**SUPPLEMENTARY MATERIAL**

For the development of the computational model, the first needed step is to build the mathematical model. All the population groups are associated to state variables providing the dynamic behaviours of such groups. The state variables considered are presented in Table S1.

Table S1. State variables of the model.

|  |  |
| --- | --- |
| **State variables (population)** | **Definition** |
| Sf | Susceptible individuals from the household |
| CfST131 | ST131-colonised from the household |
| CfESBL | ESBL-producing ST131 colonised from the household |
| EfST131 | ST131 infected from the household |
| EfESBL | ESBL-producing ST131 infected from the household |
| Sh | Susceptible individuals from the hospital |
| ChST131 | ST131 colonised from the hospital |
| ChESBL | ESBL-producing ST131 colonised from the hospital |
| EhST131 | ST131 infected from the hospital |
| EhESBL | ESBL-producing ST131 infected from the hospital |
| Sn | Susceptible individuals from the nursing homes |
| CnST131 | ST131 colonised from the nursing homes |
| CnESBL | ESBL-producing ST131 infected from the nursing homes |
| Sr | Susceptible individuals from the general population |

Each state variable is represented through an ordinary differential equation. For the sake of clarity the different equations for each population group are presented.

Firstly, the equations for household group are described:



Secondly, the equations for the hospital group are:



The equations describing nursing home population are:



Finally, the general population is described by the following equation:



Interactions between state variables are represented by means of constitutive relations, some probabilistic and some deterministic, according to the size of the population which they refer to. In this model, the probabilistic approach has been chosen for small populations and the deterministic one for households and the general population.

Table S2. Constitutive relations of the model.

|  |  |
| --- | --- |
| **Variables (individuals/day)** | **Definition** |
| A1 | Population flow from susceptible individuals of the general population to ST131 colonised of the household |
| A2 | Population flow from susceptible individuals of the general population to ESBL-producing ST131 colonised of the household |
| B1 | Population flow from susceptible individuals of the households to ST131 colonised of the households |
| B2 | Population flow from susceptible individuals of the household to ESBL-producing ST131 colonised of the household  |
| C1 | Population flow from ST131 colonised of the household to susceptible individuals of the household |
| C2 | Population flow from ESBL-producing ST131 colonised of the household to susceptible individuals of the household |
| C3 | Population flow of susceptible individuals from household to susceptible individuals of the general population |
| D1 | Population flow from ST131 colonised of the household to ST131 colonised of the hospital |
| D2 | Population flow from ESBL-producing ST131 colonised of the household to ESBL-producing ST131 colonised of the hospital |
| D3 | Population flow from ST131 colonised of the hospital to ST131 colonised of the household. |
| D4 | Population flow from ESBL-producing ST131 colonised of the hospital to ESBL-producing ST131 colonised of the household |
| E1 | Population flow from ST131 colonised of the household to ST131 infected of the household |
| E2 | Population flow from ESBL-producing ST131 colonised of the household to ESBL-producing ST131 infected of the household |
| E3 | Population flow from ST131 infected of the household to ST131 colonised of the household |
| E4 | Population flow from ESBL-producing ST131 infected of the household to ESBL-producing ST131 colonised of the household |
| F1 | Population flow from ST131 colonised of the household to ST131 infected of the hospital |
| F2 | Population flow from ESBL-producing ST131 colonised of the household to ESBL-producing ST131 infected of the hospital |
| F3 | Population flow from ST131 infected of the hospital to ST131 colonised of the household |
| F4 | Population flow from ESBL-producing ST131 infected of the hospital to ESBL-producing ST131 colonised of the household |
| G1 | Population flow from ST131 infected of the household to susceptible individuals of the general population |
| G2 | Population flow from ESBL-producing ST131 infected of the household to susceptible individuals of the general population |
| H1 | Population flow from susceptible individuals of the hospital to ST131 colonised of the hospital |
| H2 | Population flow from susceptible individuals of the hospital to ESBL-producing ST131 colonised of the hospital  |
| I1 | Population flow from ST131 colonised of the hospital to susceptible individuals of the hospital  |
| I2 | Population flow from ESBL-producing ST131 colonised of the hospital to susceptible individuals of the hospital  |
| J1 | Population flow of susceptible individuals from the general population to susceptible individuals of the hospital |
| J2 | Population flow of susceptible individuals from the hospital to susceptible individuals of the general population |
| K1 | Population flow from ST131 colonised of the hospital to ST131 infected of the hospital |
| K2 | Population flow from ESBL-producing ST131 colonised of the hospital to ESBL-producing ST131 infected of the hospital |
| K3 | Population flow from ST131 infected of the hospital to ST131 colonised of the hospital |
| K4 | Population flow from ESBL-producing ST131 infected of the hospital to ESBL-producing ST131 colonised of the hospital |
| L1 | Population flow from ST131 infected of the hospital to susceptible individuals of the general population |
| L2 | Population flow from ESBL-producing ST131 infected of the hospital to susceptible individuals of the general population |
| L3 | Population flow from ST131 infected of the hospital to susceptible individuals of the nursing homes |
| L4 | Population flow from ESBL-producing ST131 infected of the hospital to susceptible individuals of the nursing homes |
| M1 | Population flow of susceptible individuals from the household to susceptible individuals of the nursing homes |
| M2 | Population flow of ST131 colonised from the household to ST131 colonised of the nursing homes |
| M3 | Population flow of ESBL-producing ST131 colonised from the household to ESBL-producing ST131 colonised of the nursing homes |
| M4 | Population flow of susceptible individuals from the general population to susceptible individuals of the nursing homes |
| N1 | Population flow from ST131 colonised of the nursing homes to ST131 colonised of the hospital |
| N2 | Population flow from ESBL-producing ST131 colonised of the nursing homes to ESBL-producing ST131 colonised of the hospital |
| N3 | Population flow from ST131 colonised of the hospital to ST131 colonised of the nursing homes |
| N4 | Population flow from ESBL-producing ST131 colonised of the hospital to ESBL-producing ST131 colonised of the nursing homes |
| O1 | Population flow from susceptible individuals of the nursing homes to ST131 colonised of the nursing homes |
| O2 | Population flow from susceptible individuals of the nursing homes to ESBL-producing ST131 colonised of the nursing homes |
| P1 | Population flow from ST131 colonised of the nursing homes to ST131 infected of the hospital |
| P2 | Population flow from ESBL-producing ST131 colonised of the nursing homes to ESBL-producing ST131 infected of the hospital |
| P3 | Population flow from ST131 infected of the hospital to ST131 colonised of the nursing homes |
| P4 | Population flow from ESBL-producing ST131 infected of the hospital to ESBL-producing ST131 colonised of the nursing homes |
| Q1 | Population flow from susceptible individuals of the general population to ST131 colonised of the nursing homes |
| Q2 | Population flow from susceptible individuals of the general population to ESBL-producing ST131 colonised of the nursing homes |

