency**: at a reasonable cost?
  →Economic analysis
- **Equity**: fair for all affected parties?
  →Policy making; social sciences

Risk assessment

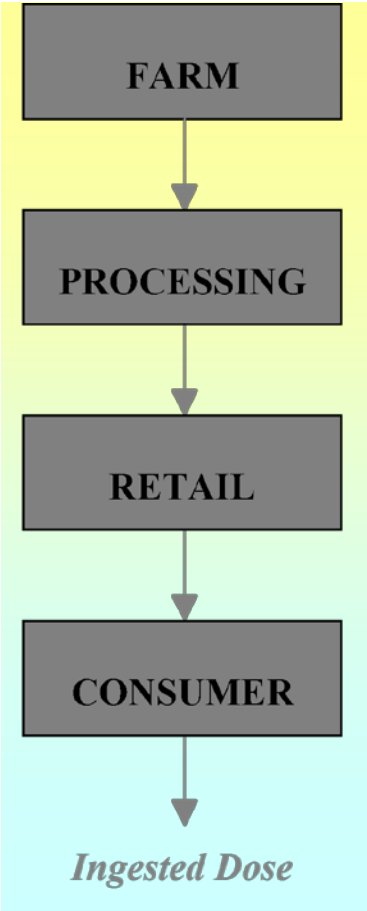
Risk assessment consists of the following steps:

- statement of purpose
- hazard identification
- hazard characterization
- exposure assessment
- risk characterization



Risk assessment is part of risk analysis, also consisting of risk management and risk communication

Farm to Fork exposure modelling…

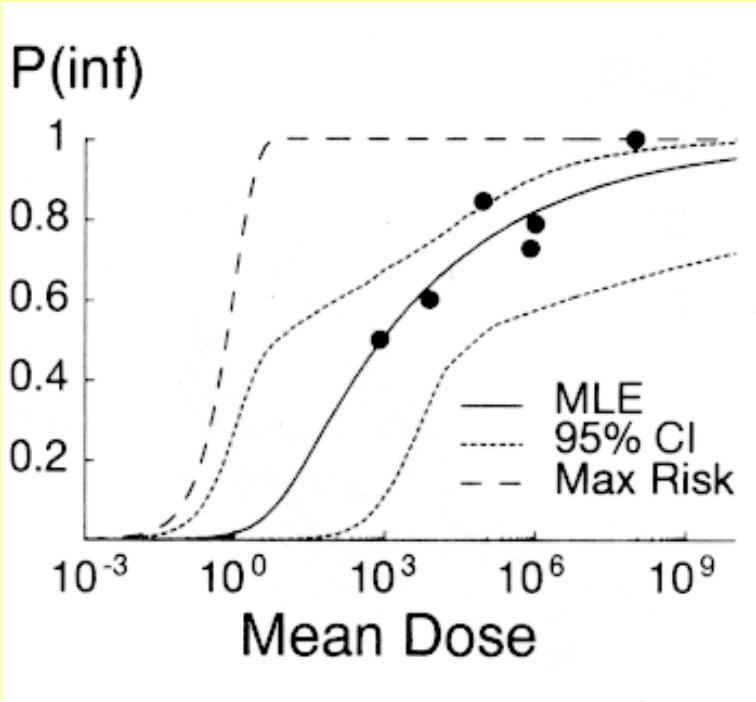


- Large and complex food chain
- Describe the transmission of a microbial hazard
  - quantitative
  - mathematical model
- Assess exposure
  - probability of exposure
  - amount of exposure
- Compare alternative scenarios
  - the effects of interventions

