Spatializing and Minimizing The Spread of MRSA

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Problem

- *Methicillin-resistant Staphylococcus aureus* (MRSA) is a dangerous type of bacteria that is resistant to several antibiotics.
- MRSA is dangerous in that it is difficult to diagnose at times, and in some cases can cause pneumonia, other infections, and sepsis.
- Anyone is suspectable to contracting MRSA and is at a greater risk where there is crowding, skin-to-skin contact, and shared equipment or supplies. These risks are all in effect in hospitals.
- While hospitals are designed to heal the sick and assist the wounded, they carry the overlooked risk of contracting infections and viruses. This issue was emphasized throughout the COVID-19 pandemic, but has been prevalent with other infections, and specifically MRSA, as approximately 5% of patients in U.S. hospitals carry MRSA in their nose or on their skin.
- With hospital blueprints and patient data, it is possible to create a hospital network to track MRSA positive cases. Network analysis and understanding spatial properties of this described network can lead to crucial discovery and systematic change in minimizing the spread of MRSA and other hospital acquired infections.

Creating the Network

- The diagramming software, yEd graph editor was utilized to construct the initial network. This software enables custom graph construction and simple exporting of graphs to graphML files.
- More specifically through yEd, blueprint files were able to be uploaded as the background of the network to allow for consistency and accuracy in network construction. This was also essential as X,Y coordinates and edge lengths were able to be preserved exporting the graphML file. Lastly, this software feature allowed for organization and additional accuracy as room numbers were mapped to each node through labeling.
- With a constructed and organized network, the data of positive MRSA cases were mapped according to room number for network analysis and spatial case information.
- Before network analysis, a Python program was created to provide information regarding the MRSA positive cases in neighboring rooms. This program provided results for rooms that were up to three rooms away.

