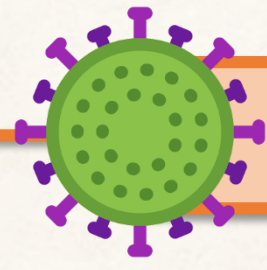




Acknowledgments:
Students from the National University of Singapore: Kong Cheng En, Xie Ling Yi, Wang Yuzhuzhu, Zhang Te;
Student from the Singapore Management University: Patrick Lim

¹Singapore Health Services
²Duke NUS Medical School
³Singapore Management University
⁴Singapore General Hospital
⁵National Cancer Centre, Singapore



Introduction

During the COVID-19 pandemic, exposure of healthcare workers (HCWs) to patients with COVID-19 causes **disruptions to the delivery of care** and essential healthcare services. This risk is **influenced by the characteristics of the pandemic** and can be mitigated using different strategies but have complex interactions that are hard to evaluate.

The aim of this study is hence to use **simulation modelling approaches** to **evaluate different strategies** to **reduce the risk of transmission** for healthcare workers.



Methodology

An **agent-based simulation model** was developed using NetLogo based on surgical service processes in SGH and the Major Operating Theatres (MOTs) layout to **evaluate the effectiveness of 5 strategies** to **reduce the risk of transmission** for HCWs.

