

Does the Vaccine Works?

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ABSTRACT

Vaccination programs have led to dramatic declines in the incidence of contagious diseases in the United States over the past century. However, some of contagious diseases are still increasing in spite of the availability of vaccines. We use data visualization as a tool to help analyze the occurrence of contagious diseases in time-series.

Keywords

visual analytics, vaccination program, contagious diseases

1. Introduction

The current low overall incidence of contagious diseases has resulted in a perception that the risk of these diseases is low and, paradoxically, in increased concern about the costs and consequences of vaccination programs (e.g., adverse events, expenses, and inconvenience). (van Panhuis et al., 2013) This is a game-theory principle. People may think the outbreak of contagious disease may never happen again and organized antivaccination movements amplify these problems. We want to use our visualization system to get people's attention of the importance of injecting vaccines. Using data visualization to help us analyze the public health date, thus influencing viewers and make the message more impressive. To design a more user-centered system, we use different types of visualization graph to show different dimension of data.

2. Related Work

We explored the epidemiological data from Tycho project. Original data is very abundant that the websites can allow users choose disease or location, cases or incidents, city or states to investigate different dimensions of dataset. (e.g., Figure 1)

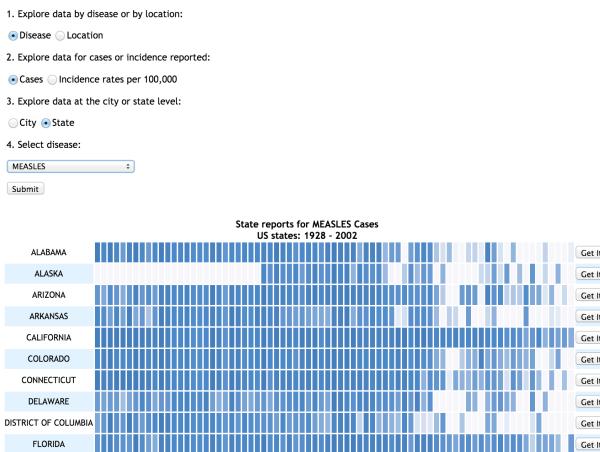


Figure 1. interface design of Tycho project

But we find that it only used one type chart – heat map. Although this kind of chart could show data according to time-series and state at the same time, it's very inconvenient to explore the tendency of case numbers and to compare statistic of two states if they were arranged far from each other. So we tried to use multiple charts to meet above two demands of users in our systems.

3. Interactive Visualization Design

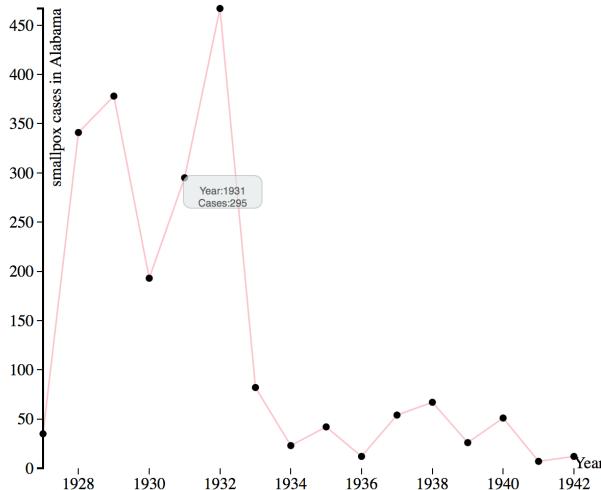
For the vertical comparison, we use line chart to show change trend of infection case of specific contagious disease. We can detect the difference of infection case before and after the licensure for a specific disease. Also, the vaccination programs that the government enacted that people are forced to inject vaccines can have an importance effect on the transmission rate.

For horizontal comparison, we use bar chart to show the difference of infection case across different states. Due to sanitation and medical condition among the states, which may influence the transmission rate, they may have different incidence rate. In addition, some of state governments promulgated decrees to force people to inject vaccine, while other governments did not. This may also influences the rate.

And we use the choropleth to show the overall picture of incidence rate in geographical distribution. We can clearly and directly detect the distribution of the infected people geographically. We code the data into the color of graph to show the difference of infection rate.