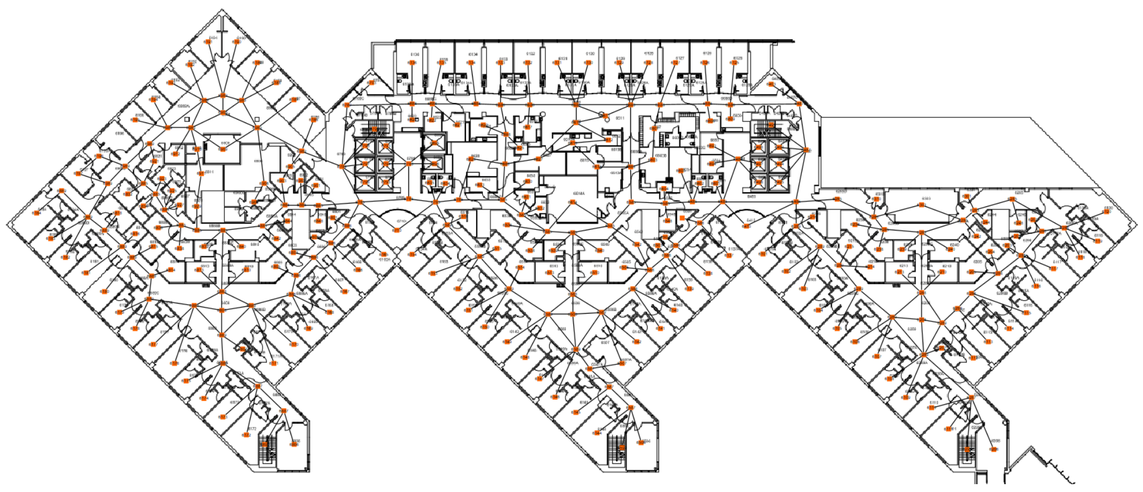

Figure #1

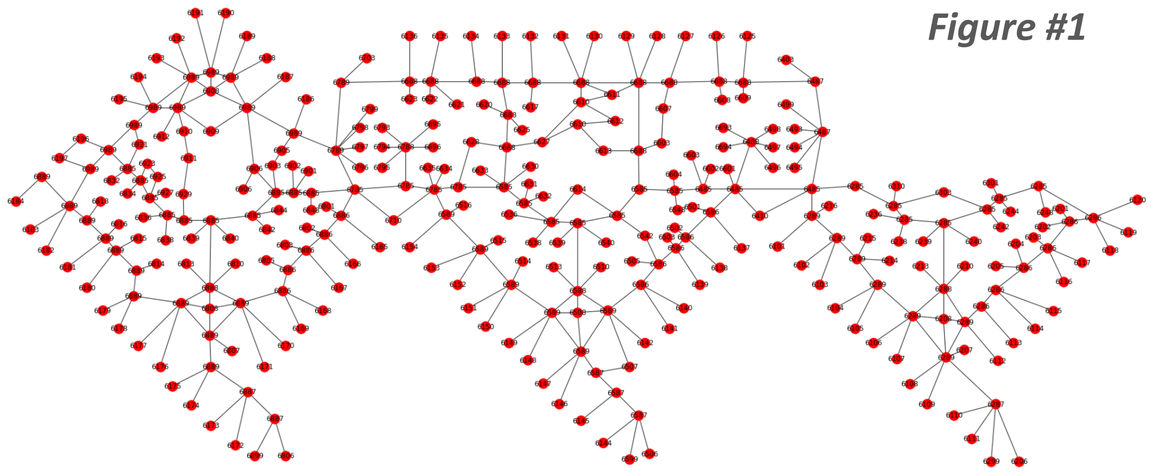

Figure #2

Spatial Properties and Network Analysis

- After uploading the graphML file for each floor plan and matching the MRSA patient data to each room in the Ivy computing cluster, the graphs were read in the Python NetworkX library.
- Here various scripts were written to run tests and create graphs that computed different tests regarding spatial case information and properties that could be compared across different floors.
- The graphs represent a heatmap for degree, closeness, betweenness, and eigenvector centrality as well as positive MRSA patient count associated by room.

Conclusion

- After analyzing the heatmaps constructed in network, it is apparent through the betweenness, degree, and closeness centrality comparisons to the MRSA case count that MRSA cases are more common through rooms located on the edges of the hospital that are close together with few pathways in between.
- From these results, it would be interesting to see how different placement of patients in the hospital effects the number and location of MRSA positive cases. This research opens the door to future studies involving machine learning algorithms to minimize the spread of MRSA and other hospital acquired infections.

