Parametrization and Model Fitting

The per year counter-productive carbapenem prescription in the Malthusian selection coefficient equation (a_y in **Model step 2.**) was assumed to be a product of the per year proportion of inappropriate treatment (α_y) and the per year total carbapenems per capita use in the US (U_y):

$$a_y = \alpha_y U_y.$$

We assumed that for each year *y*, α_y and U_y had Beta and Gamma prior distributions. We weakly informed the distributions for α_y by using the alpha and beta parameters 7.19 and 3.79 based on the fact that 719 out of 1098 uses of carbapenem against *A. baumannii* were determined to be inappropriate empiric treatment (Zilberberg et al. 2016). Meanwhile, we constructed the parameters of the Gamma distributions for U_y so that the mean of the distributions increases with respect to time but converges to a fixed value:

$$E\left(U_y\right) = \bar{U}_{y_0} + \frac{s(y - y_0)}{1 + s(y - y_0)/\bar{U}_\infty}, \tag{6}$$

where y_0 is the first year in the analysis (1999), whereas the variance of the distributions for U_y (denoted by *v*) was constant across the years. We assumed uninformed uniform distributions for the hyperpriors of the initial mean per capita usage for y_0 ($\bar{U}_{y0}$), the initial linear increase in the mean per capita usage (*s*), the upper limit for the mean per capita usage ($\bar{U}_\infty$) and the variance of per capita usage (*v*).

We used uniformed uniform distributions for the priors of θ and ϱ in **Model step 2.** We informed the Beta distribution for the prior of the initial resistance in the year y_0 by finding parameters so that the distribution had a mean of 6% and a 95% confidence interval of 4% to 8% (The Center for Disease, Dynamics Economics & Policy n.d.) (alpha and beta parameters 31.97 and 500.86, respectively).

We specified the likelihood of the data as a product of three types of likelihood functions: (i) for each year *y* in 1999–2016, the binomial likelihood of observing samples positive for resistance (k^r_y, **Table 1**) among a total number of isolates tested (n^r_y, **Table 1**) with a unknown probability (r_y computed according to **Model step 3.**:

$$\mathcal{L}^r_y \propto r_y^{k^r_y}(1 - r_y)^{n^r_y - k^r_y};$$

(ii) for each year *y* in 1999–2016, the likelihood of observing a sample of total per capita usage (x_y, **Table 1**) from a Gamma distribution

$$\mathcal{L}^U_y \propto x_y^{\alpha^U_y - 1} e^{-\beta^U_y x_y},$$

where the unknown parameters α^U_y and β^U_y are computed according to the procedure described above; and (iii) a binomial likelihood of observing respectively 719 and 1098 cases of inappropriate and appropriate use of carbapenem against *A. baumannii* analyzed in a database for the years 2009–2013:

$$\mathcal{L}^\alpha \propto \bar{\alpha}^{719}(1 - \bar{\alpha})^{1098},$$

with the unknown probability $\bar{\alpha}$ that is computed as the average of the α_y parameters described above weighted by total usage:

$$\bar{\alpha} = \sum_{y=2009}^{2013} w_y \alpha_y,$$

for the weights:

$$w_y = \frac{x_y P_y}{\sum_{z=2009}^{2013} x_z P_z},$$

where P_y represents the US population in the year y obtained from census estimates (US Census Bureau n.d., n.d.).

Table 1: Data used to inform the likelihood of the model

Year	Carbapenem resistant *A. baumannii* isolates (The Center for Disease, Dynamics Economics & Policy n.d.)	Total *A. baumannii* isolates tested (The Center for Disease, Dynamics Economics & Policy n.d.)	Total per capita carbapenem usage (per 1,000 population) (The Center for Disease, Dynamics Economics & Policy n.d.)
1999	27	452	
2000	61	681	15
2001	124	887	17
2002	191	955	21
2003	180	998	24
2004	214	1187	26
2005	263	1143	26
2006	187	890	29
2007	301	860	31
2008	295	757	33
2009	302	603	34
2010	184	419	34
2011	135	365	35
2012	84	240	37
2013	92	263	35
2014	73	269	37
2015	71	274	40
2016	96	319	