

Expansion of Antimicrobial Resistance in Correlation with Antibiotic Use on Livestock



Alina Taniuchi

Department of Geography and Regional Studies, Public Health Major, University of Miami



Background

Antibiotics have long proved to be some of the most important technical medical advances in treating microbe-borne diseases in humans. More recently, their scope of use has expanded to plants and animals, and has been exploited as a growth or product enhancer for livestock. This unnecessary overuse of these vitally important medical treatments has led to the emergence of many antibiotic resistant microbes. According to Doane and Sarenbo (2014) over “23,000 people die and 2 million people get sick from [these] infections in the USA” every year. The antibiotic over usage has additionally led to pollution of nearby environments, which is threatening or eliminating many major components of ecosystems (Martinez, 2009). In order to meet the food supply needs of an increasing population, concentrated animal feeding operations (CAFOs) have emerged for many livestock. Most CAFOs are overcrowded and many introduce copious amounts of antibiotics to their animals and consequently the surrounding environment.

Objective

This study aims to determine whether there is a correlation between density of concentrated animal feeding operations to incidence of infections resistant to antibiotic treatment in humans.



Methods

Data was collected from a variety of sources:

- ✓ Cattle data from 2012 was downloaded from the U.S. Department of Agriculture’s National Agricultural Statistics Service (NASS)
- ✓ CAFO locations came from the Environmental Protection Agency’s map of Large Concentrated Animal Feeding Operations (CAFOs) and EPA Inspections and Enforcement Actions accessed via ArcGIS online.
- ✓ Information on resistant infections from 2011 to 2014 was obtained from the Center for Disease Control and Prevention’s National Healthcare Safety Network.

IBM SPSS Statistics was used for statistical analysis and the creation of the graph. ArcMap software was used to calculate new data fields and create maps.

Results

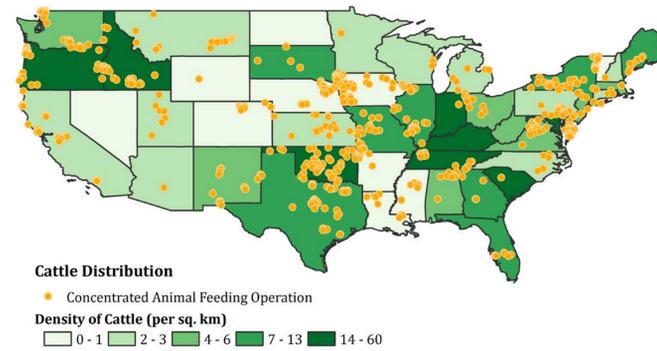


Figure 1. Locations of large CAFOs across the United States
Large concentrated animal feeding operations are farms with considerably large densities of livestock that often overuse antibiotics in feed as a growth promoter.

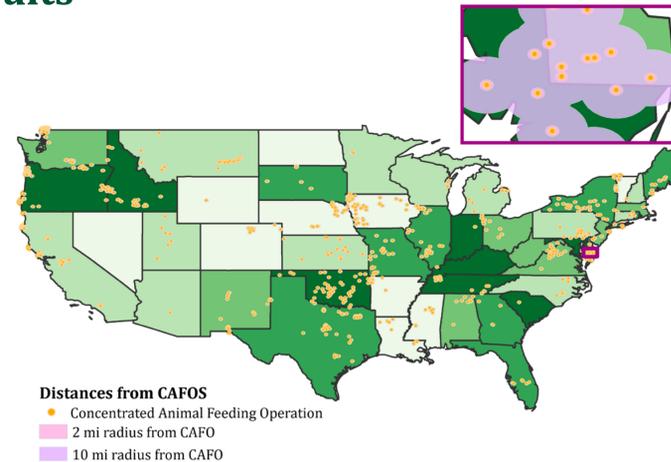


Figure 2. CAFO pollutant effects on surrounding area
Pollution from CAFOs take on a range of forms, including waste that contaminates ground and surface water, and release of gaseous and particulate that significantly reduce surrounding air quality. In two miles surrounding CAFOs, significant respiratory impairments can be seen, and the affects still seen up to ten miles. So far, research is limited on the exact spread of water contaminants, but it is speculated to be vast.

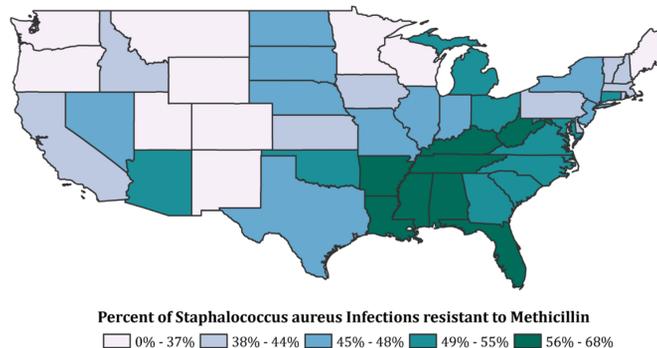


Figure 3. Prevalence of MRSA
Methicillin-resistant *Staphylococcus aureus* is a serious bacterial infection that can cause skin infections, sepsis, pneumonia, and/or bloodstream infections. MRSA is resistant to many forms of antibiotics and considered of serious threat level by the CDC.