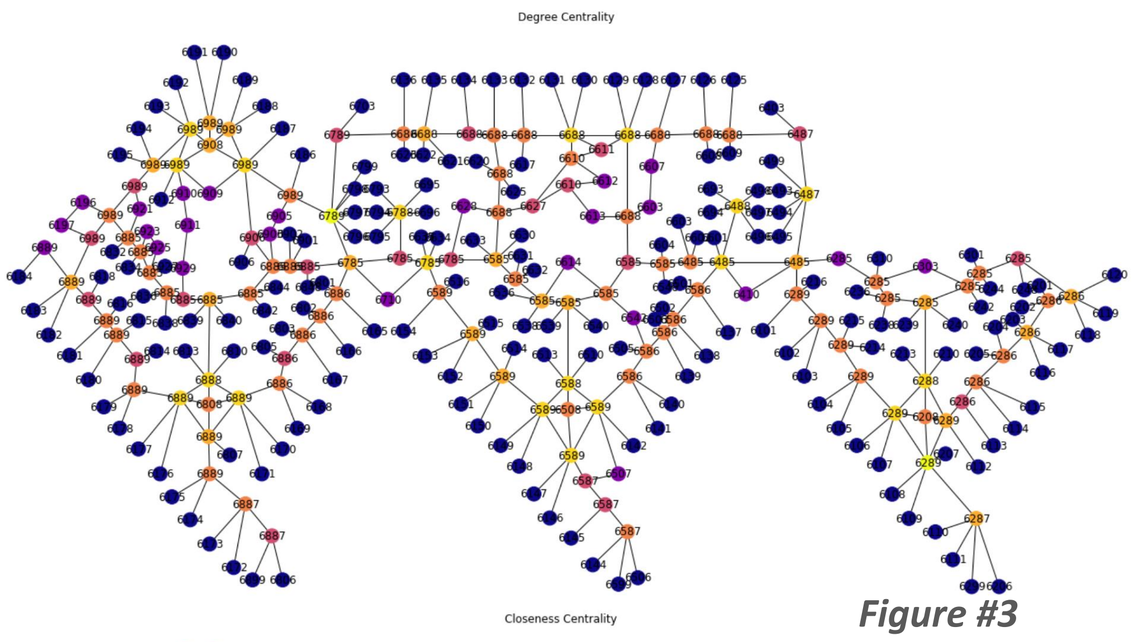

Figure #3

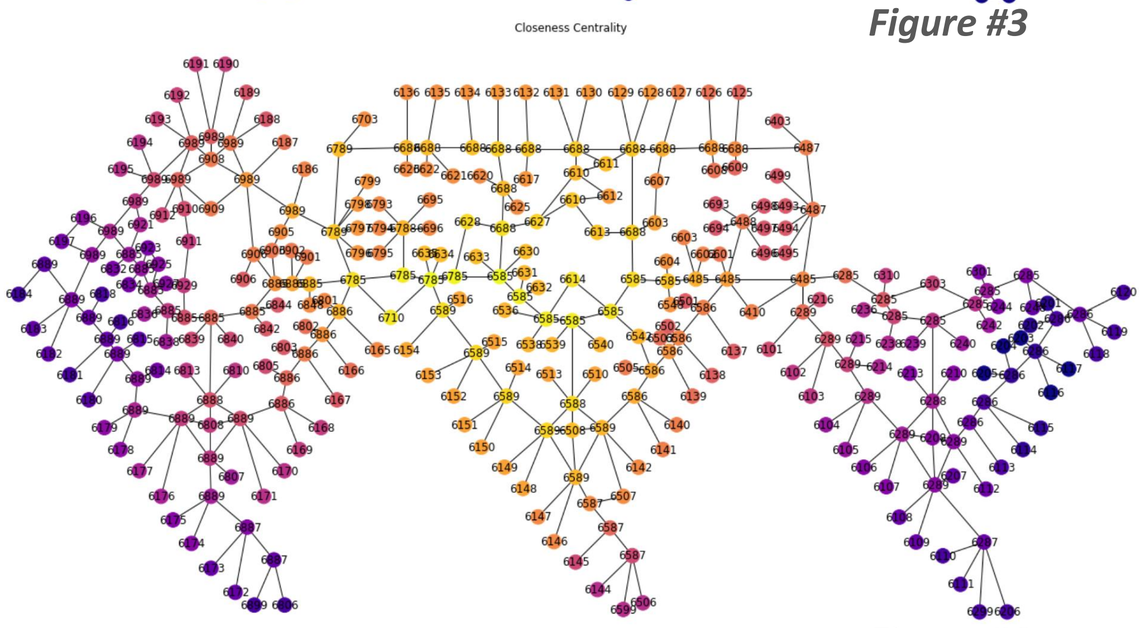

Figure #4

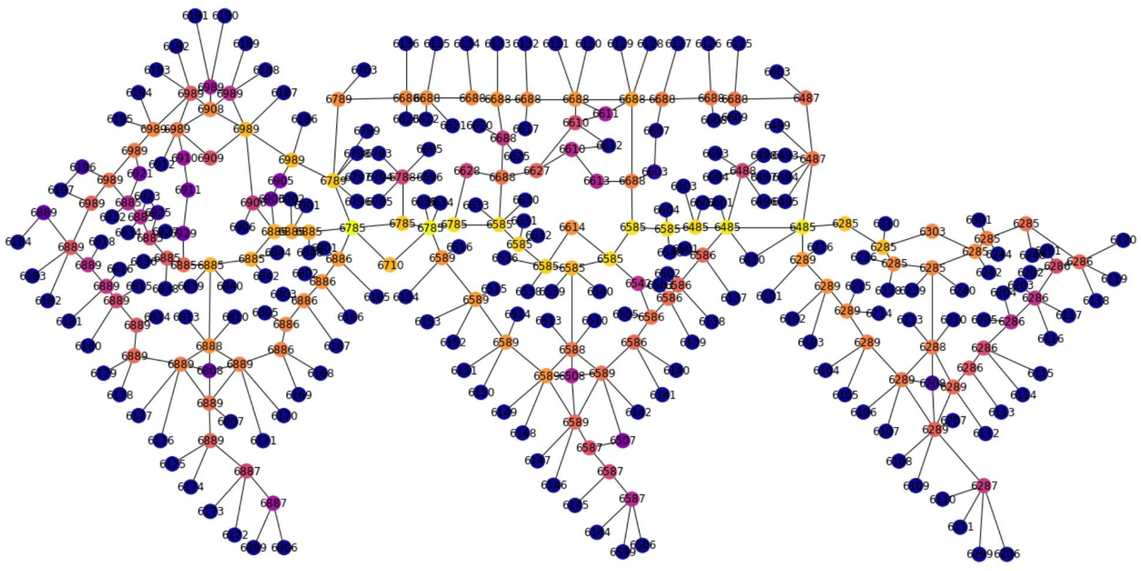

Figure #5

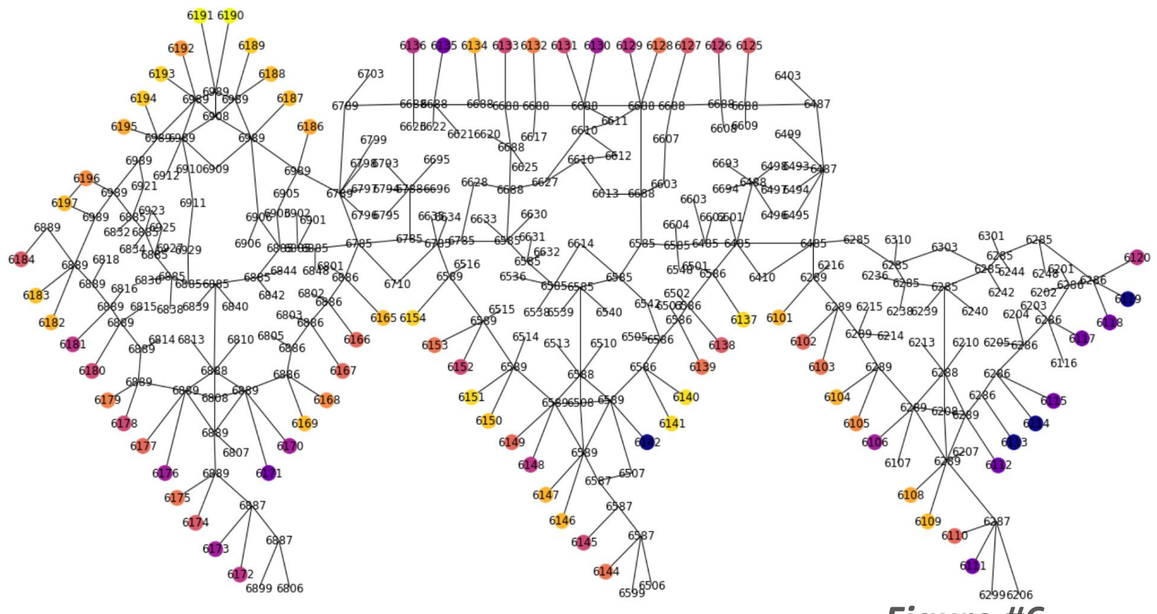

Figure #6

References

- Centers for Disease Control and Prevention. (2019, June 26). *General information*. Centers for Disease Control and Prevention. https://www.cdc.gov/mrsa/community/index.html.
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