**Supplementary material**

1. **Initialization algorithm and transmission and recovery algorithm**

**Explanation on the notations used:**

* : the anatomical site of infection, ;
* : fraction of people initially infected in site with susceptible strain;
* : fraction of people initially infected in sites and with susceptible strain;
* : fraction of people initially infected with symptomatic infection in urethra;
* An infectious profile:
  + is the anatomical site of infection, ;
  + is the resistance profile that takes 0 for susceptible to ceftriaxone and 1 for resistant to ceftriaxone;
  + is the symptom status: 0 for asymptomatic and 1 for symptomatic;
* yearly rate of sexual acts;
* : the probability that a sexual act is between anatomical sites and ;
* : the probability that a sexual act between anatomical sites and leads to the transmission of infection;
* : the probability that an infection in anatomical site will become symptomatic (it was assumed that );
* : average time until natural recovery for asymptomatic infection at site ;
* : average time between screening episodes;
* : average time until seeking treatment for individuals with symptomatic urethral infection;
* : average time until recovery after receiving treatment;
* : probability of developing resistance while under treatment.

**Initialization algorithm**

1. A population of susceptible agents is created.

2. a. An agent is infected at pharynx with a drug-susceptible strain with the probability ;

b. An agent is infected at rectum with a drug-susceptible strain with the probability ;

c. An agent is infected at urethra with a drug-susceptible strain with the probability ; the infection becomes symptomatic with the probability .

1. An agent is infected at rectum and pharynx with a drug-susceptible strain with the probability ; the infection becomes symptomatic in urethra with the probability .
2. An agent is infected at rectum and urethra with a drug-susceptible strain with the probability ; the infection becomes symptomatic in urethra with the probability .
3. An agent is infected at pharynx and urethra with a drug-susceptible strain with the probability ; the infection becomes symptomatic in urethra with the probability .

**Transmission and recovery algorithm**

1. Individuals with infectious profile with , and send the following messages:
   1. , with , at the rate and if those receiving the message will develop symptomatic infection at site with resistance status ;
   2. , with , at the rate and those receiving the message will develop asymptomatic infection at site with resistance status .
2. Individuals with infectious profile with , and send the following messages:
   1. , with , at the rate and those receiving the message will develop symptomatic infection at site with resistance status ;
   2. , with , at the rate and those receiving the message will develop asymptomatic infection at site with resistance status .
3. Individuals with infectious profile with , and recover naturallyTime until natural recovery follows an exponential distribution with rate .
4. Individuals with infectious profile with , and undergo screening. Time between screening episodes follows an exponential distribution with rate .

Immediately after individuals receive the first-line treatment.

1. Individuals with infectious profile with , and seek the first line treatment. Time until seeking treatment for individuals with symptomatic urethral infection follows an exponential distribution with rate .
2. a. Individuals with infectious profile with , and receive the first-line treatment. Time until recovery after receiving the first-line treatment follows an exponential distribution with rate . During the treatment, the infection might develop resistance with the probability , which results in changing the resistance status of infection to . If resistance is not developed, the individual recovers in this site.

b. The first-line therapy is not successful on infectious profiles with , , and , and does not change the infectious profile.

c. In case of individuals being infected in two sites with infectious profiles with , and , the infection might develop resistance with the probability in one site or it might develop resistance with the probability in another site, which results in changing the resistance status of infection to in that site. If resistance is not developed, the individual recovers in both sites.

1. Individuals with infectious profile seek re-treatment with the second-line antibiotic (ertapenem). Time until seeking treatment with the second-line antibiotic for individuals with symptomatic urethral infection follows an exponential distribution with rate .
2. Individuals with infectious profile receive the second-line treatment. Time until recovery after receiving the second-line treatment follows an exponential distribution with rate .

