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Livsmedelsverket • Finnish Food Authority

Probabilistic uncertainty towards risk comparisons

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Risk Assessment and Ranking of Risks in European Food Safety Systems

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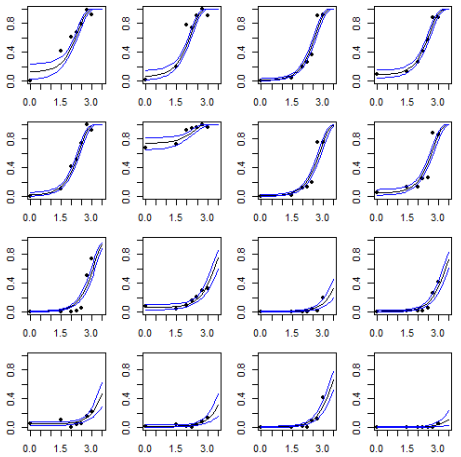
To compare chemical & microbiological risks: Bottom-up approach for both?

- Calculating from exposures to population effect. (Cause to effect).
  - Chemical hazards:
    - Chronic effect (here binary: yes/no), in a lifetime.
    - Several effects with different severity.
    - Data for chronic exposure estimation (foodborne).
    - (Animal) data for dose-response. Nonzero baseline risk.
  - Microbiological hazards:
    - Acute effects, several per lifetime.
    - Single effect (gastrointestinal illness).
    - Data for acute exposure estimation model (foodborne).
    - (Human) data for dose-response model.
  - Similar topics discussed in a former risk ranking project: https://www.efsa.europa.eu/en/supporting/pub/e210201

Unknown factors:

- Calculating from exposures to population effect. (Cause to effect).
  - Chemical hazards:
    - Chronic effect (here binary: yes/no), one for a lifetime.
    - Several effects with different severity.
    - Data for chronic exposure estimation (foodborne).
    - **(Animal) data for dose-response. Nonzero baseline risk.** **← Animal-human: equivalent dose?**
  - Microbiological hazards:
    - Acute effects, several per lifetime.
    - Single effect (gastrointestinal illness).
    - **Data for acute exposure estimation model (foodborne).** **← growth/inactivation factor?**
    - (Human) data for dose-response model.

Further simplification: aiming at comparable counts in lifetime

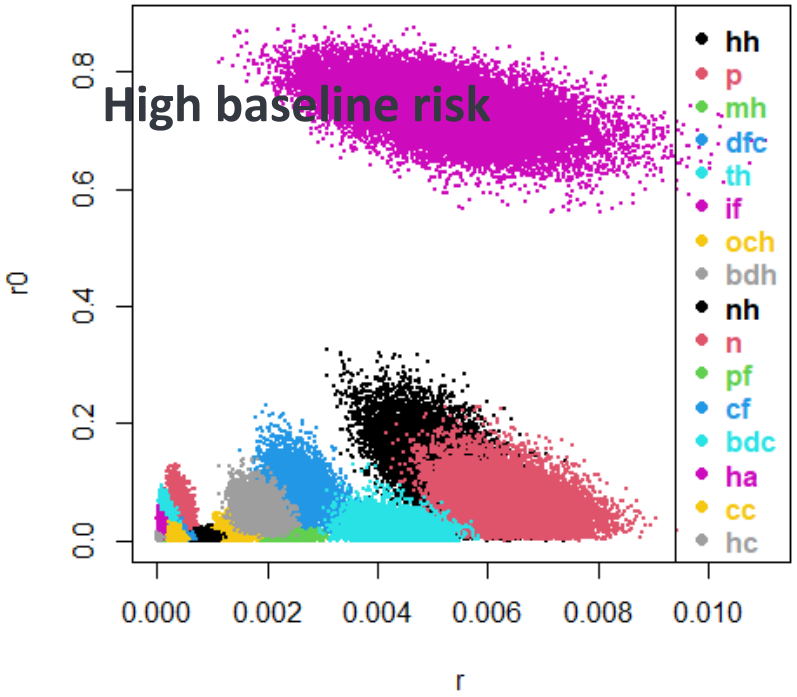


- Chemical hazards:
  - Grouping a *large number of effects* into a small number of severity categories.
  - Estimating dose-response function per each severity (=due to any effect of same severity).
  - Assume **lifetime = 80 years**. (Could also consider annual risk).
  - Only one chronic illness (or adverse effect) in a lifetime.
- Microbiological hazards:
  - Assume **lifetime = 80 years** = 29200 days. (Could also consider annual risk).
  - Acute exposure (and illness) is possible every day! (Assume no immunity).
- Common approach for ranking was discussed in:

