

Source: Atlanta Journal Constitution

A Network-Based Modeling Analysis of Interventions for SARS-CoV-2 Prevention Among Jailed Adults

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BACKGROUND

- Carceral populations are vulnerable to respiratory viral outbreaks
- Factors increasing the risk of transmission include:
  - Overcrowding, limited infection control, and limited health care delivery
- Pandemic and outbreak preparedness for jails/prisons is often uncoordinated:
  - Jurisdictions historically overlook carceral facilities in mitigation efforts, including vaccination

The goal of this research was to determine the impact of different interventions on the spread of SARS-CoV-2 in a jail/prison setting.

METHODS

- Study used roster data from the **Fulton County Jail**
  - Most people incarcerated housed in two-person cells
- Network-based transmission model using EpiModel package
- Two network levels: cell (shared confined sleeping space) and block (shared common space)
- Scenarios simulated over 185 daily time steps
  - 300 simulations per scenario
- Output measures of interest:
  - Number of infections averted (NIA), percentage of infections averted (PIA), average daily quarantines
- Sensitivity analysis comparing daily vaccination rate against proportion traced

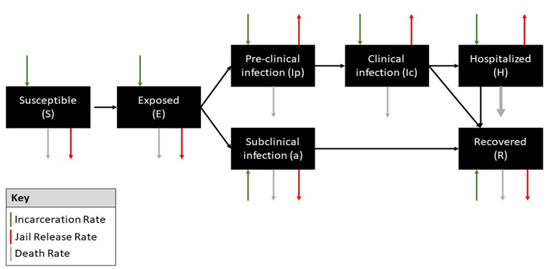


Figure 1. Disease transmission process displaying the stages of infection, transition between stages, and entry/exit processes

Contact tracing at both the jail cell- and block-level, along with jail release, have greater impact on averting new infections than only tracing contacts at the cell-level. Adding vaccination to contact tracing and jail release has an additive impact.

RESULTS

Table 1. Median and IQR cumulative incidence and percentage of infections averted for 9 intervention scenarios against a baseline, and total new quarantines per day for 7 scenarios with 300 simulations per scenario

Scenario Description	Label	Cumulative Incidence Median (IQR)	Percentage of Infections Averted (PIA) Median (IQR)	Total Quarantined per day Median (IQR)
Baseline – no interventions	N/A	2560 (2496, 2616)	–	–
Vaccination only	a	2278 (2229, 2326)	11.0% (9.1%, 12.9%)	N/A
Cell-level contact tracing only (50% of contacts traced)	b	2515 (2459, 2579)	1.8% (-0.7%, 4.0%)	0.83 (0.77, 0.91)
Cell-level contact tracing only (100% of contacts traced)	c	2479 (2420, 2558)	3.2% (0.1%, 5.5%)	1.60 (1.50, 1.70)
All-level contact tracing only (50% of contacts traced)	d	2293 (2233, 2350)	10.4% (8.2%, 12.8%)	9.44 (9.06, 9.76)
All-level contact tracing only (100% of contacts traced)	e	2140 (2075, 2204)	16.4% (13.9%, 18.9%)	14.12 (13.62, 14.70)
Jail release only	f	2061 (1997, 2122)	19.5% (17.1%, 22.0%)	N/A
All interventions combined (Cell-level tracing)	g	1757 (1700, 1816)	31.4% (29.1%, 33.6%)	1.05 (0.96, 1.14)
All interventions combined (All-level tracing – 50% quarantine capacity)	h	1621 (1562, 1679)	36.7% (34.4%, 39.0%)	5.16 (4.83, 5.42)
All interventions combined (All-level tracing – 100% quarantine capacity)	i	1476 (1420, 1536)	42.3% (40.0%, 44.5%)	9.62 (9.08, 10.12)

Figure 2. Percentage of cell and block-level infections averted for each of the nine scenarios – see labeling in **Table 1**

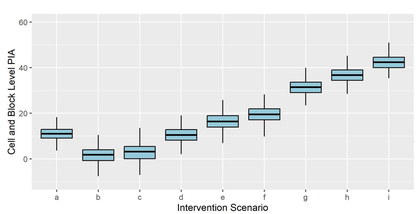
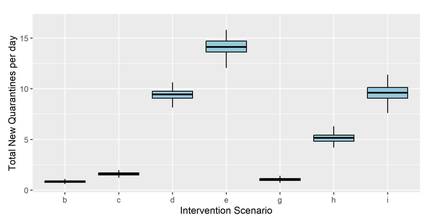


Figure 3. Number new quarantines per day for each of the seven contact tracing scenarios– see labeling in **Table 1**



CONCLUSIONS

- Combination approach required to reduce transmission of SARS-CoV-2 and other respiratory pathogens in jails
- Carceral locations must be prioritized with new vaccines
- Interventions likely protect the community from outbreaks, not just jails/prisons

This research found that outbreaks in jail settings are not completely avoidable due to the structured contact network and external forces of infection, but investing in a multiple intervention approach has the potential to drastically reduce the transmission of SARS-CoV-2 and other respiratory pathogens.

Given that morbidity and mortality were higher among people incarcerated during the COVID-19 pandemic, it is important that policymakers prioritize this vulnerable population in future pandemic preparedness.

LIMITATIONS

- Model layers were not represented hierarchically (cell-level contacts ≠ block-level contacts)
- Assumed a constant community prevalence over time
- Modeled a single dose vaccination (i.e., J&J)

ACKNOWLEDGMENTS

Fulton County Jail (FCJ) for providing roster data, Team Spaulding Lab for conducting testing in FCJ, EpiModel Research Lab for help with model and HPC troubleshooting, and Gates Foundation for funding this project

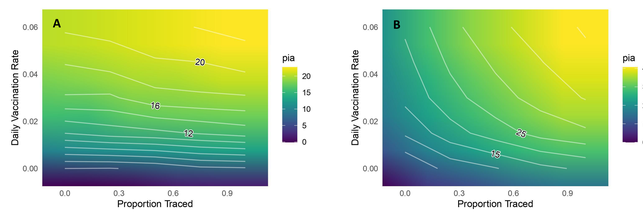


Figure 4. Sensitivity analysis of percentage of infections averted (PIA) between (A) cell-level contact tracing or (B) all-level contact tracing and varying daily vaccination rates

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