Bridging the gap between evidence and policy for AMR: How models can aid AMR containment decision-making

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RADAAR: Virtual Workshop – Southeast Asia
AMR containment decision-making

What do we want to know?
- where AMR is coming from?
- how much from where?
- what impact will different AMR containment decision-making have?
- what will it cost?

Not AMR are equal...

How can we find this out?
- data analysis
- statistical model frameworks
- mathematical modelling
What is a model?
What are the risk factors for carriage of resistant bacteria?

Example

- **Bug:** *Staphylococcus aureus*
- **Resistance:** Methicillin resistant (MRSA)
- **Setting:** Europe
- **Problem:** MRSA transmits between humans in hospitals (“model”), but getting more MRSA infections in community
- **Question:** How much is linked to hospital transmission?
- **Policy:**
  - Hospital linked: target control there.
  - Not hospital linked: where is it coming from? What can we do about this?
- **Method:**
  - Statistical modelling to extract the contributions of different risk factors
AMR transmission model

Risk factors

Carriage of AMR

Statistical modelling

Multilevel modelling

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Model 1: AMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>No resistance (0) versus resistance to at least one antibiotic (1)</td>
<td></td>
</tr>
<tr>
<td><strong>OR</strong></td>
<td><strong>95% CI</strong></td>
</tr>
<tr>
<td>Age Patient (quartile 1 = ref category)</td>
<td>0.88*</td>
</tr>
<tr>
<td>Gender Patient (male = ref category)</td>
<td>0.97</td>
</tr>
<tr>
<td>Number of GP visits (0 visits = ref category)</td>
<td>1.13</td>
</tr>
<tr>
<td>Work: Nursery</td>
<td>0.84</td>
</tr>
<tr>
<td>Work: Health care</td>
<td>1.03</td>
</tr>
<tr>
<td>Work: Livestock</td>
<td>1.08</td>
</tr>
<tr>
<td>Living with children (no = ref cat)</td>
<td>1.18</td>
</tr>
<tr>
<td>Skin condition</td>
<td>1.0</td>
</tr>
<tr>
<td>Prescriptions Total (quartile 1 = ref category)</td>
<td>1.04</td>
</tr>
<tr>
<td>% Penicillin (quartile 1 = ref category)</td>
<td>1.09*</td>
</tr>
</tbody>
</table>

*significant p<0.05

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DATA

Samples

Medical records of antibiotic usage & healthcare contact

MRSA

Demography

Evidence

Penicillin use at the GP level

Variation between countries

Implications for policy

Target primary care use

National plans

Case study

How many people carry drug-resistant bacteria?

Example
- Bug: *Mycobacterium tuberculosis*
- Resistance: Multi-drug (INH/RIF) (MDR-)
- Setting: Global
- Problem: Cannot sample the bacteria causing latent infection, but big risk factor for subsequent diseases.
- Question: How much latent infection is with MDR-TB?
- Policy:
  - Who should we give prophylactic therapy to?
  - Where is MDR-TB coming from? Latent reactivation?
- Method:
  - Mathematical modelling
  - Trend data analysis + cohort simulation model
Mathematical modelling

Understanding

Interventions

Decisions
Mathematical modelling

How much latent infection is with MDR-TB?

MDR-TB going up

TB burden going down

MDR/RR-TB detected

Incident MDR/RR-TB cases

Age going up

80% protection from re-infection

MDR-LTBI burden

Apply ARI to age structured cohort model

Prevalence of drug-susceptible-LTBI
Prevalence of MDR-LTBI

Evidence
Younger ages high MDRLTBI
3/1000 carry MDRLTBI

Implications for policy
Age based
To tackle TB need to tackle latent

Modelling for AMR containment decision-making

- Modelling provides the link between data and evidence for decision making

- Complex relationships can be written in a concise and precise way And analysed with existing methods to generate clear results

- Rigour of mathematical / statistical model supports better decision making (e.g. uncertainty quantification)

- Important to know what the problems are and the appropriate or relevant data to collect for what decision-making evidence
Conclusion

We all have models of how things work – writing them down mathematically improves their quality and our understanding of the world.

Thanks to MDR-LTBI co-authors: Rein Houben, Finn McQuaid, Pete Dodd

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Any questions?