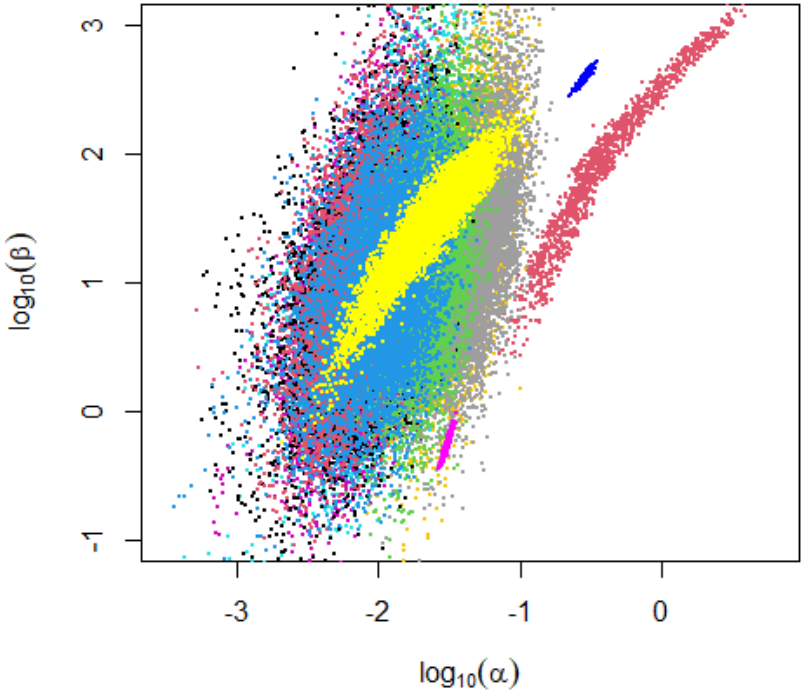
  Lindqvist et al. https://doi.org/10.1080/10408398.2019.1693957

Dose-Response:
Deriving parameter uncertainty distributions as posterior distributions P(θ|data)