3.1 Line Chart

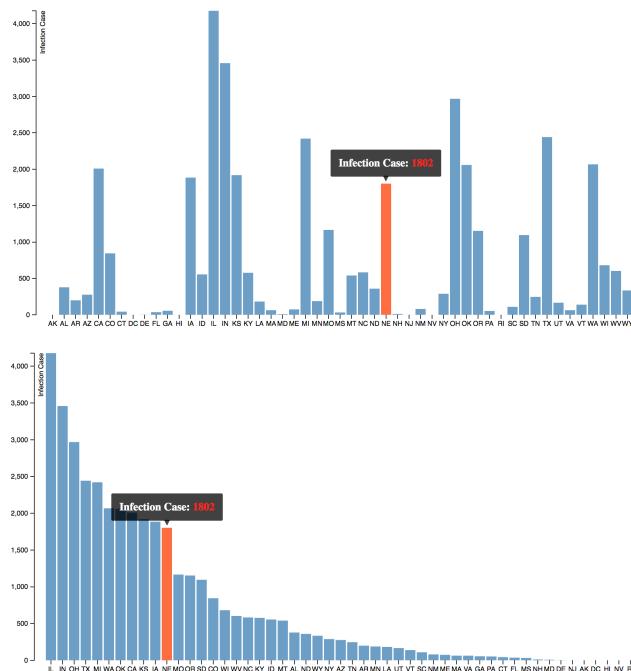
We made a line chart to present the infection cases in a specific state through a period of years. And we use the tooltip to show detail values when the mouse hovers. (e.g., Figure 2) Now line chart is independent and it shows up only according to the state name user choose. Next step, we will set up links between this chart and choropleth map to make it appears aside when mouse hovers on a state in the choropleth map.



3.2 Bar Chart

We made a bar chart to present the total infection cases of every state in a specific year. Still, we use the tooltip to show the details and change the color of the bar that the mouse hovers. In that case, we can emphasize the number and lift the readability up.

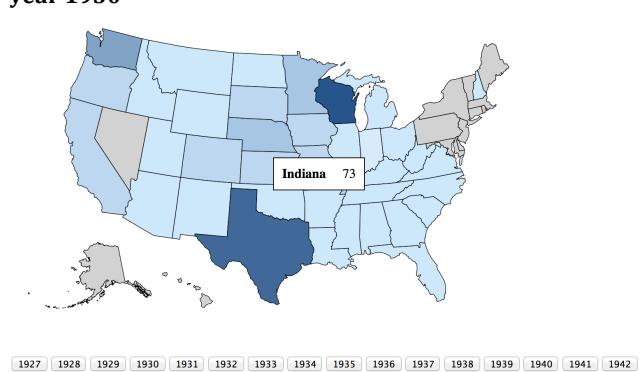
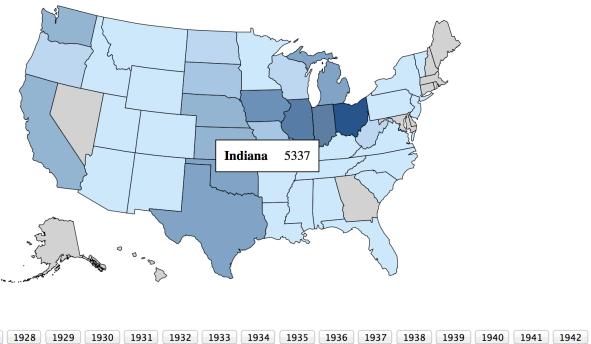
Due to the differences across the states, we want to make a comparison for that disease. Thus, we add a function so that the user can make a sort. Below is the figure showing the results after sorting. (e.g., Figure 3)



3.3 Choropleth

We picked up a specific contagious disease—smallpox to present our early blueprint. We gave the user right to choose specific year he want to investigate. In this early visualization system, we chose 5 years during which the user can choose from. In terms of his/her searching conditions, there is a corresponding choropleth map showing the results on the screen.

We use the tooltip to show the exact number of cases when mouse hovers the state, therefore, the user can get the specific information during the presentation. Besides, encoding with different color for different cases across the states, we can easily tell the difference across the US. The more cases it has, the deeper the color is. (e.g., Figure 4, Figure 5)



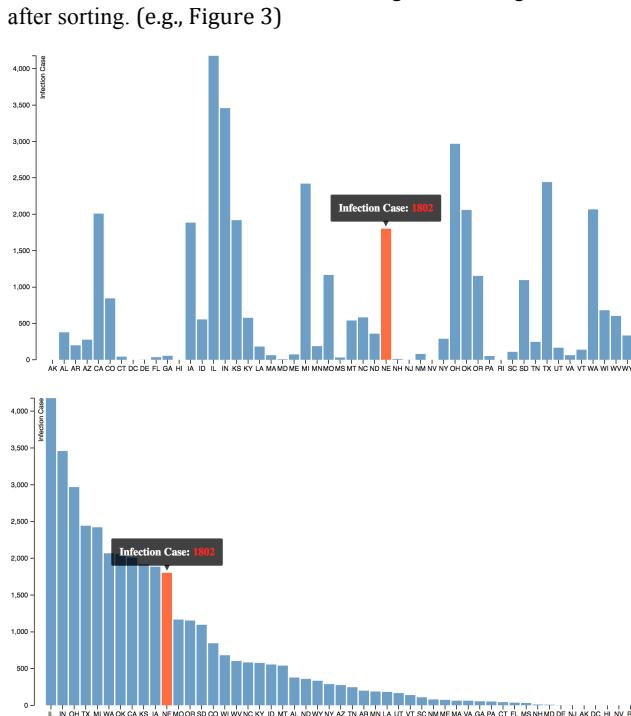
4. Visualization Techniques and Implementation Notes

4.1 System Architecture

The system contains a home page and three parts, respectively choropleth, bar chart and line chart. All the three parts can link to the home page. However, the three parts cannot link to each other.