The values of the parameters are provided in Tables 1-3.

|  |  |  |
| --- | --- | --- |
| Parameter | Prior distribution | Source |
| Total population () | 10,000 |  |
| Fraction of people initially infected at pharynx only with susceptible strain () | uniform(0.8\*0.06, 1.2\*0.06) | [12] |
| Fraction of people initially infected at rectum only with susceptible strain () | uniform(0.8\*0.035, 1.2\*0.035) | [12] |
| Fraction of people initially infected at urethra only with susceptible strain () | uniform(0.8\*0.025, 1.2\*0.025) | [12] |
| Fraction of people initially infected at rectum and pharynx with susceptible strain () | uniform(0.8\*0.02, 1.2\*0.02) | [12] |
| Fraction of people initially infected at rectum and urethra with susceptible strain () | uniform(0.8\*0.0093, 1.2\*0.0093) | [12] |
| Fraction of people initially infected at pharynx and urethra with susceptible strain () | uniform(0.8\*0.0087, 1.2\*0.0087) | [12] |
| Fraction of people initially infected with symptomatic urethral infection () | uniform(0.01, 0.3) | Assumption |

Table 1. Initialization parameters

|  |  |  |
| --- | --- | --- |
| Parameter | Prior distribution | Source |
| Probability that the infection will become symptomatic |  |  |
|  | 0 |  |
|  | uniform (0.33, 0.94) | [9-11, 13] |
|  | 0 |  |
| Yearly rate of sexual acts () | uniform(0.8\*80, 1.2\*80) | [14] |
| Probability of a sexual act between two anatomical sites |  |  |
|  | 0.83 | [15] |
|  | 0.825 | [15] |
|  | 0.6 | [15] |
|  | 0.478 | [15] |
|  | 0.03 | [15] |
|  | 0.478 | [15] |
|  | 0.6 | [15] |
|  | 0.825 | [15] |
| Probability of transmission from one anatomical site to another |  | Assumption |
|  | uniform (0.001, 0.1) |  |
|  | uniform (0.001, 0.1) |  |
|  | uniform (0.001, 0.1) |  |
|  | uniform (0.001, 0.1) |  |
|  | uniform (0.001, 0.1) |  |
|  | uniform (0.001, 0.1) |  |
|  | uniform (0.001, 0.1) |  |
|  | uniform (0.001, 0.1) |  |

Table 2. Transmission parameters

|  |  |  |
| --- | --- | --- |
| Parameter | Prior distribution | Source |
| Average time until natural recovery at different anatomical sites (years) |  | Assumption |
|  | uniform(1/12, 5) |  |
|  | uniform(1/12, 5) |  |
|  | uniform(1/12, 5) |  |
| Average time until seeking treatment for individuals with symptomatic urethral infection (z) (years) | uniform(1/365, 14/365) | Assumption |
| Average time between screening episodes () (years) | uniform(1, 10) | Assumption |
| Average time until recovery after receiving treatment () (years) | uniform(1/365, 14/365) | Assumption based on [16] |
| Probability of developing resistant while under treatment () | uniform(0.001, 0.009) | Assumption |

Table 3. Recovery parameters

1. **Histograms of the posterior distributions**

A graph of a number of blue bars

Description automatically generated with medium confidence A graph of a number of data

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A graph of a number of people

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Description automatically generated

A graph of a number of blue bars

Description automatically generatedA graph of blue bars

Description automatically generated with medium confidenceA graph of a number of blue bars

Description automatically generatedA graph of a number of blue bars

Description automatically generated

A graph of a number of people in infected areas

Description automatically generatedA graph of a person with a symptom

Description automatically generated A graph of a number of people in infected areas

Description automatically generatedA graph of a number of people in urethra

Description automatically generated

A graph of a person with a blue bar

Description automatically generated with medium confidence A graph of blue bars

Description automatically generatedA graph of a number of people in infected areas

Description automatically generatedA graph of a number of blue bars

Description automatically generated

Figure 1. Histograms of the posterior distributions.