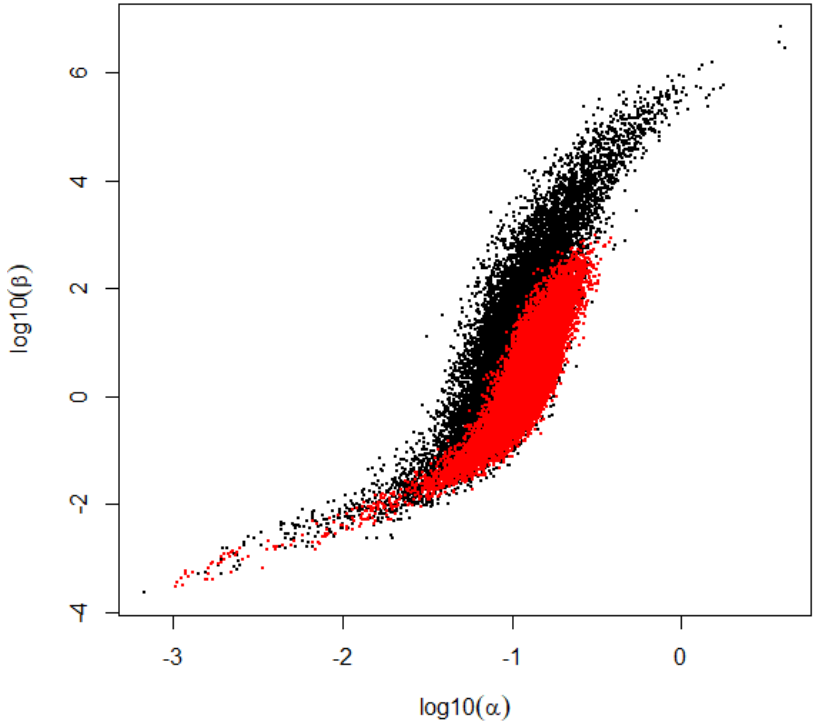
One chemical hazard, several effects



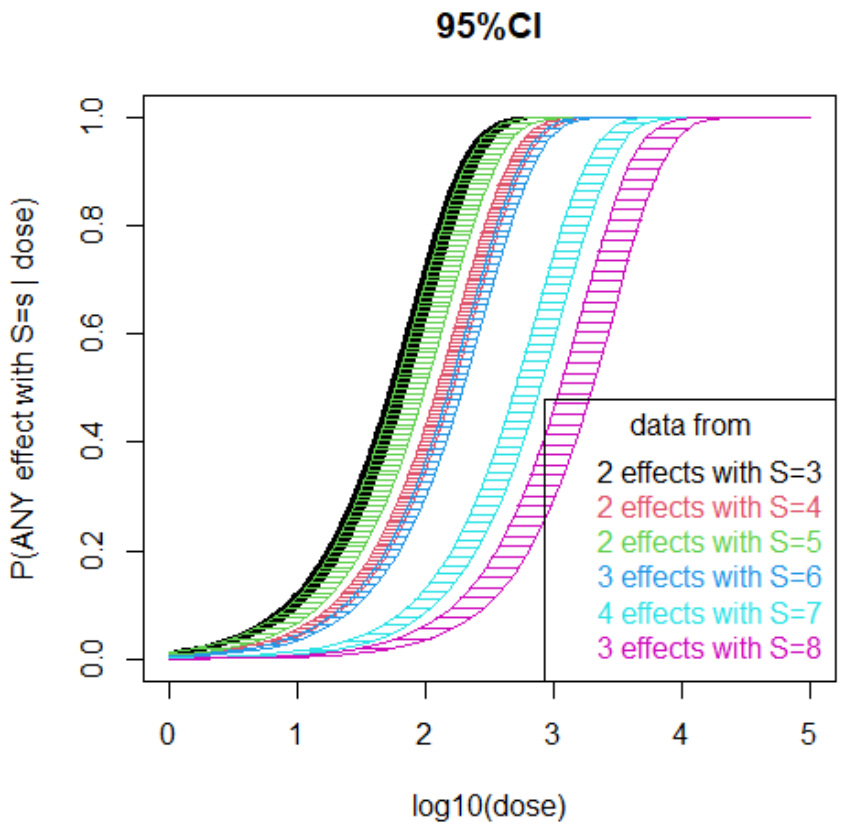
Several strains, same effect

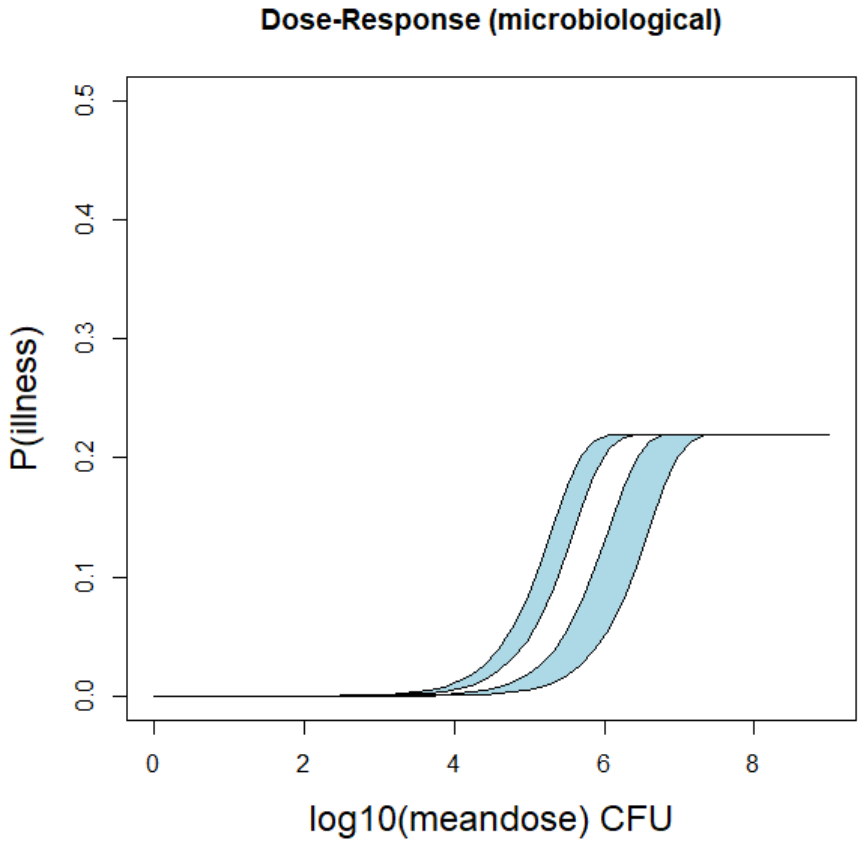


