Disease X is a WHO created theoretical disease that "represents the knowledge that a serious international epidemic could be caused by a pathogen currently unknown to cause human disease." Despite the inherent lack of information about Disease X’s origin, transmission, or pathobiology, it is possible and necessary to predict relative risks of states of an outbreak so as to maximize efficient use of resources to prevent those outbreaks. As the world becomes more interconnected, airports provide an increasingly large potential source of an outbreak. The object of this project is therefore:

1. Determine the relative risks of importing a case of Disease X through each of the 40 largest US international airports given a random disease origin.
2. Determine relative risk of states of an outbreak of a disease based general demographic and sociological data.
3. Predict which states are at relatively higher risk of importing a case of disease X through international air traffic, and having that case result in an outbreak in the state.

Methodology

The passenger traffic of the top 40 US international airports was obtained, including manifests as to which major international routes went through each respective airport as well as the proportion of traffic these routes made up. The airport pairs of these major US-international routes were determined, and risk was assigned to each international airport as a direct function of total travel through the airport. Next, risk posed by significant international routes was determined and the total risk posed by international routes was calculated.

While calculating risk, it was possible to see that there was not an even distribution of international travel; airports on the coasts carry the vast majority of international travelers per year, while airport codes in yellow represent airports receiving more than 1 million but less than 10 million passengers per year. This means that there are international ‘hubs’ or ‘gateways’ in the US Department of Transportation refers to them that proportionally receive more US international travelers per year. In the next section of analysis determined that the top region at highest risk of an outbreak was Maryland, followed by District of Columbia, New Jersey, Pennsylvania, and Illinois. These states have a large proportion of their population utilizing mass transport as well as relatively high population densities. These regions all had at least four times the odds of the least outbreak prone state (North Dakota). The lowest risk states were: North Dakota, South Dakota, Montana, Nebraska, and Kansas. These states were primarily lowest due to their extraordinarily low population density as well as lack of reliance on mass transport.

The final stage of Analysis revealed that California was the most likely state to both import a case of Disease X, and have that case result in an outbreak, while the least likely state was, unsurprisingly, North Dakota. California had nearly 350 times the odds of North Dakota of an outbreak due to an aerially imported case. The next highest risk states were New York (286x), Florida (126x), Illinois (82x) and Georgia (61x).

Life Expectancy

Public Transportation

Healthcare Spending

Population Density

Conclusions and Policy Recommendations:

While there are significant limitations to this study, it nonetheless provides useful information as to relative risks of states. States such as California, Florida, and New York should receive increased surveillance at international airports while states such as Ohio, Alaska, and the Dakotas should receive relatively less. Efficient resource allocation is critical to countering importation risks and the rough odds calculated here could serve as relative guidelines for public health surveillance spending.

It may not be possible to determine where the next pandemic may arise from, but with efficient resource allocation, it may be possible to prevent it from ever entering the US.

Limitations

While these data are useful in estimating relative risk of US states, there are far more factors that can be considered when calculating risk of a state to infectious diseases. Epidemiology was streamlined, and in reality, certain areas would be at higher risk than others, such as New York City as opposed to upstate New York.

This model would assume that the majority of people flying out of an airport reside in that state. While this is largely applicable, this downplays the importance of residence of international travelers in different US states from their gateway airports.

This model gives greater weight to larger airports than smaller ones, as only the largest 40 US international airports were considered. However, it is somewhat negligible, as the ‘gateways’ to the US service the vast majority of international travel between the US and abroad.

Lastly, this model does not account for individuals crossing into the US states by non-aerial methods. However, the focus of this study was on aerial importation.