Because the data dimensions of the three graphs are a little different, we put the three graphs into three pages separately. The line chart shows the change of time series for a certain state of certain disease. The bar chart shows the comparison of all the

Figure 2. the number of smallpox infection cases in Alabama from 1927 to 1942



states for a certain disease. So we designed the homepage as it shown in Figure 6.

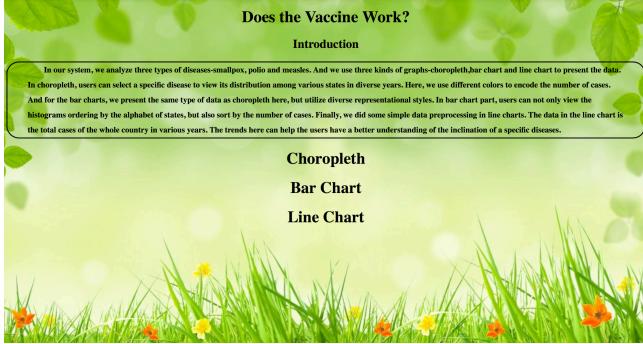


Figure 6. homepage links to three different charts

4.2 Interactive design

For the interactive design, each part of graph is a little different from each other.

4.2.1 Line Chart

For the line chart, there are two dropdown lists for the viewer to choose specified disease and state. The user can choose different state for the same disease to compare the change trend on time series between these states. The viewer can also hover on each time point to see the value of that point. (e.g., Figure 7)

The Trends of Diseases Across The Years

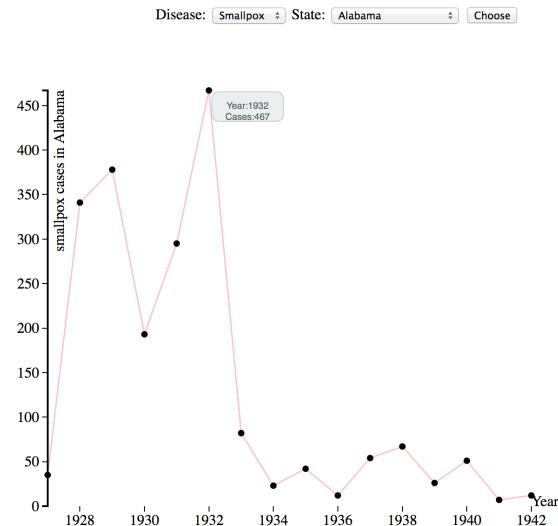


Figure 7. interactive design of line chart

4.2.2 Bar Chart

Most interestingly, we add cascading properties for the dropdown list. If we choose a certain disease on the dropdown list, the time range will also change on the dropdown list for the year. The time range synchronize with the data in the csv line. We also add a button for the sort functions. The original bar chart is sorted for alphabet order of the state. If we click on the sorting button, the bar will be sorted on height of each bar in descending order. We also add hover functions on the bar chart. If we use mouse to hover each bar, it will show the value of that bar. (e.g., Figure 8)

The Comparisons for The Diseases among The States

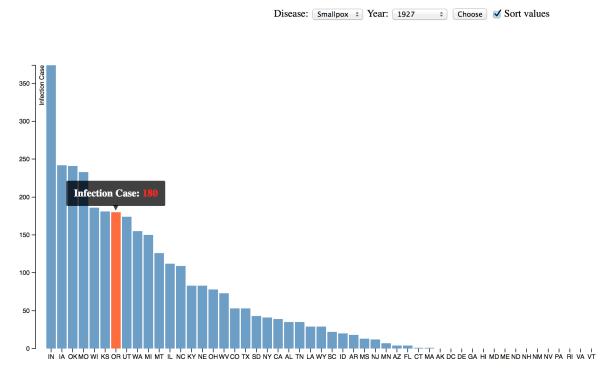


Figure 8. interactive design of bar chart

4.2.3 Choropleth

First, for the choropleth, we add animation effect on this part. If we enter this page, the color of choropleth for each state will change in a certain time range across the time series. The viewers can detect the difference of the number of infection cases between two states just comparing the colors on the map of these two states. For example, although two states are adjacent to each other, the number of infection case for a certain disease between these two states will be largely different. We also add time buttons on the bottom of the choropleth graph. If the viewer can choose time certain button, there will be a choropleth graph on that certain year. We also add a drop list for the viewer to choose certain disease. (e.g., Figure 9)

