

# Surveillance simulation equations

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## 1 Introduction

$$S_{t+1} - S_t = -S_t \lambda \quad (1)$$

$$E_{t+1} - E_t = S_t \lambda - m E_t \quad (2)$$

$$I_{At+1} - I_{At} = \alpha m E_t - (\psi_A + \gamma_A) I_{At} \quad (3)$$

$$I_{AA_{t+1}} - I_{AA_t} = \psi_A I_{At} - \tilde{\gamma}_A I_{AA_t} \quad (4)$$

$$I_{P_{t+1}} - I_{P_t} = (1 - \alpha) m E_t - (\sigma_P + \psi_P) I_{P_t} \quad (5)$$

$$I_{AP_{t+1}} - I_{AP_t} = \psi_P I_{P_t} - \tilde{\sigma}_P I_{AP_t} \quad (6)$$

$$I_{M_{t+1}} - I_{M_t} = \sigma_P I_{P_t} - (\sigma_M + \psi_M + \gamma_M) I_{M_t} \quad (7)$$

$$I_{AM_{t+1}} - I_{AM_t} = \tilde{\sigma}_P I_{AP_t} + \psi_M I_{M_t} - (\tilde{\sigma}_M + \tilde{\gamma}_M) I_{AM_t} \quad (8)$$

$$I_{C_{t+1}} - I_{C_t} = \sigma_M I_{M_t} - (\gamma_C + \psi_C + \mu_C) I_{C_t} \quad (9)$$

$$I_{AC_{t+1}} - I_{AC_t} = \psi_C I_{C_t} + \tilde{\sigma}_M I_{AM_t} - (\tilde{\gamma}_C + \tilde{\mu}_C) I_{AC_t} \quad (10)$$

$$R_{t+1} - R_t = \gamma_A I_{At} + \gamma_M I_{Mt} + \gamma_C I_{Ct} \quad (11)$$

$$R_{A_{t+1}} - R_{A_t} = \tilde{\gamma}_A I_{AA_t} + \tilde{\gamma}_M I_{AM_t} + \tilde{\gamma}_C I_{AC_t} \quad (12)$$

$$D_{t+1} - D_t = \mu_C I_{Ct} \quad (13)$$

$$D_{A_{t+1}} - D_{A_t} = \tilde{\mu}_C I_{AC_t} \quad (14)$$

$$\lambda = \beta \frac{(I_A + I_P + I_M + I_C) + r(I_{AA} + I_{AP} + I_{AM} + I_{AC})}{N} \quad (15)$$

$$\psi_A + \gamma_A = 1 \quad (16)$$

$$\sigma = \text{Progression rates between infectious compartments} \quad (17)$$

$$\gamma = \text{Recovery rates} \quad (18)$$

$$\psi = \text{Ascertainment rates} \quad (19)$$

$$\mu = \text{Death rates} \quad (20)$$

*Tilde on top of symbols indicate the same biological process, but for an ascertained class. T*  
(21)