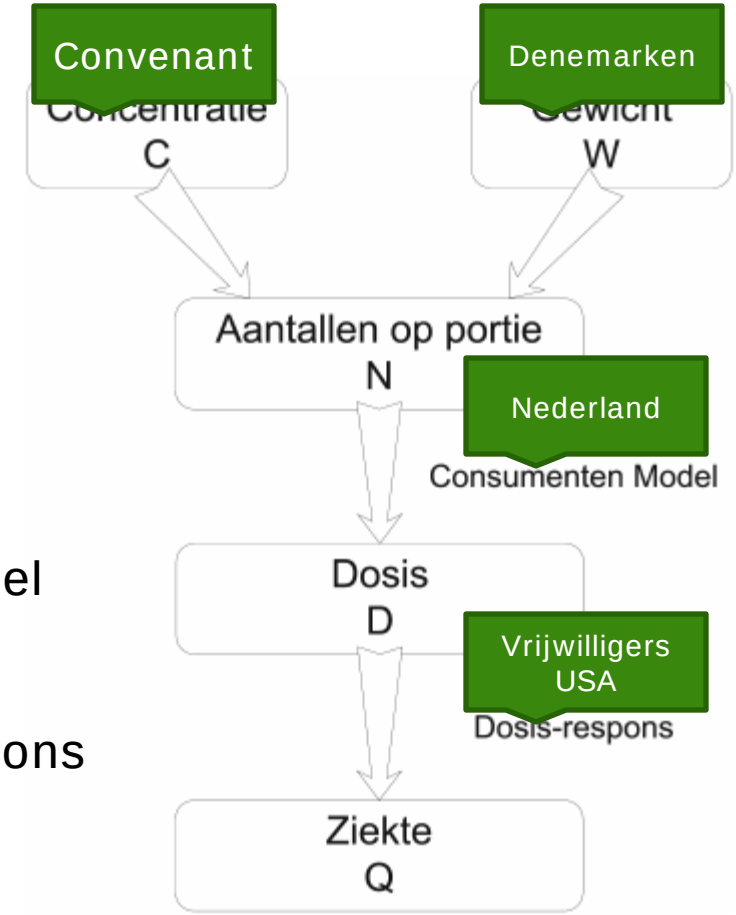
Microbial dose-response modeling

- Conditional chain of events
  - Exposure → Infection → Illness
- Single hit
- Independent action
- Random distribution