Campylobacter & Salmonella

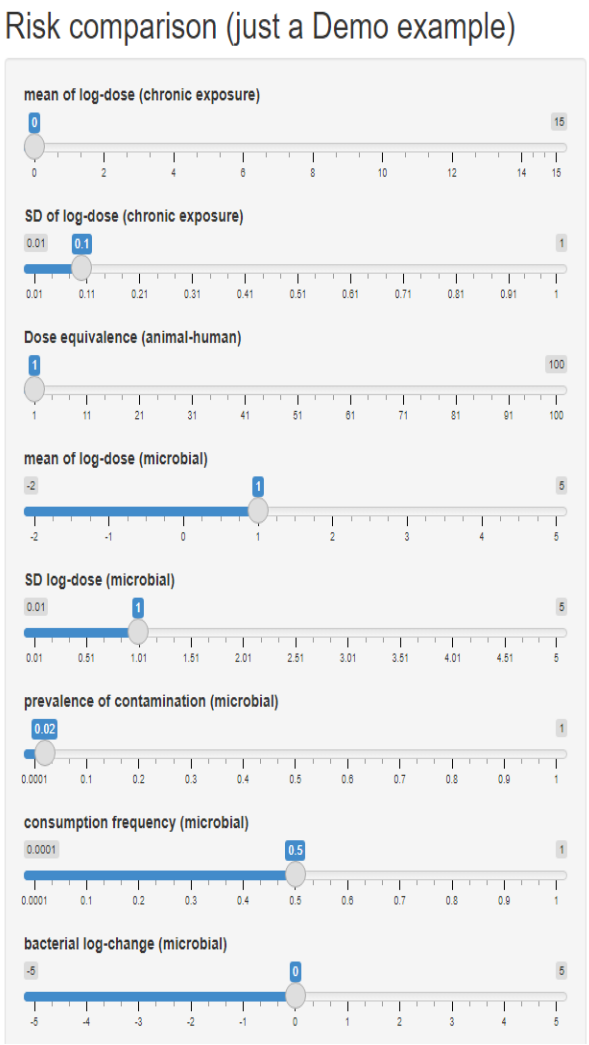


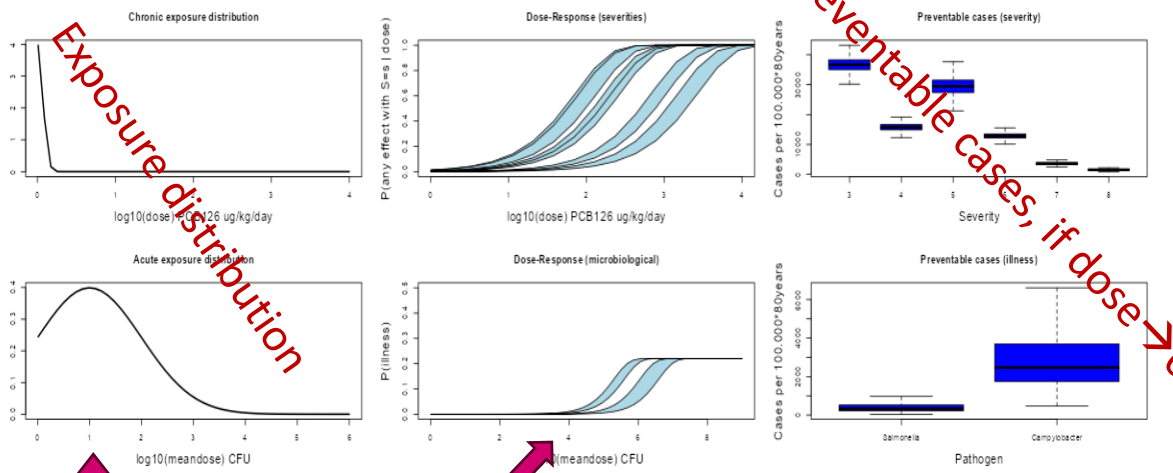
Parameter uncertainty as dose-response uncertainty





Simple comparison tool: parameter uncertainties