

RESISTANCE: *Hot Spot Analysis to Track C. Difficile Prevalence in Massachusetts*

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BACKGROUND



Antibiotic resistance is the ability of microbes to resist the effects of drugs. This epidemic continuously becomes a rising threat, especially in the field of public health, as it becomes tougher to fight various infections throughout different healthcare facilities. Overprescription of drugs, antibiotic usage in the food industry, and an overall lack of knowledge on both the parts of the patient and provider have been the causal reasons behind this epidemic. However, this is not just a matter of containment.

Clostridium difficile (*C. diff*) is a potentially life-threatening bacterium that is the most commonly recognized cause of infectious diarrhea in hospitalized patients and also in residents of long-term care facilities.¹ *C. diff* infections (CDI) have continuously shown evidence to be on the rise, both in incidence and severity. Between 2003 to 2009, the number of discharges from Massachusetts hospitals with a diagnosis of CDI increased over 40%.¹ Furthermore, according to a study conducted in 2007, Massachusetts hospitals spent \$3.2 billion per year due to costs of CDI.²

It's difficult to follow CDI infections, especially as patients are frequently moved from acute to long-term care facilities. Yet, in order to fill some of these gaps and gain more insight, this study will analyze patterns of CDI all throughout parts of Massachusetts. The focus will be to map the healthcare facilities in order to conduct a hot spot analysis and track the prevalence of CDI throughout each county. This will present an idea of where the burden exists in the state, where people might go for healthcare and where they might acquire their infections.

To build this analysis, I collaborated with the Massachusetts Department of Public Health and received guidance from Professor Thomas J. Stopka and his GIS coursework at Tufts University.

METHODOLOGY

The data source was acquired as current as April 2016 from the Massachusetts Department of Public Health. CDI data was collected on the county level based on reported address of residence and was further divided into male and female categories of those under the age of 65 and over and/or equal to the age of 65. Acute and long-term care facility data was acquired with their specific addresses, facilities names and zip codes.

To geocode the facilities, the addresses were converted into longitudinal and latitudinal locations based on each hospital's respective address. This was turned into a shapefile and added to ArcMap to display XY data. This created a dot density map of all the facilities throughout the state of Massachusetts, which can be seen in Figure 1.

CDI data was later used as an overlay on this map to understand where people might seek out healthcare or where they may have contracted the infection. The hot spot analysis was used to determine the presence of any statistically significant clustering in the spatial pattern of the data.

RESULTS

Based on the results, Middlesex and Essex County had the highest prevalence of CDI, especially among females and those who are over the age of 65. Franklin and Barnstable County had the least amount of CDI.