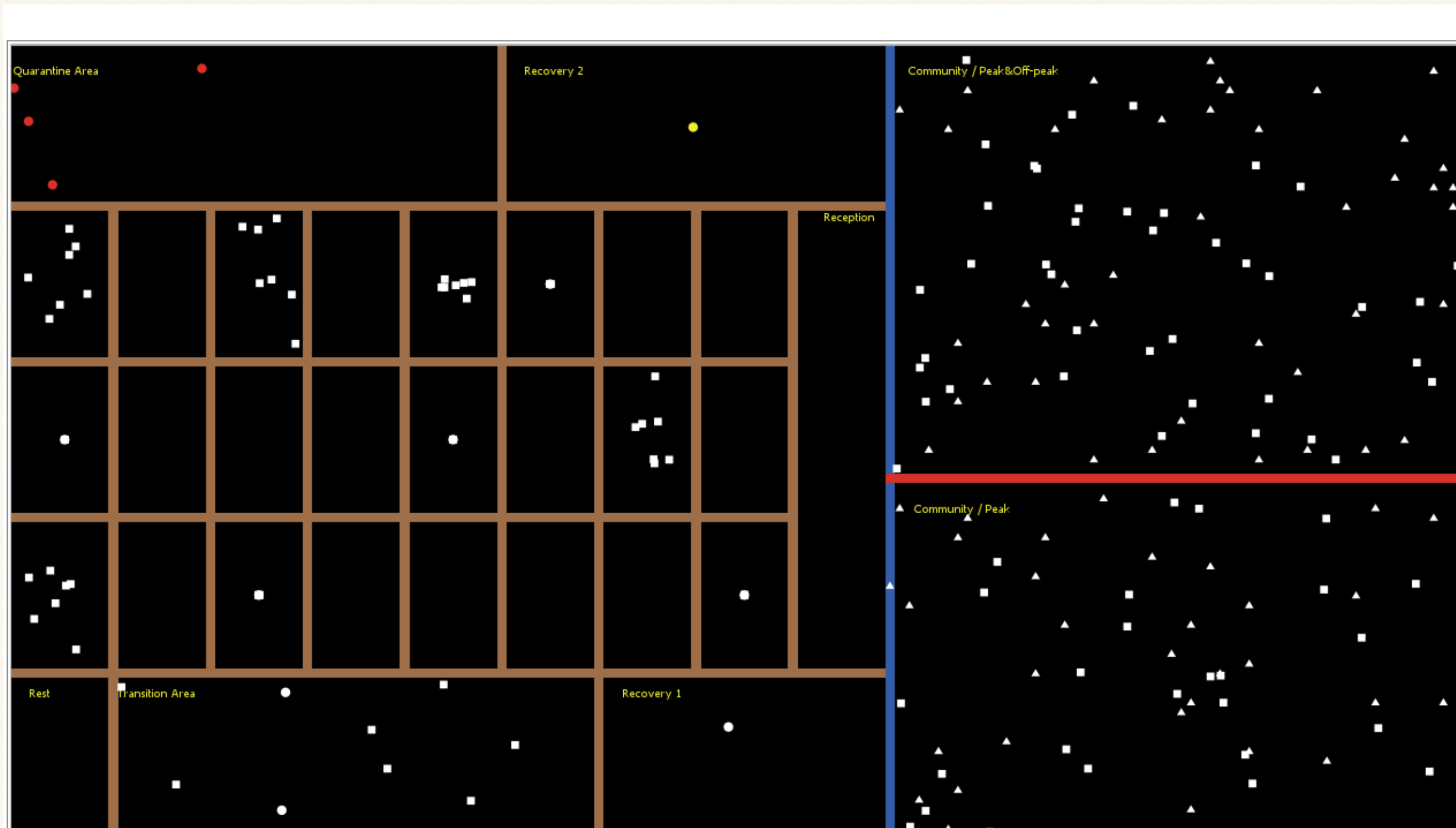


Figure 1: Simulation Model Layout in NetLogo

Individual entities such as patients and HCWs are modelled as agents who **interact and affect** one another such as **transmission of COVID-19** and **movement and interaction** within the hospital and community.

