Project Title

Using Digital Twin for Infectious Disease Surveillance and Outbreak Investigations

Project Lead and Members

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Organisation(s) Involved

Singapore General Hospital and Changi General Hospital

Healthcare Family Group Involved in this Project

Healthcare Administration

Applicable Specialty or Discipline

Infectious Diseases, Public Health, Medical Social Workers, Healthcare Administrator

Project Period

Start date: Not Provided

Completed date: Not Provided

Aims

- Aim to develop a prototype system to promptly identify persons with infectious disease exposures and to detect infectious disease clusters

Background

See poster appended/ below

Methods

See poster appended/ below

Results

See poster appended/ below

Lessons Learnt

See poster appended/ below

Conclusion

See poster appended/ below

Additional Information

NHIP 2023 – Best Practice Medal (Automation, It & Robotics Innovation)

Project Category

Technology

Digital Health, Data Analytics, Artificial Intelligence, Big Data, Data Modelling, Data Visualization

Keywords

COVID, Contact Tracing, 3D Modelling, Modeling, Acute Respiratory Illness (ARI), Infectious Disease Cluster, 4D-DOSS

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Using Digital Twin for Infectious Disease Surveillance and Outbreak Investigations

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Background

The COVID-19 pandemic brought to light the importance of contact tracing in outbreak management. Digital technologies have been leveraged to enhance contact tracing in community settings. However, within complex hospital environments, where patient and staff movement and interpersonal interactions are central to care delivery, tools for contact tracing and cluster detection remain limited. We aimed to develop a prototype system to promptly identify persons with infectious disease exposures and to detect infectious disease clusters.

Methods

We created a 3D mapping tool 3-Dimensional Disease Outbreak Surveillance System (3D-DOSS) prototype, to obtain a spatial representation of patients in the hospital inpatient locations (Fig. 1).

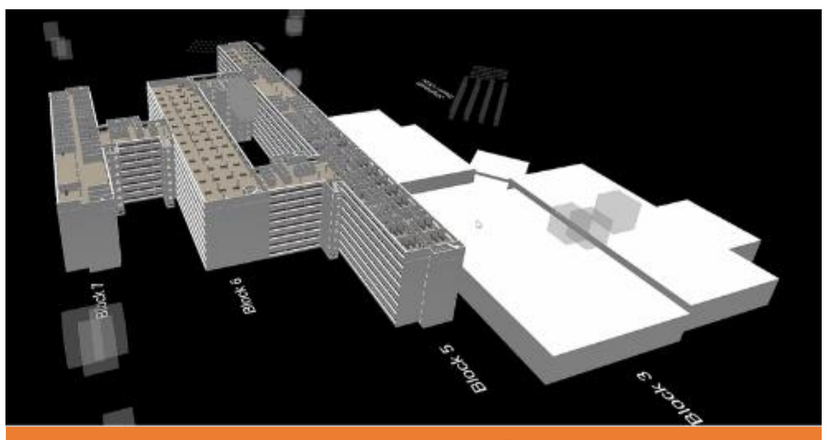

Fig. 1: Digital representation of clinical hospital blocks (GIF)

The hospital physical spaces were built within a game-development software to obtain accurate digital replicas. Clinical, laboratory and patient movement data were then integrated into the virtual map to develop syndromic and disease-specific surveillance systems. Mathematical modelling was utilized to assign risk to individuals exposed based on distance coordinates, room type and ventilation parameters and disease transmission route (contact, droplet or airborne).

The team is working on the next phase, i.e. 4D-DOSS, which integrates real time data and utilizes machine learning and mathematical risk prediction analytic models to further enhance infection prevention capabilities.

Results

We mapped acute respiratory illness (ARI) data for the period September to December 2018. This enabled us to identify an influenza cluster of 10 patients in November 2018. In a COVID-19 exposure involving a healthcare worker (HCW), we identified 44 primary and 162 secondary contacts

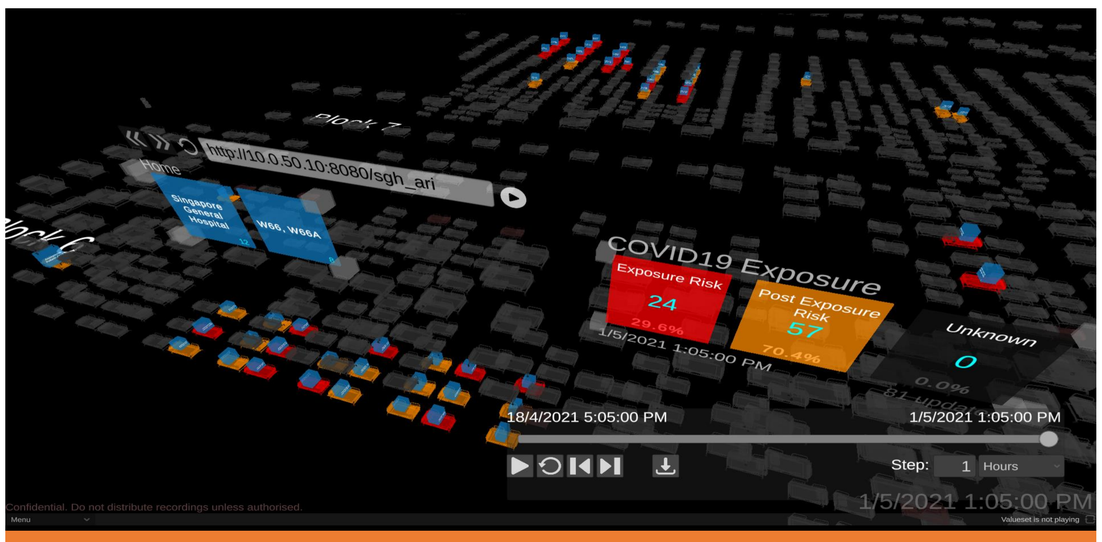

Fig. 2: Digital model showing primary contacts (red) and secondary contacts (orange) in a COVID-19 exposure

who were then managed as per our standard exposure management protocols (Fig. 2)

Conclusion

Through early identification of at-risk contacts and detection of infectious disease clusters, the system can potentially facilitate interventions to prevent onward transmission. The system can also support security, environmental cleaning, bed assignment and other operational processes. Simulations of novel diseases outbreaks can enhance pandemic preparedness planning and bolster health system resilience.