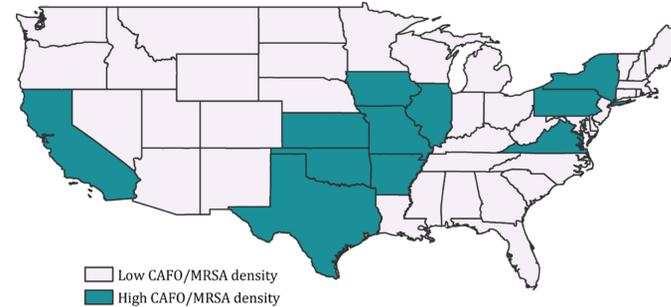


Figure 4. States with high CAFO and MRSA density
Means of both CAFO number (25) and MRSA prevalence (45%) were determined independently. Using these values as limits, states were selected that contained above average of both values.

Relationship between CAFO density and MRSA prevalence by state

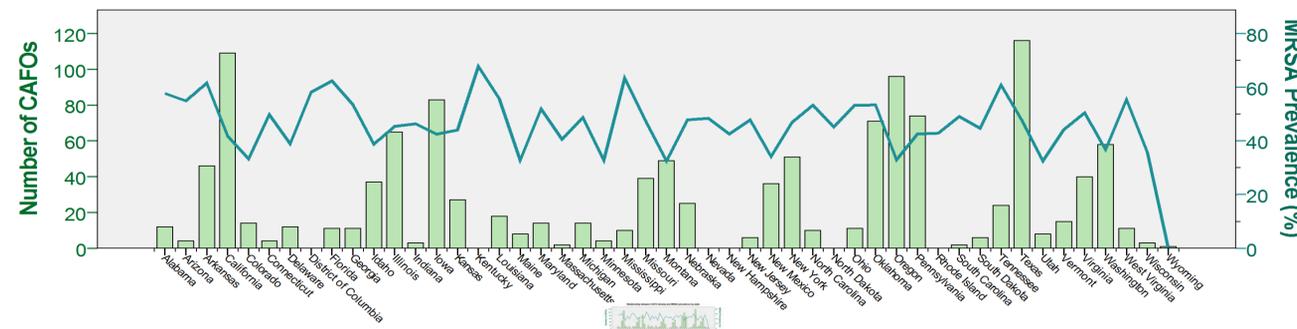


Figure 5. Graph showing relationship between each state’s CAFOs and MRSA prevalence
A significant ($p=0.0002$) negative correlation ($p=0.0002$, $Z=-3.700$) was determined for the correlation between CAFOs and MRSA prevalence by Wilcoxon matched pair test.

Discussion and Limitations

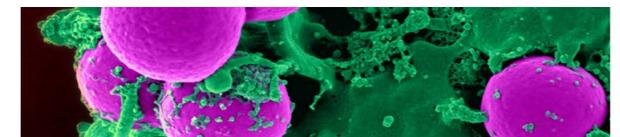
The maps and graph created show a significant but negative correlation between large CAFO concentrations and antibiotic resistant infections. Since MRSA can be aerosolized and antibiotics can get into water supplies which then enter watersheds that can expand into surrounding states, it could be that one state’s CAFOs may cause an increase in another state’s incidence of resistant infections.

A confounding variable that may affect MRSA incidence is antibiotic use, which is generally high among CAFOs, but may vary with regards to amount or type of antibiotics. This discretion in antibiotic administration may be more significantly affected by the type of livestock raised at each CAFO.

Data on incidence of human antibiotic resistant infections was only available at the state geographical level, so more precise maps showing direct effect of CAFOs could not be created. CAFO data on these maps represent farms in the large CAFO category (e.g. cattle $\geq 1,000$). A more accurate depiction of these concentrated farms would include CAFOs within all size categories, and also allow for a deeper level of analysis.

Conclusion

- According to the FDA, in 2014, 84% of domestic sales of antibiotics went towards use in livestock, with 62% of this being medically important antibiotics for humans.
- While antibiotic use is important in veterinary medicine, the risks of indiscriminate use of antibiotics in food animal feed vastly outweigh the slight benefits they may produce. Restrictions to overuse should be imposed on agricultural practices that are increasing pollutants to the environment and the selection for antimicrobial resistant strains.
- An interesting opportunity of research expansion on this topic is looking into which health care facilities report the highest number of antimicrobial resistant infections, and determining their proximity to CAFOs and watershed draining CAFOs.



Acknowledgments

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