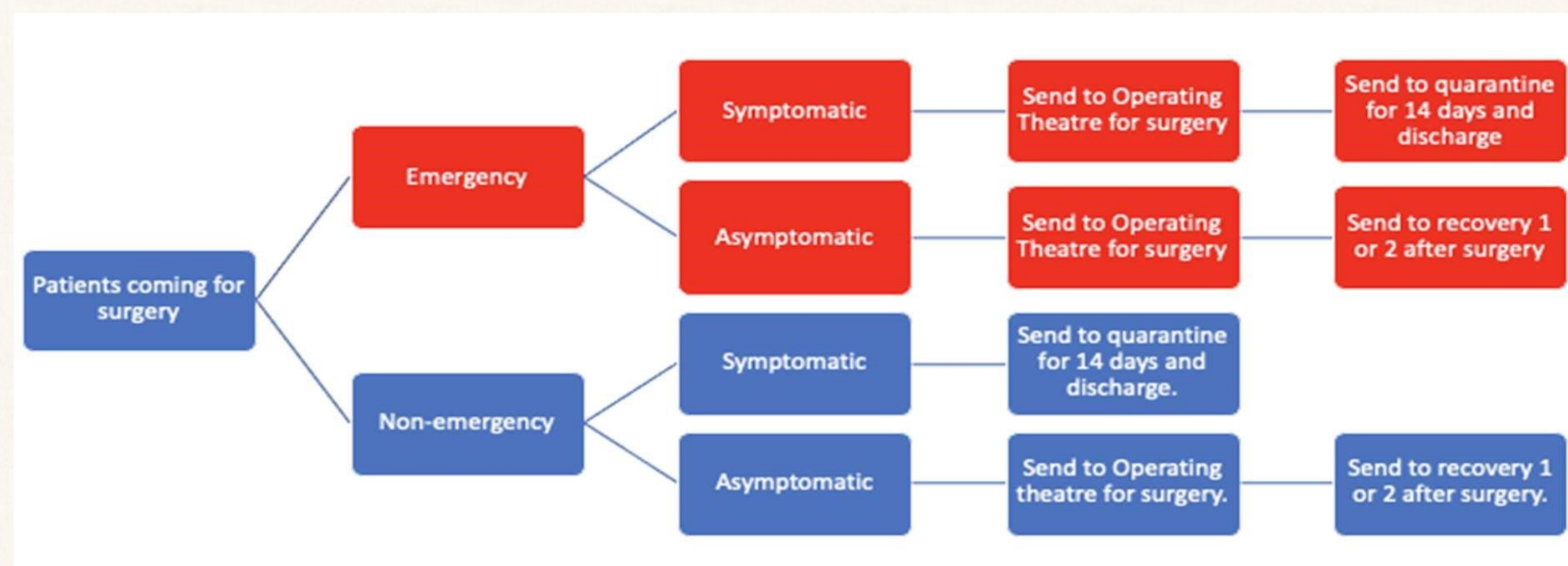


Figure 2: Movement of Agents in the Model



User Interface

A **user-friendly interface** was also implemented for the model to allow users to **configure model parameters** and **test different scenarios**

- Quick and easy setup for model parameters
- Customized charts and fields for displaying model output
- Allows flexibility to respond to changes in pandemic settings

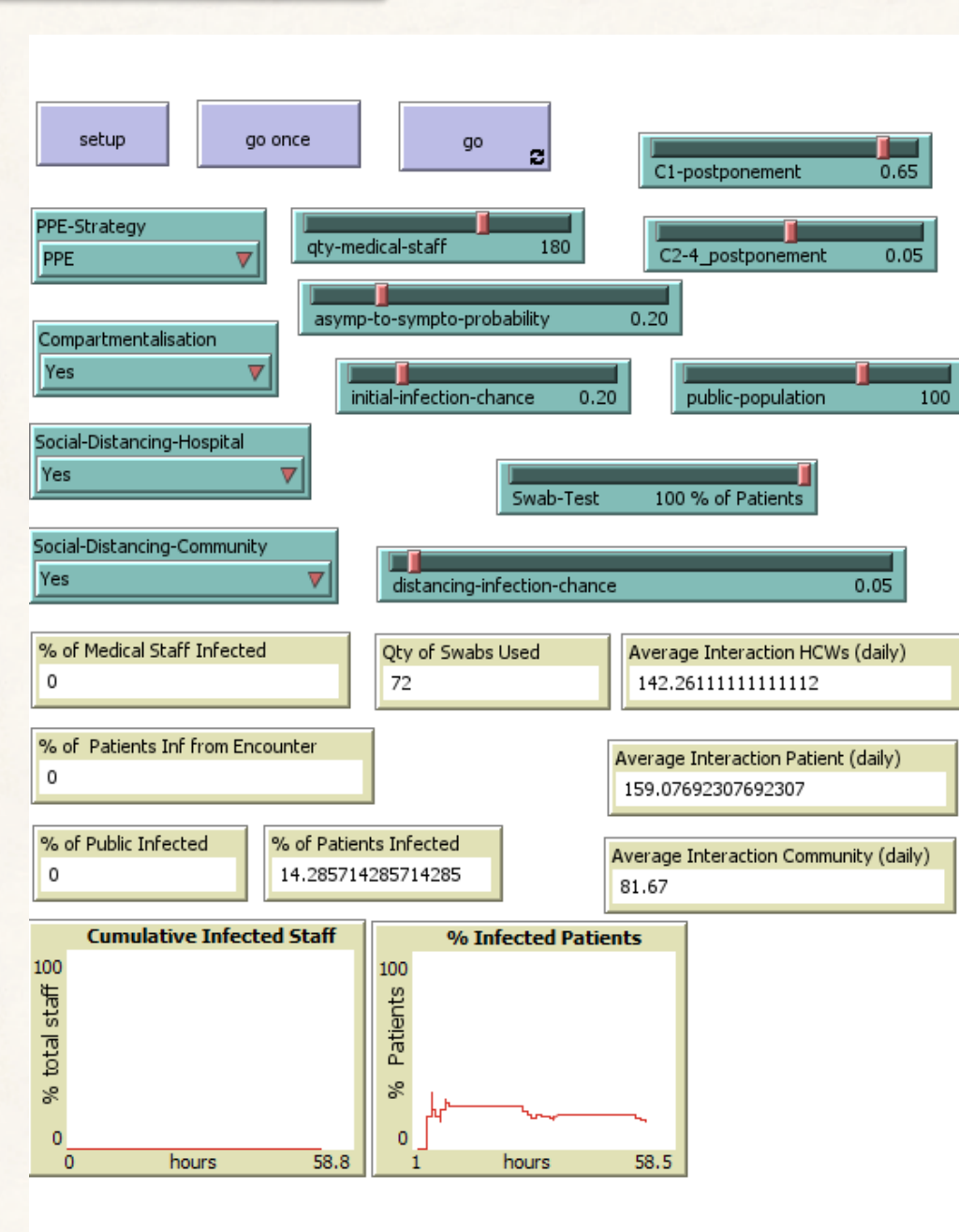
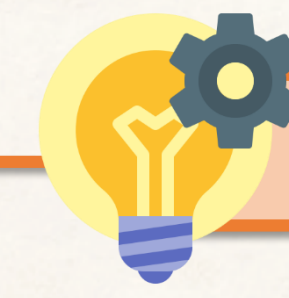


