

# MCMC for Influenza Burden Estimation from Hospitalization Surveillance data

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## Data

1.  $N$ : Total FluSurv-NET (FSN) population (given stratum, e.g. age group, state, etc.)
2.  $M$ : Total US population
3.  $n_H$ : Number of observed influenza hospitalizations with non-lethal outcome
4.  $n_D$ : Observed influenza deaths
5.  $t_{kj}$ : Numbers tested by outcome and test type (1: PCR, 2: Rapid, 3: Other, 4: No test)
6.  $\rho_k$ : Prior dist. for test sensitivities (PCR, rapid; mean, SD)

## Parameters to be sampled, fully conditional likelihoods $L$

**$m_H$ : True number of influenza hospitalizations (non-lethal) in FSN population, unobserved**

$$L(m_H | \dots) \propto \frac{e^{-\lambda_H N} (\lambda_H N)^{m_H}}{m_H!} \times \binom{m_H}{n_H} \tau_0^{n_H} (1 - \tau_0)^{(m_H - n_H)}, \quad (1)$$

where the “detection probability” in those with non-lethal outcomes is  $t_0 = \phi_0 \sum_j \pi_{0j} \sigma_{0j}$ ; definitions of  $\phi_0$ ,  $\pi_{0j}$ , and  $\sigma_{0j}$  as given below.

**$\lambda_H$ : Influenza hospitalization rate, non-lethal outcome**

$$L(\lambda_H | \dots) \propto \frac{e^{-\lambda_H N} (\lambda_H N)^{m_H}}{m_H!} \times \quad (2)$$

**$\lambda_D$ : Influenza hospitalization rate, lethal outcome**

$$L(\lambda_D | \dots) \propto \frac{e^{-\lambda_D \epsilon N} (\lambda_D \epsilon N)^{m_D}}{m_D!}, \quad (3)$$

**$m_D$ : total number of influenza deaths deaths in FSN population**

$$L(m_D | \dots) \propto \frac{e^{-\lambda_D \epsilon N} (\lambda_D \epsilon N)^{m_D}}{m_D!} \times \binom{m_D}{n_D} \tau_1^{n_D} (1 - \tau_1)^{(m_D - n_D)}, \quad (4)$$

**$\epsilon$ : Outside-hospital death proportion**

$$L(m_D|\dots) \propto \frac{e^{-\lambda_D} \epsilon^N (\lambda_D \epsilon N)^{m_D}}{m_D!} \quad (5)$$

**$\phi_0$ : True influenza-positivity rate, in non lethal outcomes)**

$$L(\phi_0|\dots) \propto \binom{m_H}{n_H} \left( \phi_0 \sum_j \pi_{0j} \sigma_{0j} \right)^{n_H} (1 - \phi_0 \sum_j \pi_{0j} \sigma_{0j})^{m_H - n_H} \times \begin{pmatrix} above \\ below \end{pmatrix} \quad (6)$$

**$\pi_{0j}$ : Testing probabilities in non-lethal outcomes, by test type**

$$L(\pi_{0j}|\dots) \propto \frac{e^{-\lambda_H} N (\lambda_H N)^{m_H}}{m_H!} \times \binom{m_H}{n_H} \tau_0^{n_H} (1 - \tau_0)^{(m_H - n_H)}, \quad (7)$$

$g_{kj}$

Unobserved number of influenza positives, by outcome  $k$  and test type  $j$

$\sigma_{kj}$

Test sensitivity, by outcome  $k$  and test type  $j$