based on models, unknown factors as scenarios





Chemical risk

Microbial risk

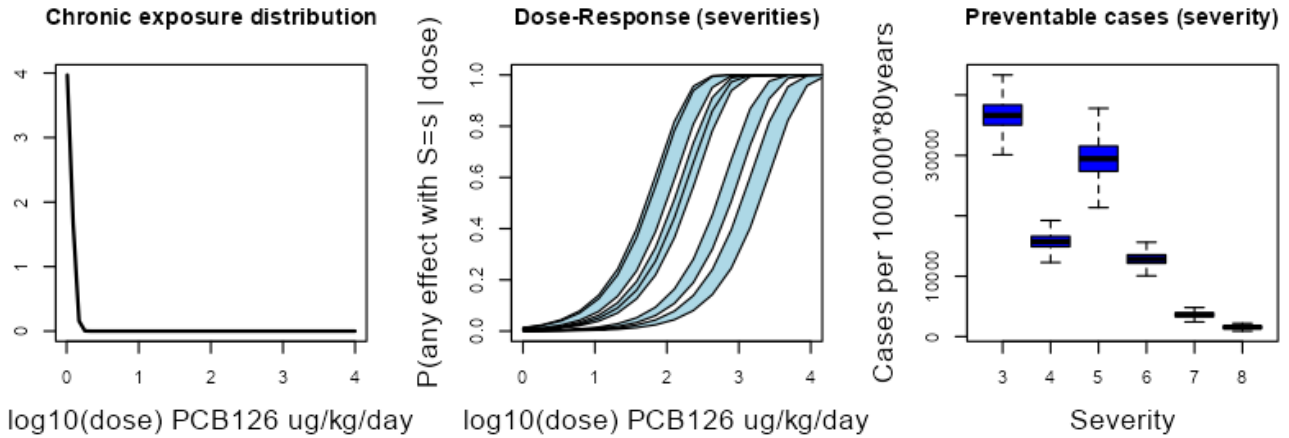
Based on Exposure models (food consumption & hazard concentration data)