The equations defining the constitutive relations are:





Table S3. Parameters of the model.

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Definition** | **Value** |
| γrST131(1/day) | Factor of ST131 contagion for susceptible individuals of the general population | 0.0007833 |
| γrESBL(1/day) | Factor of ESBL-producing ST131 contagion for susceptible individuals of the general population | 0.00059 |
| γfST131(1/day) | Factor of ST131 contagion for susceptible individuals of the household | 0.0296 |
| γfESBL(1/day) | Factor of ESBL-producing ST131 contagion for susceptible individuals of the household | 0.006 |
| sfST131(1/day) | Factor of release from the ST131 clone for ST131 colonised of the household | 0.0546 |
| sfESBL(1/day) | Factor of release from the ESBL-producing ST131 clone for ESBL-producing ST131 colonised of the household | 0.02 |
| sfS(1/day) | Factor of transference for susceptible individuals moving from the household to the general population | 0.005 |
| tfST131(1/day) | Factor of transference for ST131 colonised moving from the household to the hospital | 0.00025 |
| tfESBL(1/day) | Factor of transference for ESBL-producing ST131 colonised moving from the household to the hospital | 0.0007 |
| thST131(1/day) | Factor of transference for ST131 colonised moving from the hospital to the household | 0.00144 |
| thESBL(1/day) | Factor of transference for ESBL-producing ST131 colonised moving from the hospital to the household | 0.0015 |
| afST131(1/day) | Factor of ST131 infection for ST131 colonised of the household | 0.0014 |
| afESBL(1/day) | Factor of ESBL-producing ST131 infection for ESBL-producing ST131 colonised of the household | 0.00042 |
| zfST131(1/day) | Factor of release from the ST131 clone for ST131 infected of the household | 0.003 |
| zfESBL(1/day) | Factor of release from the ESBL-producing ST131 clone for ESBL-producing ST131 infected of the household | 0.004 |
| wfST131(1/day) | Factor of transference for ST131 infected moving from the household to the hospital | 0.0004 |
| wfESBL(1/day) | Factor of transference for ESBL-producing ST131 infected moving from the household to the hospital | 0.002 |
| whST131(1/day) | Factor of transference for ST131 infected moving from the hospital to the household | 0.003 |
| whESBL(1/day) | Factor of transference for ESBL-producing ST131 infected moving from the hospital to the household | 0.004 |
| rfST131(1/day) | Factor of ST131 recovering for ST131 infected of the household | 0.9 |
| rfESBL(1/day) | Factor of ESBL-producing ST131 recovering for ESBL-producing ST131 infected of the household | 0.6 |
| γhST131(1/day) | Factor of ST131 contagion for susceptible individuals of the hospital | 0.0001 |
| γhESBL(1/day) | Factor of ESBL-producing ST131 contagion for susceptible individuals of the hospital | 0.000007 |
| shST131(1/day) | Factor of release from the ST131 clone for ST131 colonised of the hospital | 0.28 |
| shESBL(1/day) | Factor of release from the ESBL-producing ST131 clone for ESBL-producing ST131 colonised of the hospital | 0.065 |
| khr(1/day) | Factor of transference for susceptible individuals moving from the hospital to the general population | 0.000125 |
| krh(1/day) | Factor of transference for susceptible individuals moving from the general population to the hospital | 0.0333 |
| ahST131(1/day) | Factor of ST131 infection for ST131 colonised of the hospital | 0.12 |
| ahESBL(1/day) | Factor of ESBL-producing ST131 infection for ESBL-producing ST131 colonised of the hospital | 0.033 |