- Mathematical models fitted to data:
  - Volunteer experiments
  - Outbreaks

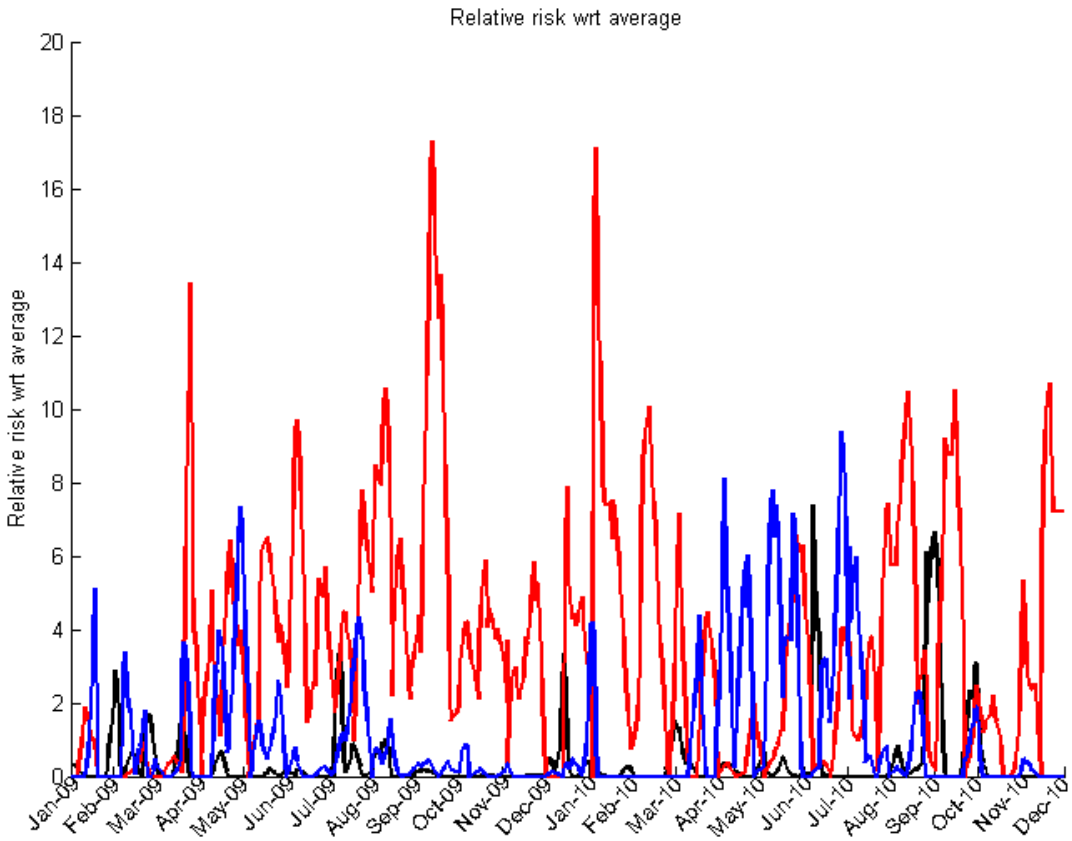


Risk assessment model Campylobacter convenant



All data in the model are variable and represented by statistical distributions

Relative risk per slaughterhouse



Process hygiene criterion

- Purpose - to control contamination of end-products in industrial slaughter plants for broiler chickens
- Point in the food chain – broiler chicken carcasses after chilling
- Microorganism -thermophilic *Campylobacter* spp.
- Microbiological limits - two-class sampling plan (*m* cfu / g is the limit between complying and non-complying batches)
- Sampling plan - number of samples (*n*), acceptance number (*c*)
- Statistical performance of the sampling plan - by risk assessment
- Analytical methods – enumeration according to ISO 10272-2

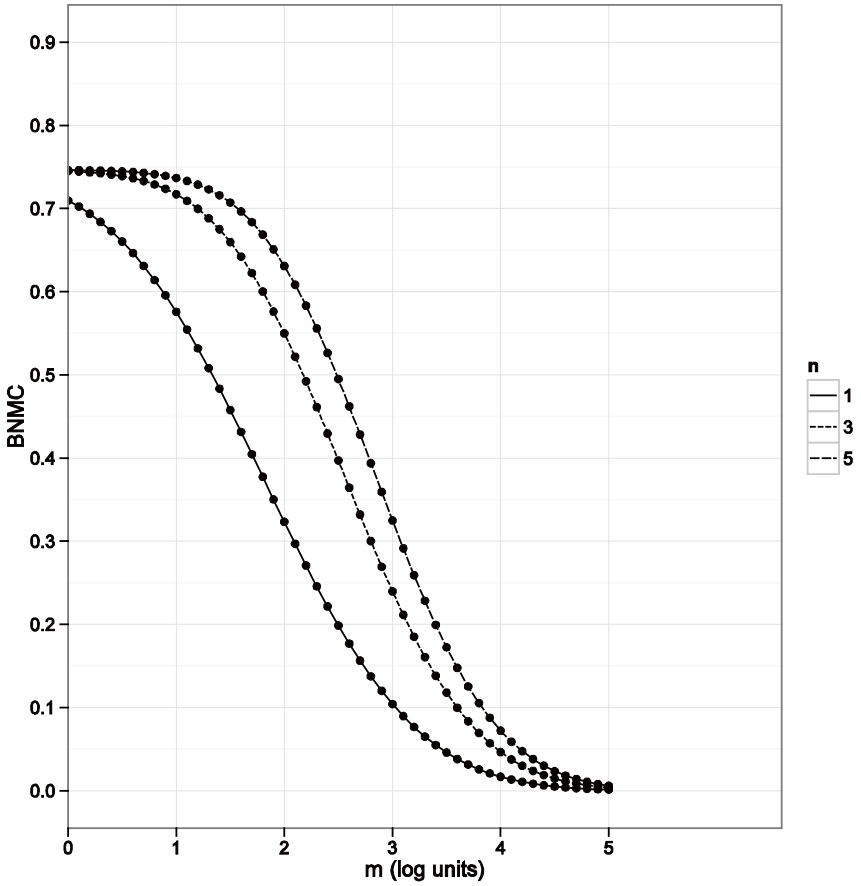
- For example, n=5, c=0, m=1000 means:
  " we sample each batch, take five samples, none of these may exceed 1000 cfu / g"

