A Sensitivity Analysis Framework for Health Economic Evaluation in Middle Income Countries

Appropriately Incorporating a Comprehensive Approach

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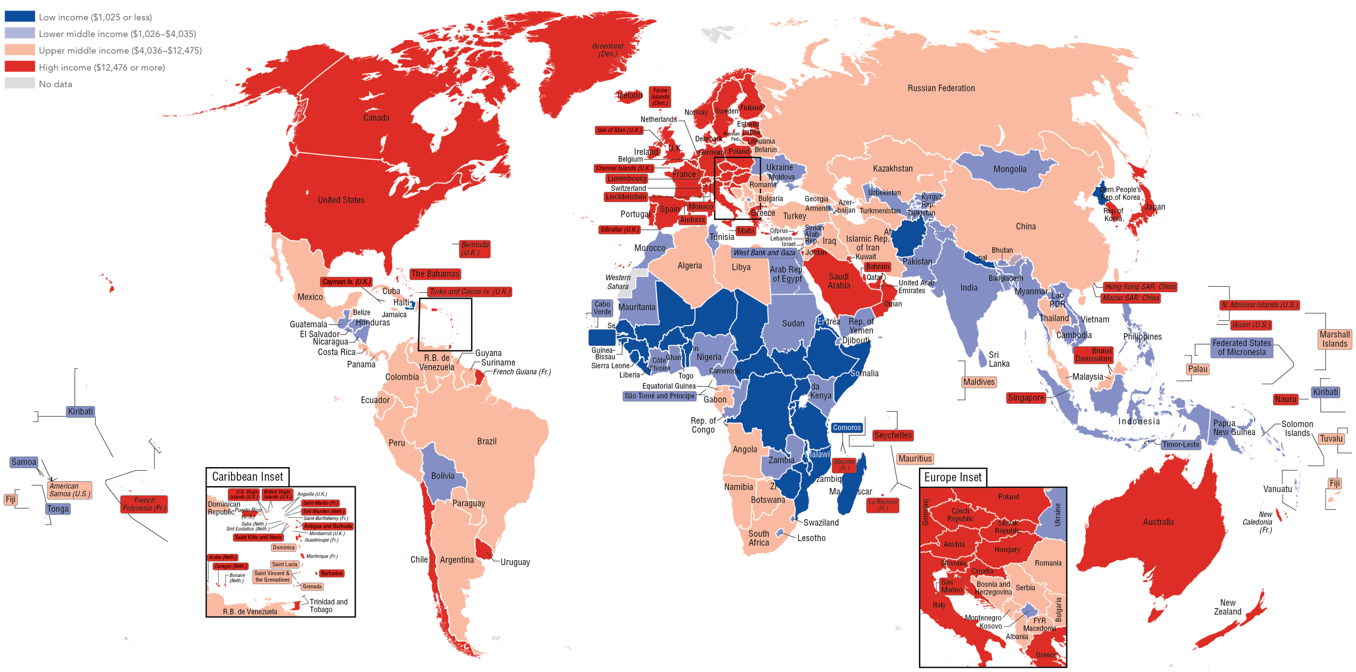
Background

As Middle Income Countries (MICs) move towards the principles of Universal Health Coverage (UHC) this will incur a rise in demand for health economic evaluation.

In addition, the burden of NCDs is expected to rise in these jurisdictions…

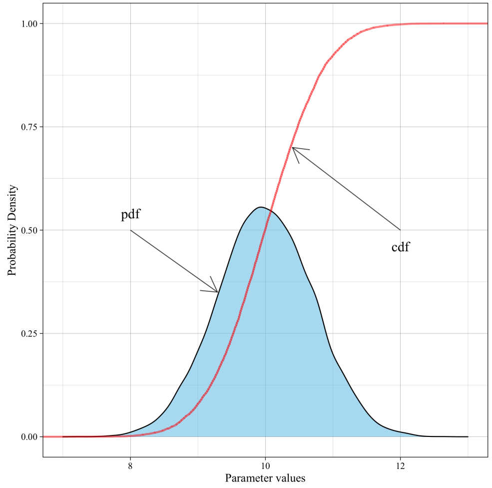
- even more pressure on strained health care budgets

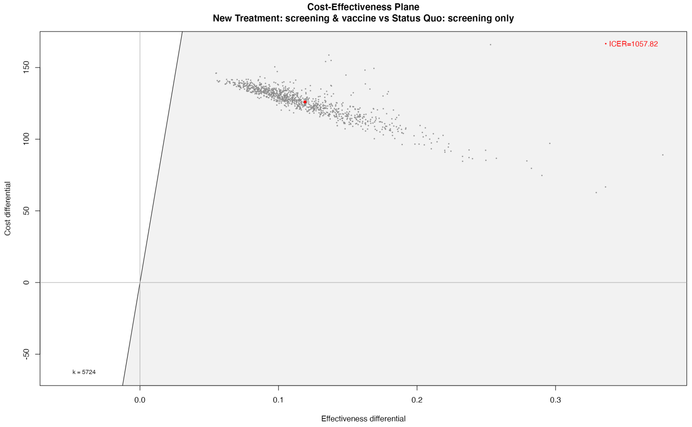


Rationale

The general MIC evaluation context also faces shortages in accessible & high-quality data