Not all infections lead to illness

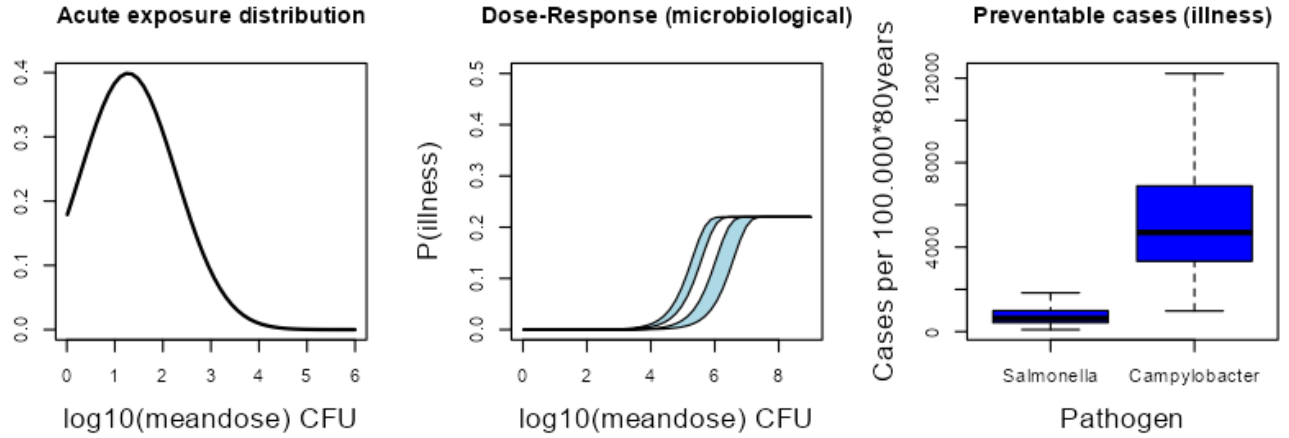
Cases in a population over lifetime → comparisons

Setting parameters for scenarios

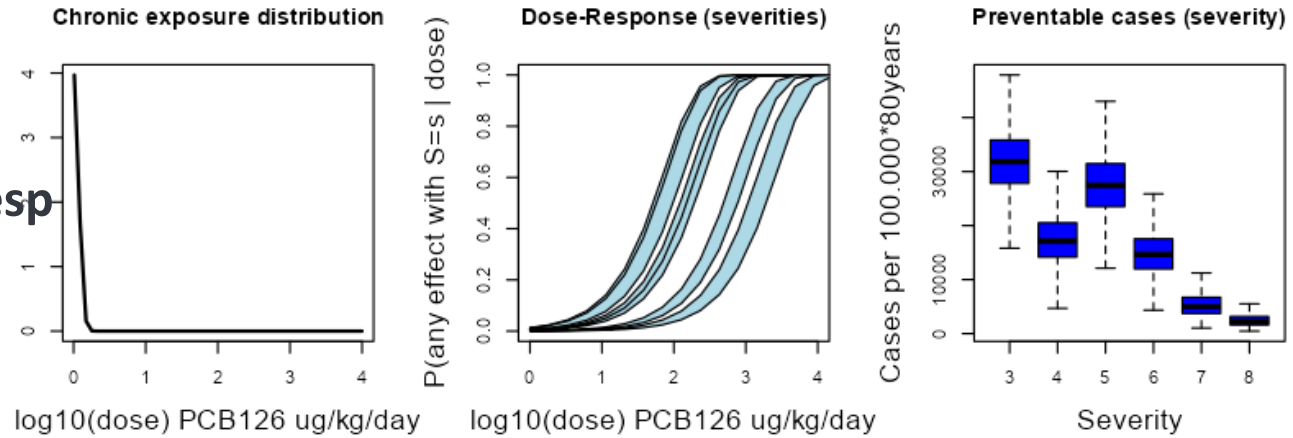
Assume human dose-resp equals animal dose-resp



