Exploring the relationship between importation frequency and the persistence of gonorrhoea strains in an MSM population: a modelling study

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Introduction

Repeated importation from overseas is the main source of gonorrhoea antimicrobial resistance (AMR) in Australia. \textsuperscript{[1]}

We investigate the impact of importation frequency on the persistence of an imported strain (defined as the ability of a strain to remain prevalent in the population over an extended period of time) through mathematical modelling.

Method

An individual-based model was developed to investigate the role of importation in the persistence of a theoretical resistant gonococcal strain in a population of urban men who have sex with men (MSM).

Each member of the population can be infected at the urethra, rectum and pharynx. Gonorrhoea can be transmitted between these anatomical sites through anal sex or oral sex (see Figure 1).

We assume that an endemic prevalence of the local strains is already established prior to any importation, while the imported strain is introduced to the population over a one year period.

Figure 1 illustrates how an individual can become infected with local and imported strains concurrently. Mixed infections are of particular concern, as these can facilitate the direct transfer of AMR through exchange of genetic material.

The model was calibrated against sexual behaviour and prevalence data for an urban MSM population in Australia. \textsuperscript{[2-4]}

Results

\begin{itemize}
\item The imported strain is more likely to persist as importation frequency increases (Table 1). This holds true even if mixed infection cannot occur.
\item The imported strain is more likely to persist if the likelihood of mixed infection increases, or if the imported strain is 100% resistant to treatment (Table 2).
\end{itemize}

Conclusion

\begin{itemize}
\item Increasing the importation frequency increases the probability of an imported strain persisting in the population.
\item If importation events are rare, then an imported strain is unlikely to persist unless it can coexist with local strains at the same anatomical site.
\end{itemize}

Table 1: The percentage of simulation runs in which the imported strain persisted as a function of importation frequency

<table>
<thead>
<tr>
<th>Importation frequency (Ave)</th>
<th>Once every month for one year</th>
<th>Once every 3 months for one year</th>
<th>Once every 6 months for one year</th>
<th>Once every 12 months for one year</th>
<th>Single importation event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed infection possible</td>
<td>24.3%</td>
<td>7.5%</td>
<td>4.1%</td>
<td>2.2%</td>
<td>2%</td>
</tr>
<tr>
<td>Mixed infection impossible</td>
<td>1.9%</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

Table 2: The percentage of simulation runs in which the imported strain persisted under selected scenarios, with an importation frequency of one importation event per month on average.

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>% simulation runs with import strain persisted</th>
</tr>
</thead>
<tbody>
<tr>
<td>50% probability of forming mixed infection</td>
<td>18.5%</td>
</tr>
<tr>
<td>Imported strain is 100% resistant to treatment, mixed infection possible</td>
<td>63.1%</td>
</tr>
<tr>
<td>Imported strain is 100% resistant to treatment, mixed infection impossible</td>
<td>13.4%</td>
</tr>
</tbody>
</table>

Acknowledgements

This study was funded by NHMRC Project Grants (1007937, 1056803, 568971 and 1071269). The Kirby Institute is funded by the Australian Government Department of Health and Ageing and is affiliated with the Faculty of Medicine, University of New South Wales. The views expressed in this publication do not necessarily reflect the position of the Australian Government.