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S2.2: Modeling COVID-19 Transmission on the Diamond Princess Cruise Ship

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ABSTRACT

Several lines of evidence support the possibility of airborne transmission of coronavirus disease 2019 (COVID-19). However, quantitative information on the relative importance of specific transmission pathways of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) remains limited. To evaluate the relative importance of multiple transmission routes for SARS-CoV-2, we developed a modeling framework and leveraged detailed information available from the Diamond Princess Cruise Ship outbreak that occurred in early 2020. We modeled 21,600 scenarios to generate a matrix of solutions across a full range of assumptions for eight unknown or uncertain epidemic and mechanistic transmission factors. A total of 132 model iterations met acceptability criteria ($R^2>0.95$ for modeled vs. reported cumulative daily cases and $R^2>0$ for daily cases). Analyzing only these successful model iterations quantifies the likely contributions of each defined mode of transmission. Mean estimates of the contributions of short-range, long-range, and fomite transmission modes to infected cases aboard the ship across the entire simulation time period were 35%, 35%, and 30%, respectively. Mean estimates of the contributions of large respiratory droplets and small respiratory aerosols were 41% and 59%. Our results demonstrate that aerosol inhalation was likely the dominant contributor to COVID-19 transmission among the passengers, albeit considering high ventilation rates and no air recirculation conditions for the cruise ship. Moreover, close-range and long-range transmission likely contributed similarly to disease progression aboard the ship, with fomite transmission playing a smaller role. The passenger quarantine also affected the importance of each mode, demonstrating the impacts of the interventions.