Supplemental Online Content

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**eMethods.** Modeling Infectious Diseases in Healthcare Model Description Framework  
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This supplemental material has been provided by the authors to give readers additional information about their work.
eMethods. Modeling Infectious Diseases in Healthcare Model Description Framework

Purpose and Scope:
Purpose: The purpose of this model is the estimation of the per-application effectiveness of two MRSA decolonizing compounds (Chlorhexidine Gluconate and Mupirocin) based on site-level effect estimates found in the empirical literature.

Scope: A single 18-bed intensive care unit in a U.S. academic medical center. This ICU is represented as a closed ICU, with no interaction with the rest of the hospital.

Entities, state variables, and scales:
Entities: Patients, Nurses and Doctors. Interaction is defined entirely based on potentially contaminating/transmitting interactions. As a result, patients interact with nurses and doctors but not each other, while nurses and doctors both interact with patients but, again, not with each other. Nurses are specifically restricted to only interact with their assigned patient group.

State Variables: Patients are classified as Uncolonized, Colonized, or Latent (a delay state between the transmission event and detectable colonization). Patients are further segregated into five distinct groups, representing patients assigned to a particular nurse.

Nurses and Doctors are both represented as being either Uncontaminated or Contaminated and are identified individually within the model.

Scale: An 18-bed intensive care unit simulated for one year.

Initialization:
In the initial state of the model (at time = 0), there are six uncontaminated nurses, one uncontaminated doctor, and six groups of three patients, all of whom are uncolonized. Further discussion of the effects of varying this initial state may be found in1. No burn-in period was used in the model as visual inspection suggested this initial state was relatively close to the stochastic equilibrium of the model.

Process Overview and Scheduling:
A full description of the processes of the model may be found in the eTable, and for brevity are not presented here. The model is simulated using Gillespie’s Direct Method2, which selects the time the next event of any type occurs, and then randomly determines what type of event occurs based on their respective rates. As such, there is no overlying scheduling structure.

Input Data:
The model uses no external input data to represent processes in the model.

Agent interactions and organism transmission:
Interactions: Interactions are event driven, and concentrated on the interactions between healthcare workers (HCWs) and patients. At a given rate per hour $\rho_N$ for nurses and $\rho_D$ for doctors, HCWs engage in a “direct care task”\(^3\) which involves touching the patient or their immediate surrounding environment.

This interaction prompts many other possible events in the model, including pathogen transmission (described below), HCW hand/body contamination, hand washing, and the donning/doffing of PPE by HCWs.

Patients do not interact with other patients directly – all patient-to-patient conflict is modeled as indirect interactions via shared and contaminated HCWs.

Pathogen Transmission:
Pathogen transmission is entirely indirect. A patient who is colonized (or has contaminated their environment) can contaminate a HCW they have come into contact with. If this HCW does not clear this contamination either by washing their hands or by removing contaminated PPE, there is a per-direct care task probability ($\psi$) that an uncolonized patient will be successfully colonized, representing a within-healthcare facility transmission event.

Stochasticity:
Due to the model’s implementation using Gillespie’s Direct Method\(^2\), the times events occur, and which event triggers at a given time are fully stochastic in the model. All other elements of the model, such as population size and parameter values, are deterministic.

Submodels: This model has no submodels.

Model verification, calibration and validation:

Verification: The model's code was based on a previously published model. All code used in the model was subject to code review, and several extreme value tests (setting particular parameter values to very high or very low values that should subsequently result in implausible results) were conducted.

Calibration and Validation: The baseline model with no intervention was calibrated to the control arm of a large MRSA-related RCT\(^4\) to produce an average incidence of 5.89 MRSA acquisitions per 1000 patient-days, as in a previously published study\(^5\). The parameters for both CHG and Mupirocin were estimated from sub-analyses of a meta-analysis published by Kim et al.\(^6\) such that the parameter values for those interventions would, on average, cause a relative reduction in acquisitions matching the value of the meta-analysis. This was done using Approximate Bayesian Computation, drawing 1,000,000 candidate values for each parameter from a uniform prior bounded by 0 and 1 with an error term $\varepsilon = 0.05$, meaning that a candidate value would be accepted if the simulated incidence rate using that parameter fell within 5% of the targeted incidence rate on the log scale.
### eTable. Transitions and Equations for Metapopulation Model of Acquisition and Decolonization

| Transition     | Equation                                                                 |
|----------------|--------------------------------------------------------------------------|
| $\text{NC}_i$ to $\text{NU}_i$ | $\tau_N N_c \frac{P_{c_i}}{(P_{c_i} + P_{u_i})} \gamma$ ; $i = 1 \ldots 6$ |
| $\text{NU}_i$ to $\text{NC}_i$ | $\rho_N \sigma_{Nui} \frac{P_{c_i}}{(P_{c_i} + P_{u_i})} \gamma$ ; $i = 1 \ldots 6$ |
| $\text{NU}_i$ to $\text{NC}_i$ | $\rho_N \sigma_{Nui} \frac{P_{c_j}}{(P_{c_j} + P_{u_j})} \left[ (1 - \gamma) / 5 \right]$ ; $i = 1 \ldots 6, j = 1 \ldots 6, j \neq i$ |
| $\text{Du}$ to $\text{Dc}$ | $\tau_D D_c \frac{\sum_{i=1}^{6} P_{c_i}}{\sum_{i=1}^{6} (P_{c_i} + P_{u_i})}$ |
| $\text{P}_u$ to $\text{C}_i$ | $\rho_D \psi_{Pui} \frac{N_{ci}}{(N_{ci} + N_{ui})} \gamma$ ; $i = 1 \ldots 6$ |
| $\text{P}_u$ to $\text{C}_i$ | $\rho_D \psi_{Pui} \frac{N_{cj}}{(N_{cj} + N_{uj})} \left[ (1 - \gamma) / 5 \right]$ ; $i = 1 \ldots 6, j = 1 \ldots 6, j \neq i$ |
| $\text{P}_u$ to $\text{C}_i$ | $\rho_D \psi_{Pui} \frac{D_C}{(D_C + D_u)}$ ; $i = 1 \ldots 6$ |
| $\text{P}_u$, Discharge to $\text{P}_u$, Admission | $\theta v_u P_{ui}$ ; $i = 1 \ldots 6$ |
| $\text{P}_u$, Discharge to $\text{P}_c$, Admission | $\theta v_c P_{ui}$ ; $i = 1 \ldots 6$ |
| $\text{P}_c$, Discharge to $\text{P}_u$, Admission | $\theta v_u P_{ci}$ ; $i = 1 \ldots 6$ |
| $\text{P}_c$, Discharge to $\text{P}_c$, Admission | $\theta v_c P_{ci}$ ; $i = 1 \ldots 6$ |
| $\text{P}_c$ to $\text{P}_u$ | $\mu P_{ci}$ ; $i = 1 \ldots 6$ |
| $\text{P}_c$ to $\text{P}_u$ | $\delta \eta P_{ci}$ ; $i = 1 \ldots 6$ |
| $\text{P}_c$ to $\text{P}_u$ | $\xi \eta P_{ci}$ ; $i = 1 \ldots 6$ |
**eFigure.** Global Sensitivity of Mathematical Model of Acquisition and Decolonization

Horizontal bars represent the change in the estimated effectiveness of CHG/mupirocin decolonization per one-percent change in the value of a specific parameter, with light bars indicating increased estimated effectiveness and dark bars indicating decreased estimated effectiveness.
References

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