

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. [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. [2-4]

Results

- The imported strain is more likely to persist as importation frequency increases (Table 1). This holds true even if mixed infection cannot occur.
- 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).

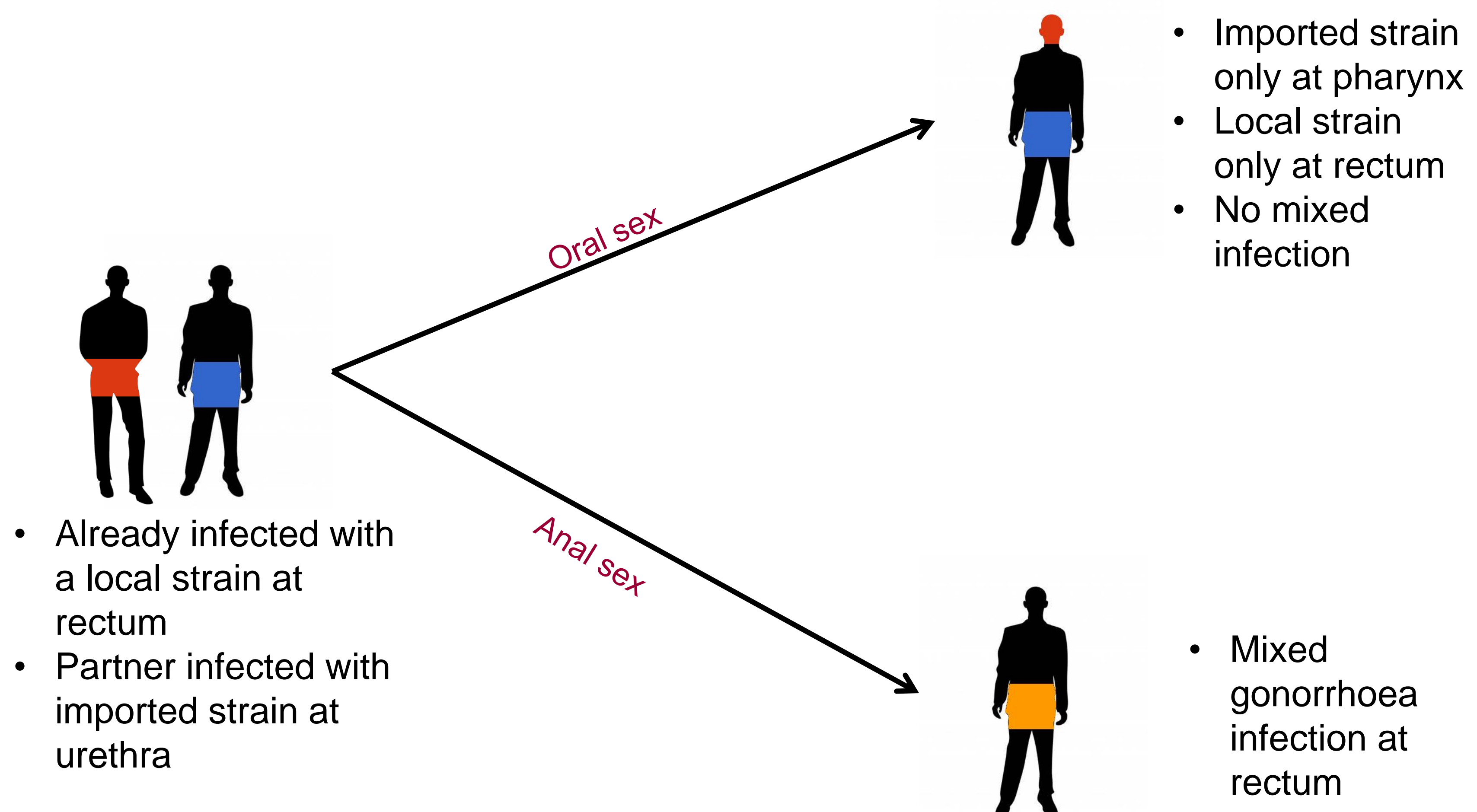


Figure 1: A representative example showing the transmission of local and imported strains amongst individuals in the population

| Importation frequency (Ave) | Once every month for one year | Once every 3 months for one year | Once every 6 months for one year | Once every 12 months for one year | Single importation event |
|-----------------------------|-------------------------------|----------------------------------|----------------------------------|-----------------------------------|--------------------------|
| Scenarios | | | | | |
| Mixed infection possible | 24.3% | 7.5% | 4.1% | 2.2% | 2% |
| Mixed infection impossible | 1.9% | <1% | <1% | <1% | <1% |

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

| Scenarios | % simulation runs with import strain persisted |
|--|--|
| 50% probability of forming mixed infection | 18.5% |
| Imported strain is 100% resistant to treatment, mixed infection possible | 63.1% |
| Imported strain is 100% resistant to treatment, mixed infection impossible | 13.4% |

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.

Conclusion

- Increasing the importation frequency increases the probability of an imported strain persisting in the population.
- 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.

References

[1] Lahra MM (2014) Australian gonococcal surveillance programme, 1 April to 30 June 2014. Commun Dis Intell Q Rep 38: E390-392 [2] National Centre in HIV Social Research (2013) Gay Community Periodic Survey Melbourne. [3]The Kirby Institute (2013) HIV, viral hepatitis and sexually transmissible infections in Australia Annual Surveillance Report 2013. Sydney, NSW: The Kirby Institute, the University of New South Wales. [4] Phang CW, Hocking J, Fairley CK, Bradshaw C, Hayes P, et al. (2008) More than just anal sex: the potential for sexually transmitted infection transmission among men visiting sex-on-premises venues. Sex Transm Infect 84: 217-219.

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