Figure 3: Scenario Parameters User Interface



Risk Management Strategies

Different combinations and levels of effectiveness of 5 strategies as well as pandemic characteristics were evaluated and compared their effects on the risk of HCWs infection rates.



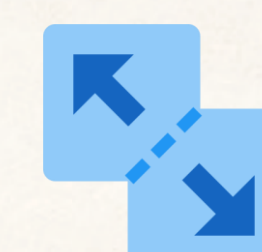
Rationalised PPE Use



Postponement of Elective Surgery



Screening of Asymptomatic Patients



Compartmentalization of Care Teams



Social Distancing



Results & Discussion

The strategies were evaluated using the simulation model with 30 repetitions per strategy over a period of one year to determine the **Proportion of HCWs infected** in the hospital environment. Key findings from the results show that:

- Implementation of **full PPE** as well as **compartmentalization** among surgical teams provided the lowest mean infection rate
- Introduction of **social distancing** within the hospital also yields similar results as compartmentalization
- **Elective surgery postponement** reduces the infection rate but similar effects can be obtained with full PPE, social distancing and compartmentalization.

Scenario No.	Elective Surgery Postponement (%)	Social Distancing	Swab Test (%)	Compartmentalisation	PPE Strategy	Mean (SD) % of Infected HCWs Mean/Std Dev
1	0	Yes	100	Yes	PPE	0.037 (0.141)
2	45	No	100	No	Mask	0.037 (0.203)
3	45	No	100	No	No PPE	0.037 (0.203)
4	45	No	100	No	PPE	0.037 (0.203)
5	45	Yes	0	Yes	PPE	0.056 (0.224)
6	45	Yes	100	No	PPE	0.074 (0.192)
7	0	Yes	100	No	PPE	0.093 (0.415)
8	0	No	0	No	Mask	0.407 (0.743)
9	0	No	0	Yes	Mask	0.407 (0.837)
10	0	Yes	0	Yes	Mask	0.407 (0.91)
11	0	Yes	0	No	No PPE	0.463 (1.177)
12	0	No	0	Yes	No PPE	0.5 (0.855)
13	0	Yes	0	Yes	No PPE	0.5 (0.961)
14	0	No	0	No	No PPE	0.593 (1.081)

Table 1: Comparison of Scenario Analysis Results (Simulated Data)

Recommendations

- The deployed strategies are effective and **different combinations of strategies** can be used based on other factors such as feasibility and ease of implementation
- Sensitivity analyses can be conducted to evaluate the robustness of strategies to the severity of the pandemic and can also be extended to pandemic management for other infectious diseases



Conclusion

An agent-based simulation model was developed to evaluate various strategies to mitigate the risk of healthcare work infection during COVID-19. The implementation of full PPE as well as other risk management strategies among healthcare workers were shown to be effective at reducing the infection rates of HCWs.