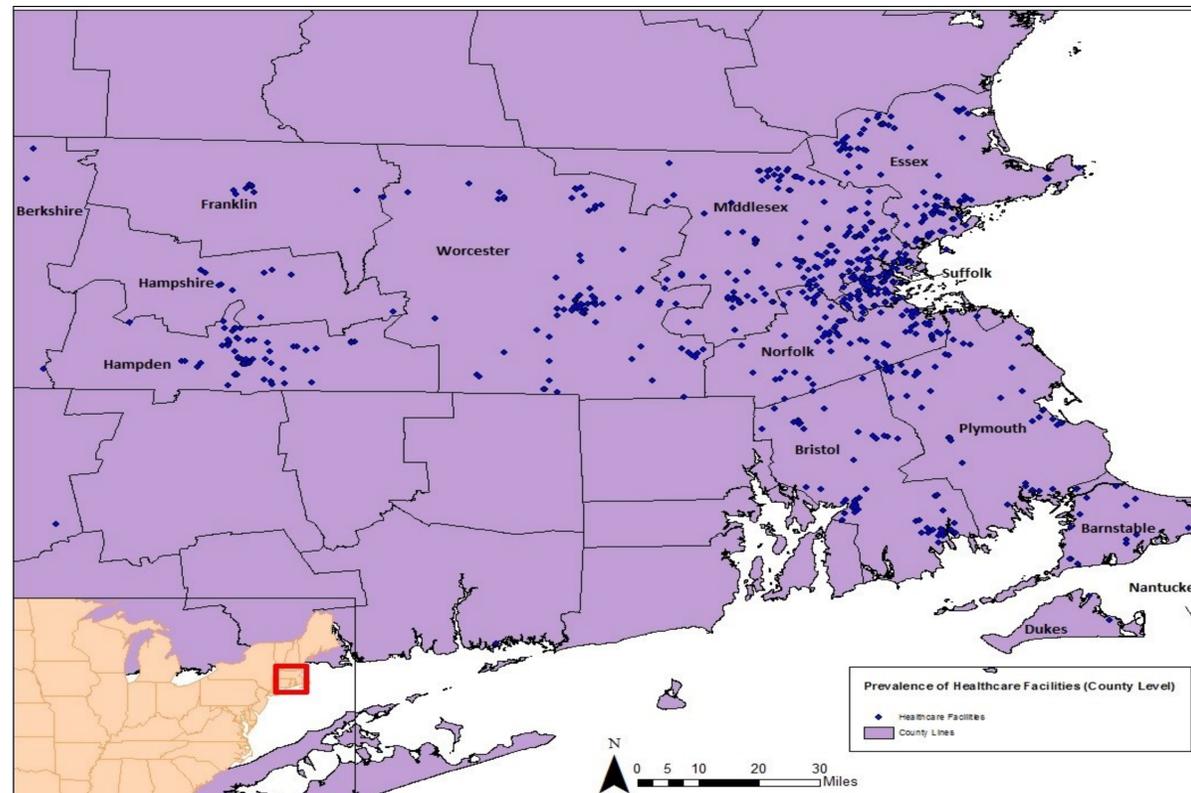


Figure 1. Prevalence of healthcare facilities throughout each county within the state of Massachusetts. This base layer was used to later conduct a hot spot analysis to visualize the burden of CDI in both genders.

It is unknown whether those of Franklin and Barnstable County have either failed to report these incidences or if there really are such few cases of CDI. If the latter is the case, further investigation on these results and how healthcare facilities may manage this containment could be looked into. Suffolk County holds the least amount of cities, with Boston, Revere, Chelsea and Winthrop. However, according to Figure 1, the density of healthcare facilities can be easily visualized. This justifies the intensity of the patterns seen in the hot spot analysis.

It is noteworthy to mention that with multiple counties, not all county lines are drawn the same. Barnstable County holds only 18 different cities, while Middlesex County has 51 cities. In turn, this creates a discrepancy as the number of healthcare facilities differs based on the populations' needs throughout each county.

Based on this knowledge, I think it would provide more insight if data was collected on the city level or even throughout each hospital. It is a large task and a greater dataset to acquire, but county data seems to provide only a general and relative idea of the association between CDI and healthcare facilities throughout the state.

DISCUSSION

The dot density map and hot spot analysis is a great visualization tool—to understand the magnitude of CDI prevalence, specifically throughout every county in the state. It produces a general connection between patients and where CDI may have been acquired and that is value information when providing recommendations for future policy changes and research.

These findings are general implications that although CDI may seemingly be under control, it could easily spread and contribute to the future of antibiotic resistance. Because hospitals are always in connection with one another, these findings can be used to generate collaborations with ongoing quarterly

reviews of CDI data, enhancement of staff engagement and quality improvement to reduce the overall number of incidences throughout the state of Massachusetts.

Policies changes that revolve around quality measures can promote leverage for these hospitals to keep the number of infections down every year.

Overall limitations included specificity of the data surrounding individual hospitals and the challenge having no comparative data from previous years. Preceding data could have been helpful when analyzing trends of resistance and the extent of CDI. Understanding the trajectory of past and current data could help researchers target their audience and develop ways in which to decrease gaps and limitations that may not have been accounted for throughout each county.

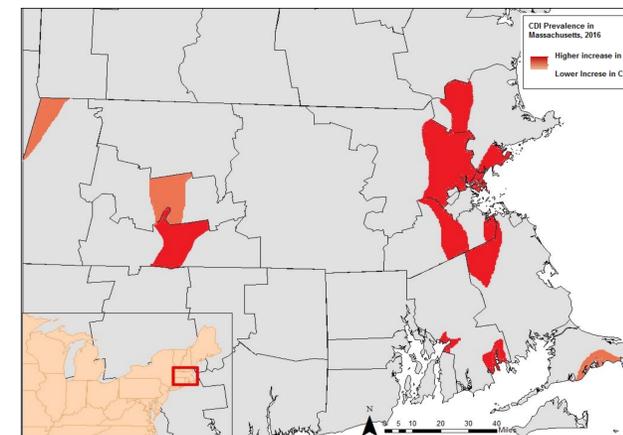


Figure 2 This hot spot analysis depicts the density of CDI occurrence throughout each county. Highest incidence is seen throughout Middlesex and Essex County, while the lowest can be seen in Barnstable and Franklin County.

SOURCES

Data Sources: JCVI, MDPH, Census Data

References:

- Alliance for the Prudent Use of Antibiotics. (2013). Programs to prevent *C. difficile* infection: a multiple strategy approach in Massachusetts, pp. 1-2.
- O'Brien, J., Lahue, B., Caro, J., & Davidson, D. (2007). The Emerging Infectious Challenge of *Clostridium difficile* – Associated Disease in Massachusetts Hospitals: Clinical and Economic Consequences • *Infection Control And Hospital Epidemiology*, 28(11), 1219-1227. <http://dx.doi.org/10.1086/522676>



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