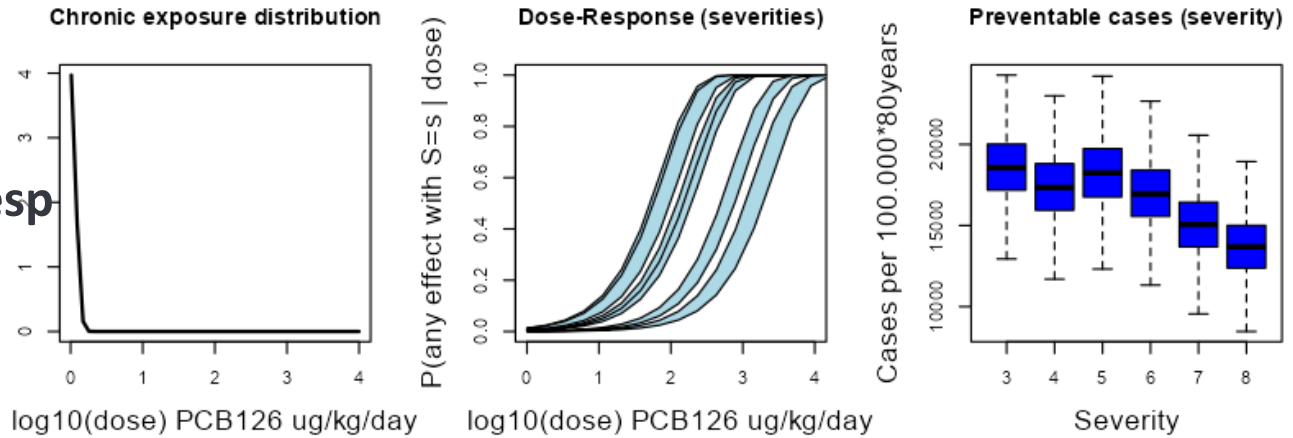
Assume no growth/inactivation occurs



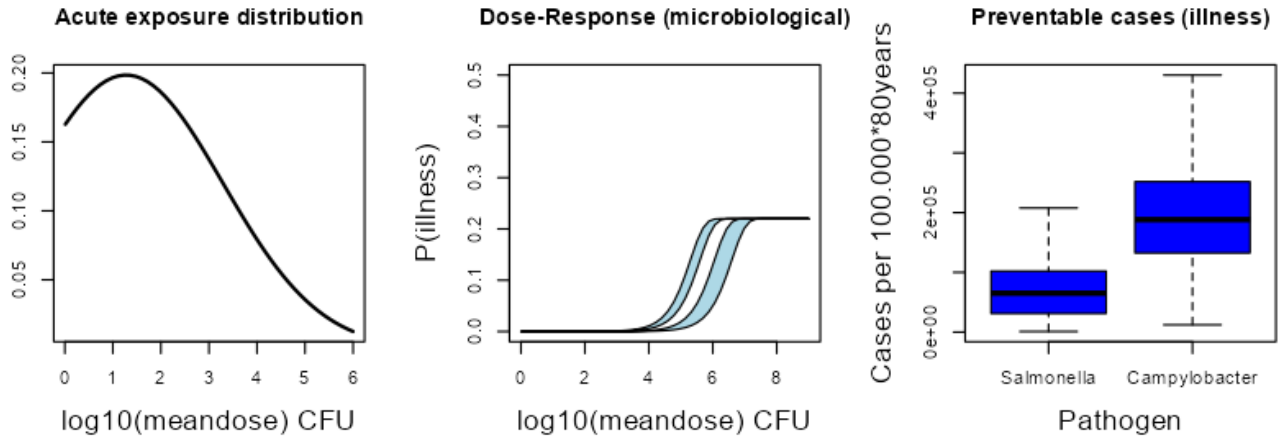
Assume human dose-resp equals 10x animal dose-resp



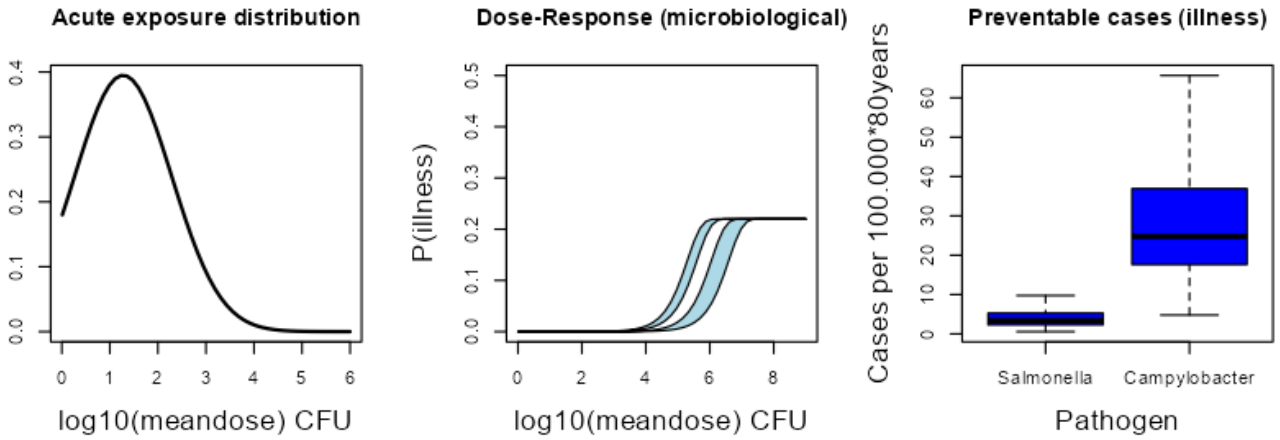
Assume human dose-resp equals 50x animal dose-resp