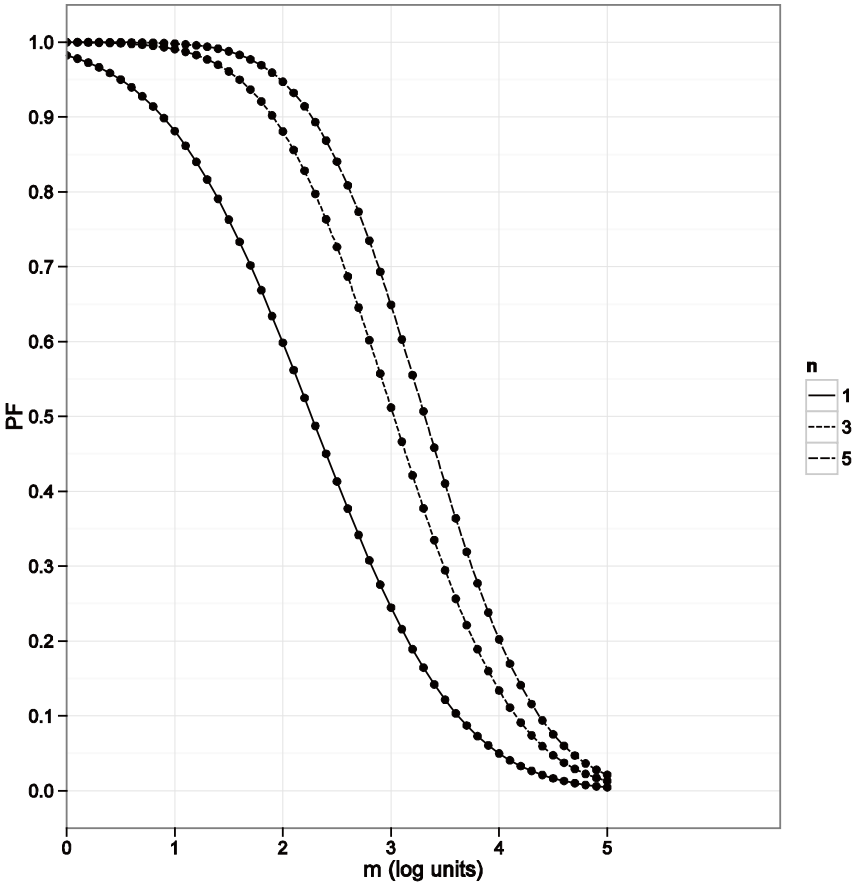
Evaluation of PHC with m = 1,000 cfu/g; n=5; c=0

Year	2009	2010
BNMC overall	32%	37%
per plant	10-62%	14-54%
PF overall	67%	72%
per plant	32-89%	38-90%

BNMC: Batches Not Meeting the Criterion
PF: Preventable Fraction

Impact of varying the critical limit in a PHC





Estimating the efficiency of an intervention

- (Direct) costs of an intervention
  - Investments and variable costs *K (in €)*
- Benefits of an intervention
  - Reduced human disease burden *Z (in DALYs)*
  - Reduced cost of human illness *W (in €)*
  - No benefits for animal health

- Cost-utility ratio $\frac{K - W}{Z}$ € / averted DALY

- Costs are discounted at a rate of 4%, and benefits at a rate of 1.5%

Efficiency of a PHC for Campylobacter on Dutch broiler meat

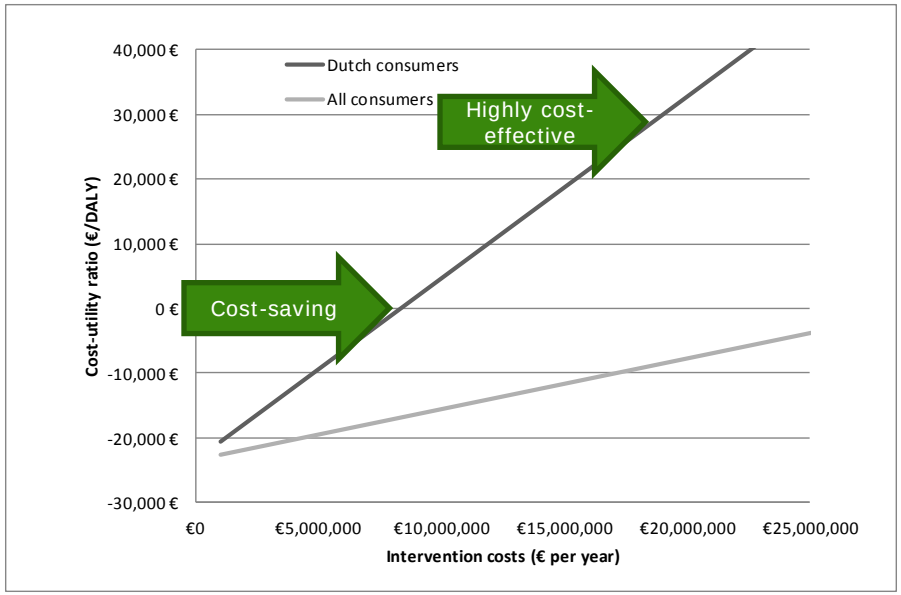
	All human cases	All broiler meat	Dutch broiler meat	Impact of PHC$
Fraction	100%	28%	56%	70%
Incidence (2011)	108,000	30,000	17,000	12,000
Disease burden (DALY)*	3,250	910	509	360
Cost-of-illness (M€)^	76	21	12	8.4
Intervention costs (M€)^				1.7
Cost-utility ratio (€ / DALY)				-18,000