- thus, frequent imputing of data from external jurisdictions
- application of robust sensitivity analyses is critical to reflect this added uncertainty
- But, shortage in skills and research capacity
    - "time is of the essence"





Case Study

Applying more complex methods to achieving sensitivity analysis within MICs

- E.g., **comprehensive modelling**:
  - i.e., fully-Bayesian

$$p(\theta \mid y) = \frac{p(y \mid \theta)p(\theta)}{p(\theta)}$$

- combine disparate sources of evidence
- PSA is a by-product
- consistency checks

*Note: we don't distinguish between one- & two-step approaches

Pros and Cons in MICs:

- Better reflection of uncertainty
  - especially in terms of evidence synthesis
- But more advanced skills required
  - and thus greater opportunity for modelling error
- Purpose specific software is needed (perhaps not familiar)

Case study continued...

Replicated a deterministic model using comprehensive methods.

```
### SUB-MODEL 2: POP. LEVEL VACCINE-EFFICACY.
# Note: this is a fully integrated Bayesian model, as it combines
evidence directly via the likelihood and a prior.
  for (i in 1:Nstud.vac) {
    # Likelihood:
     rA.vac[i] ~ dbin(pA.vac[i], nA.vac[i])
     rB.vac[i] ~ dbin(pB.vac[i], nB.vac[i])

    # Logistic link function:
     logit(pA.vac[i]) <- mu.vac[i]
     logit(pB.vac[i]) <- mu.vac[i] + delta.vac[i]

    # Average effect prior for SUB-MODEL 2:
     mu.vac[i] ~ dnorm(0, 1e-4)
    # Prior for sub-model 2 (Random. pop. effect):
     delta.vac[i] ~ dt(psi.vac, prec.vac, 1)
     # if desired can be ~ dnorm(psi.vac, prec.vac)

     ### Mixed predictive check for SUB-MODEL 2:
       # Predictive likelihood:
        rA.mxd[i] ~ dbin(pA.new[i], nA.vac[i])

       # Predictive logit link function:
        logit(pA.new[i]) <- mu.vac[i] + delta.new

       # Mixed predictve p-value:
        pA.mxd[i] <- step(rA.mxd[i] - rA.vac[i]) - 0.5 *
equals(rA.mxd[i], rA.vac[i])

  }

   # Hyperpriors for SUB-MODEL 2:
    psi.vac ~ dnorm(0, 1.0e-4)
    prec.vac <- pow(tau.vac, -2)
    tau.vac ~  dt(0, 1, 1)T(0, )

  # Transformations for SUB-MODEL 2:
   # Convert LOR to OR
    OR.vac <- exp(psi.vac)
   # Convert OR to probability for vaccine efficacy
    pEfficacy.vac <- 1 / (1 + OR.vac)

     # Predicted average
     # treatment effect:
      delta.new ~ dnorm(psi.vac, prec.vac)

### END OF SUB-MODEL 2.
```

Resulted in:

- reduced costs in status quo but greater costs for alternative
- vice versa for benefits
- ICER $\approx$ \$1000 more versus original estimate
- model with 30 health states consistently ran $\leq$ 1 minute
- but > 2000 lines of code

And... using complex approach did not *practically* change overall decision...

Overview of framework

So, we advocate a bang-for-buck ideology, based on the concept of *Occam's Laser*. The framework rests on several features which we relate to using different sensitivity analysis methods and software:

- **Decision-Maker Preferences** (Decision Power, Investment, Risk Preference)
    - considers the preferences of the decision maker and fiscal demands of the technology
- **Analytical Considerations** (Available Resources, Indirect Evidence)
    - considers the analyst's own toolbox and the use of indirect evidence
- **Policy Context** (Knowledge of Topic, Technical Expertise)
    - considers the decision-maker's own expertise and how more complex models may be received

Overarching purpose: given time and resource constraints within MICS, to relate different approaches to achieving a sensitivity analysis to different software

Relating back to R for HTA

The framework relates the pros and cons of different sensitivity analysis methods to different software

For example:

- more complex tools desire more purpose-specific software to be efficient, e.g., if
- an evidence synthesis
- VOI; and

  probabilistic sensitivity analysis are desired…

In R, we can produce:

- more complex models;
- more robust synthesis methods; and
- more coherent model structures

… without significant time trade-offs

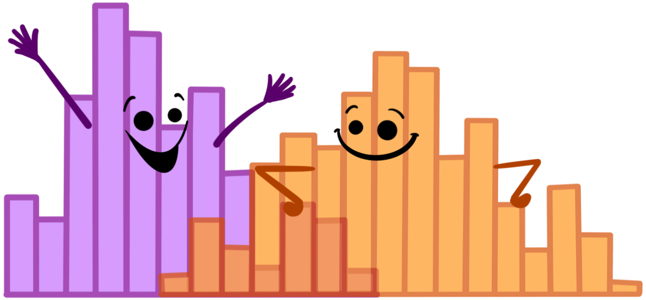


*Illustration by Allison Horst

Thank you!

Questions?

*Illustration by [Allison Horst]