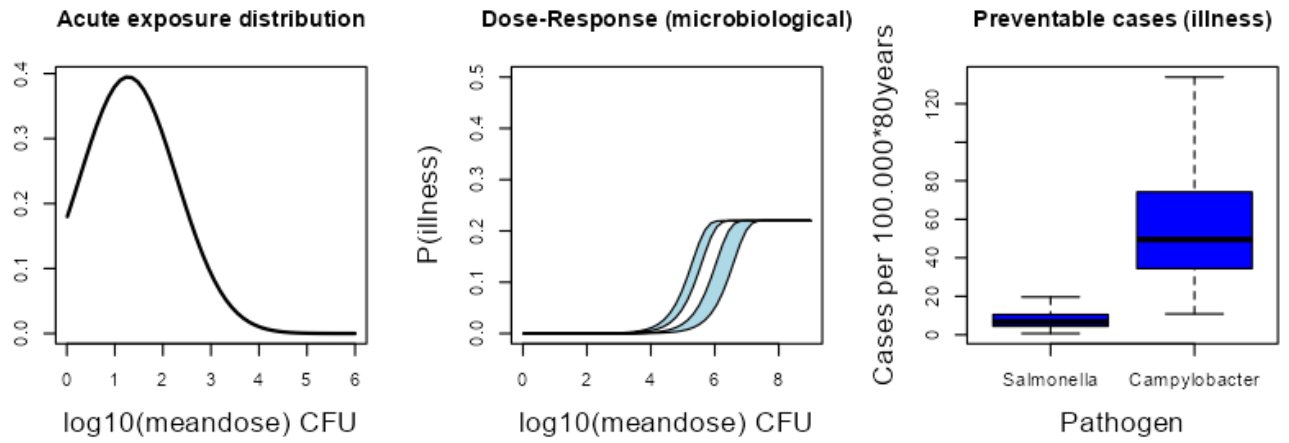
Increasing variance of CFU counts
→ More high doses → more cases



Pushing prevalence down
→ Less contaminated servings → less cases



Reducing concentrations by -2 log
→ Better hygiene → less cases



Quantifiable & unquantifiable uncertainties

- Parameter uncertainty:
  - Can be computed based on data. Bayesian models & simulations.
  - More and better data → less uncertainty.
  - Important differences: some parameters (hazards) remain more uncertain than others.
- Unknown factors:
  - Could be assessed as scenarios (worst case, best case).
  - Comparison could prove a factor to be either unimportant or important.
  - Contributes to the overall uncertainty.
- Model choice:
  - Exposure models integrated with dose-response models.
  - Different models should be compared.
  - Contributes to the overall uncertainty.

Bottom-up or top-down?

- Bottom-up:
  - Challenges due to inherent knowledge gaps along the causal pathway → tiered approach.
  - Time scales: acute (microbiological) vs. chronic (chemical).
  - Modelling of competing and dependent risks? One health condition is a precondition for another → set of effects are not independent.
    - E.g. sequelae requires illness requires infection.
    - E.g. gradually progressing health condition due to chemical exposure.
- Top-down:
  - Requires epidemiologic register data on (reported) cases. Unreported cases?
  - Requires epidemiological risk-ratios for computing population attributable fractions.
  - Source attribution methods.
- Final call: MCDA, or common metrics as DALYs if applicable?

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Thank you