* Discounted at 1.5%
^ Discounted at 4%

$ m = 1,000 cfu/g; n=5; c=0

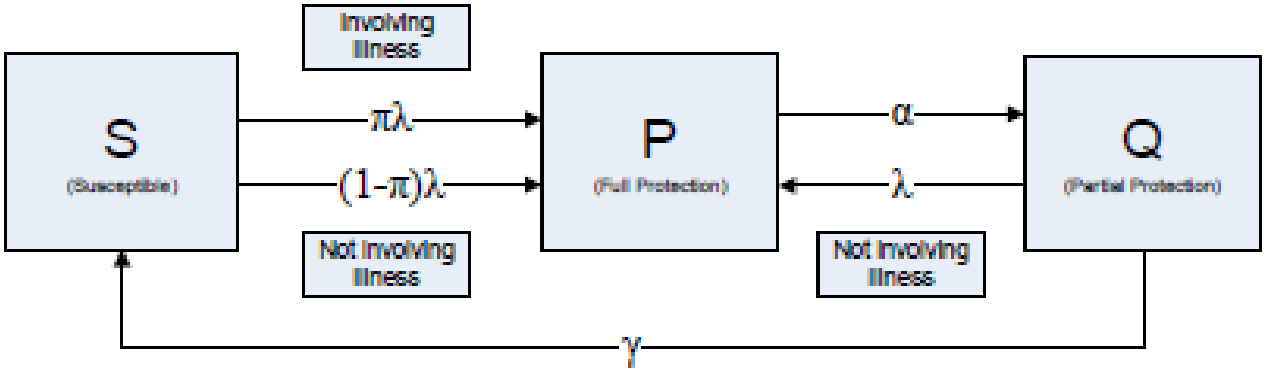
Limitations of economic analysis

- Costs are currently uncertain
- Benefits extend to consumers of Dutch poultry meat outside the Netherlands
- Benefits to Dutch consumers would increase if PHC would also apply to non-domestic fresh broiler meat



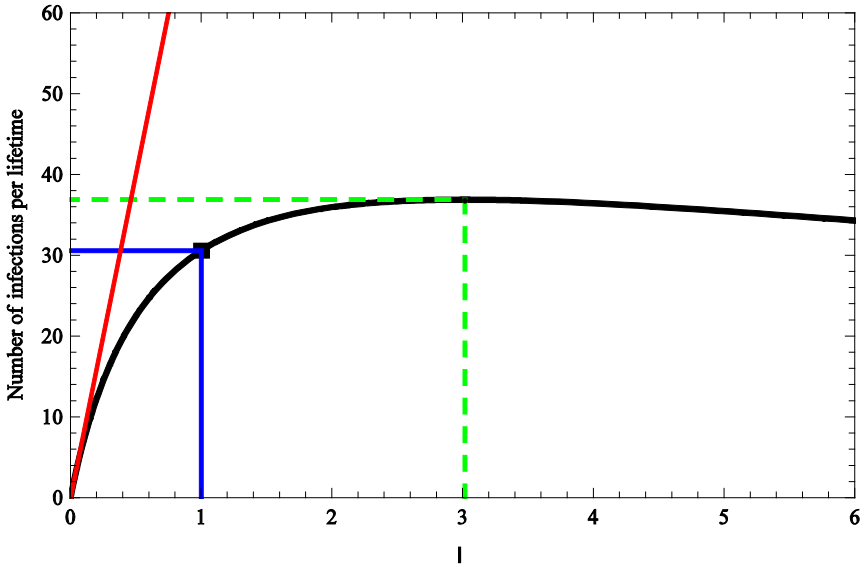
Dynamic model of Campylobacter infection

