Modelling the Potential Costs & Benefits of Protecting an Island Nation from Extreme Pandemic Threats

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Background: Global trends

• Population growth: 1 → 7+ billion in ~100 years
• Growth of jet travel volumes
• Climate change → favours some infectious diseases & environmental refugees
• Expansion of settlements in wilderness areas; disturbing microbial ecosystems
• Biotechnology & potential for bioweapon development
Global air traffic volumes
Border closure for pandemic control

- Generally not supported in the international literature and IHR – high failure rate & economic harm
- But this literature hardly considers island nations
- Border closure actually worked on occasions in 1918 influenza pandemic (islands, military bases)
- There could be time to close borders in some modern day scenarios eg, the spread of SARS was slow enough
Aim & Methods (Study 1)

**Aim:** To estimate costs & benefits of complete border closure in response to pandemic threats for NZ

**Methods:**
- Cost-benefit analysis, spreadsheet model (Excel)
- Epidemiological data – past NZ pandemics
- NZ data on: health costs, valuation of life, tourism revenue

Key assumption: End to international tourism but shipping and cargo flights continue (but crew don’t disembark)
Results (Study 1)

**Threat:** Pandemic A with **half mortality** rate of 1918 influenza pandemic:

**Intervention:** 26 weeks of successful border closure (tourism ends; healthy year-of-life valued at $45,000 [GDP/capita]):

- Net societal benefit of **NZ$11 billion**

**Threat:** Pandemic B with **10 times above mortality rate**

**Intervention:** Border closure + *trade also stopping* *(scenario)*

- Net societal benefit of **NZ$54 billion**
Aim & Methods (Study 2)

Aim: To estimate the costs & benefits of complete border closure in response to pandemic threats for NZ – but using NZ Treasury’s CBAX model

Methods:
- CBAX model – includes productivity, welfare payments, tax revenue
- Cost data as in CBAX
- Epidemiological parameters (as per Study 1)

Further methods details on request: Boyd et al. Economic evaluation of border closure for a severe pandemic threat using New Zealand Treasury methods. (Submitted manuscript)
Results (Study 2)

**Threat:** Pandemic A

**Intervention:** 26 weeks of successful border closure (tourism ends; CBAx methods/costs, 50y time horizon, 6% discount rate):

- Net societal benefit of **NZ$7.9 billion**

**Threat:** Pandemic B

**Intervention:** Successful border closure

- Net societal benefit of **NZ$144 billion**
Results (Study 2): Cost-utility analyses

Threat: Pandemic A

Intervention: Successful border closure

- ICER (societal perspective) $14,400 per quality-adjusted life-year (QALY) gained
- ICER (health system perspective but with tourism losses included): $51,300 per QALY
Limitations of this work

- Border closure may fail (but even failure after 1-2 weeks may provide some time for preparations); failure risk might decline with drone cargo ships
- NZ Treasury model – doesn’t value the future as much as standard analyses (DR=6% vs 3%)
- Hard to cost trade disruptions eg, some products can be left growing (eg, trees), others can be stored (eg, milk powder).
Possible implications

1. Island nations could reasonably plan for border closure (including laws that protect politicians from legal action & allow compensation to tourism sector)

2. NZ could work to produce better international guidance (eg, via WHO) for island nations around border closure & pandemics
Conclusions

1. Two different modelling approaches suggest high net societal value in border closure for NZ – for severe pandemic threats

2. All such modelling has limitations – but historically border closure has sometimes worked

3. Island nations could reasonably plan for border closure
Selected new results for the prevention of two pandemic scenarios via border closure for NZ (using CBAx, net present values, discount rate = 6%) (Boyd et al *Submitted manuscript*)

<table>
<thead>
<tr>
<th>CBA / CUA</th>
<th>Scenario A Pandemic (similar to 1918)</th>
<th>Scenario B Pandemic (10 x the severity of 1918)</th>
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<tbody>
<tr>
<td><strong>CBA: Full societal perspective (monetised QALYs, productivity/tax, health system costs/savings, superannuation, tourist revenue)</strong></td>
<td>($2.88b) – 5 year horizon&lt;br&gt;$994m – 10 year&lt;br&gt;$7.86b – 50 year</td>
<td>$44.9b – 5 year horizon&lt;br&gt;$80.4b – 10 year&lt;br&gt;$144b – 50 year</td>
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<tr>
<td><strong>As above but excludes monetised QALYs</strong></td>
<td>($2.60b) – 50 year</td>
<td>$40.8b – 50 year</td>
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<tr>
<td><strong>CUA: cost per QALY gained</strong></td>
<td>• ICER (societal perspective) $14,400 per QALY gained&lt;br&gt;• ICER (health system perspective but with tourism losses): $51,300 per QALY</td>
<td>• ICER (societal perspective) cost-saving&lt;br&gt;• ICER (health system perspective but with tourism losses): $6970 per QALY</td>
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Does border closure have a legal base?

- Enabling legislation for NZ State response to infectious threat
  - **Epidemic Preparedness Act 2006.**
- Issuing of notice in response to “an outbreak of a stated quarantinable disease” as defined by the Health Act 1956, Part 3:
  - Avian influenza (capable of being transmitted between human beings)
  - Cholera
  - Middle East Respiratory Syndrome
  - Non-seasonal influenza (capable of being transmitted between human beings)
  - Plague
  - Viral haemorrhagic fevers (capable of being transmitted between human beings)
  - Yellow fever
- Does not apply to a new pathogen?
“The modelling undertaken for New Zealand suggests that the most effective single intervention at the border to prevent or delay the introduction of a pandemic virus into New Zealand would be to minimise numbers of incoming travellers."*

high costs limited effectiveness