| zhST131(1/day) | Factor of release from the ST131 clone for ST131 infected of the hospital | 0.1 |
| zhESBL(1/day) | Factor of release from the ESBL-producing ST131 clone for ESBL-producing ST131 infected of the hospital | 0.0039 |
| rhST131(1/day) | Factor of recovering for ST131 infected individuals moving from the hospital to the general population | 0.09 |
| rhESBL(1/day) | Factor of recovering for ESBL-producing ST131 infected moving from the hospital to the general population | 0.009 |
| rnST131(1/day) | Factor of recovering for ST131 infected moving from the hospital to the nursing homes | 0.01 |
| rnESBL(1/day) | Factor of recovering for ESBL-producing ST131 infected moving from the hospital to the nursing homes | 0.001 |
| efS(1/day) | Factor of transference for susceptible individuals moving from the household to the nursing homes | 0.00001 |
| efST131(1/day) | Factor of transference for ST131 colonised moving from the household to the nursing homes | 0.000022 |
| efESBL(1/day) | Factor of transference for ESBL-producing ST131 colonised moving from the household to the nursing homes | 0.008 |
| erS(1/day) | Factor of transference for susceptible individuals moving from the general population to the nursing homes | 0.0001 |
| ynST131(1/day) | Factor of transference for ST131 colonised moving from the nursing homes to the hospital | 0.00003 |
| ynESBL(1/day) | Factor of transference for ESBL-producing ST131 colonised moving from the nursing homes to the hospital | 0.000015 |
| yhST131(1/day) | Factor of transference for ST131 colonised moving from the hospital to the nursing homes | 0.0011 |
| yhESBL(1/day) | Factor of transference for ESBL-producing ST131 colonised moving from the hospital to the nursing homes | 0.00011 |
| γnST131(1/day) | Factor of ST131 contagion for susceptible individuals of the nursing homes | 0.00008 |
| γnESBL(1/day) | Factor of ESBL-producing ST131 contagion for susceptible individuals of the nursing homes | 0.00003 |
| vnST131(1/day) | Factor of ST131 infection for ST131 colonised of the nursing homes | 0.004 |
| vnESBL(1/day) | Factor of ESBL-producing ST131 infection for ESBL-producing ST131 colonised of the nursing homes | 0.001 |
| vhST131(1/day) | Factor of release from the ST131 clone for ST131 infected moving from the hospital to the nursing homes | 0.00011 |
| vhESBL(1/day) | Factor of release from the ESBL-producing ST131 clone for ESBL-producing ST131 infected moving from the hospital to the nursing homes | 0.00074 |
| γrnST131(1/day) | Factor of ST131 contagion for susceptible individuals moving from the general population to the nursing homes | 0.00000015 |
| γrnESBL(1/day) | Factor of ESBL-producing ST131 contagion for susceptible individuals moving from the general population to the nursing homes | 0.000000015 |
| nf (adimensional) | Factor related to the number of members composing the household | 3 |
| Pt (individuals) | Total population considered | 800000 |
| Ph (individuals) | Total population of the hospital | 3000 |
| Pn (individuals) | Total population of the nursing homes | 7000 |

Figure S1. Cumulative estimation of the number of individuals colonized with non-ESBL producing ST131 *E. coli* (EO25) and ESBL-producing ST131*E. coli* (Eblee) over two years.



Figure S2. Sensitivity analysis considering a ±5% variation in the rate of infections in all compartments. The data represent the number of persons infected due to non-ESBL-producing ST131 *E. coli* (EO25, left) and ESBL-producing ST131 *E. coli* (Eblee, right) over one year.