- Asymptomatic infections are common, in developing and developed countries alike
- They continuously boost an acquired immune response that protects the vast majority of exposed individuals from developing symptomatic illness
- A simple mathematical model has three states
  - S: fully susceptible (with probability π of getting ill upon infection)
  - P: fully protected
  - Q: partially protected (re-infection is possible, but without disease)
  - Exponential residence times with rates λ, α and γ



Impact of acquired immunity on disease incidence

- Define R as the number of infections per lifetime
- R as a function of the force of infection has a single maximum
- Incidence of infections reduced by a factor of 2.5 to 25
- Reducing λ may lead to increased incidence of illness



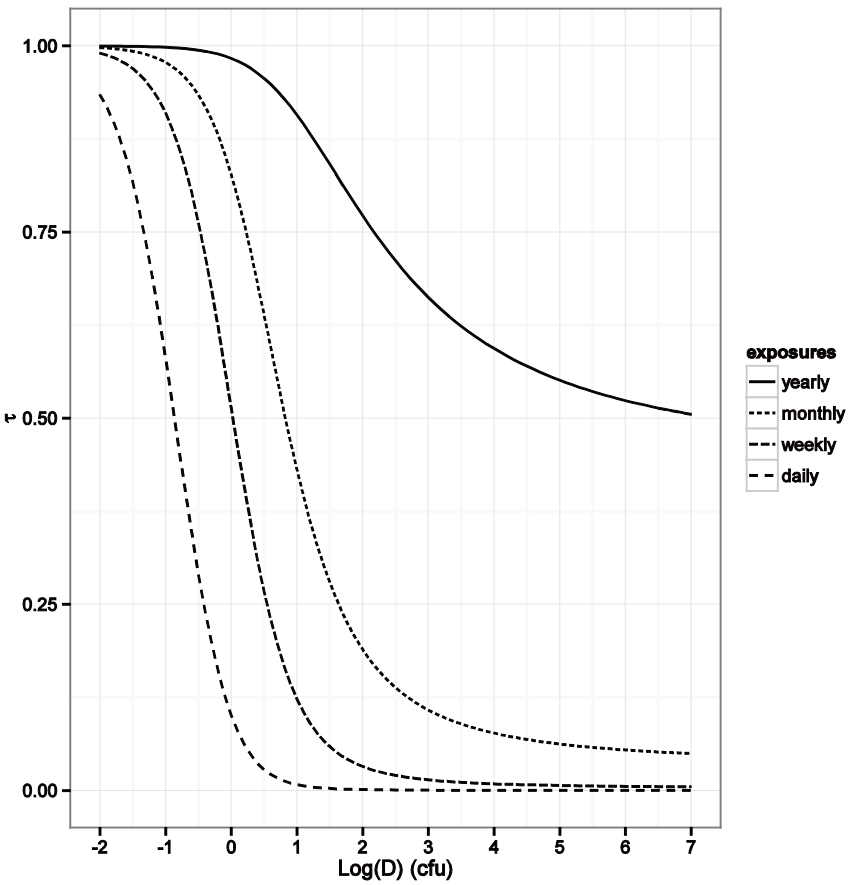
Swart et al., Epidemics 2012;4:43-47

Impact of immunity on risk assessment

- Naïve approach
  $R_n = \lambda A$
  (A = age)
- Inflation factor due to immunity

$$\tau = \frac{R}{R_n} = \frac{\alpha\gamma}{(\alpha+\lambda)(\gamma+\lambda)}$$

- Additional impact of repeated exposure to low doses



Conclusies

- De ziektelast en kosten van Campylobacter in Nederland zijn aanzienlijk
- Kippenvlees is een belangrijke, maar niet de enige, blootstellingroute
- Risicomodellering levert relevante inzichten:
  - verlagen van het aantal Campylobacter bacteriën op vers kippenvlees tot maximaal 1000 cfu/gram is een effectieve en efficiënte maatregel om het volksgezondheidsprobleem te reduceren
  - strengere grenswaarden leveren relatief minder gezondheidswinst op tegen hogere kosten

- Meer informatie: www.rivm.nl