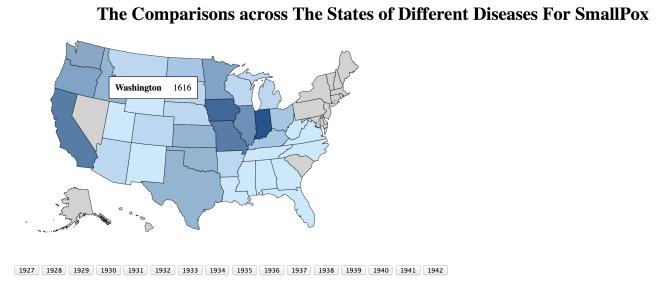


Figure 9. interactive design of choropleth

5. Evaluation

We came up with three main tasks we dealt with in our project: Could the user find out the general trend of a certain disease? Could the user search the details of a certain disease in a certain year? Could the user find the influence of the vaccine through the visualization?

Through the operation of our system, we first could get the trend of a specific disease overall with the line chart. Also, according to the line chart, we found the influence of the vaccine based the dramatic decline in the graph. Besides, based on the bar chart, we could get the exact numbers of the cases of each state. In addition to the two charts above, we could compare different situation across the United States.

6. Discussion and Conclusion

6.1 Advantages

In our current system, users can view three kinds of graphs, from which they can get a pretty clear image of the tendency of a specific disease among various states in diverse periods.

In the map, viewers can notice the severity of a specific disease immediately by the first sight. And when open the map, viewers will see the animation of changes in different years first. And if users choose a specific year, they can know the cases of that year for a specific state.

In the bar chart, we give the users the exact same information as map, but use different kinds of representational types. In the previous graph, the number encoding by color may be not detailed enough for the users know the most specific information. But in the bar chart, users can view the exact number pretty clearly for each state and the comparisons will be much more clear when sorting by the number cases in various states.

In the line chart, our graph bases on the preprocessing data. Different from the above two graphs, the line charts here show the inclination of a particular disease in different years. Therefor, this part is kind of like analysis for the research. Here, users can get the overall impression about how conditions of the diseases.

And our system can fulfill good interaction between the system and the users. Users can filter the graph according to diseases, years and states. And we design cascading dropdown lists considering the explosion of different diseases in various years.

6.2 Limitations

In our system, users can only view the three kinds of graphs separately. So it may be a little hard for the users to construct a deep understanding of the tendency for a particular disease. And because of limitation of time, our group can't design the graph to show the tendency of a particular disease in the whole country. Thus our analysis here may be less convincing when it come to the vaccine effects of the entire country rather than a specific state.

6.3 Conclusion

According to our analysis, we believe the utility of vaccine is useful in the effect of curbing the explosions of smallpox, polio and measles.

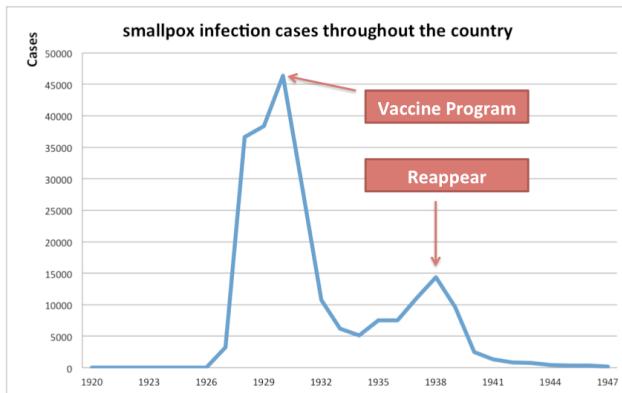


Figure 10. the tendency of disease cases

From the final graph we get, we believe that when start to use suitable vaccine, the infection number for a specific disease will drop down dramatically. However, we also need pay attention to

the future utility if vaccine, because the negligence of it may lead to twice explosion, just like what happened in 1938 for smallpox in the above graph. (e.g., Figure 10)

7. Future Improvement of Design

The purpose of our research is to find out the effects of vaccine on diseases, but now we cannot get the data of injection numbers for each disease, so our system is only to find the trends of disease cases changing among the time by visualization. Also, we had some improvement plans we thought that could make our system more attractive and user-friendlier, however, because of limitation of time and effort we haven't achieved them by now. We list them as our future plan as following.

7.1 Combining all the detailed graphs in the same interface

In this way, when users choose a particular disease, year and state, all the graph can change accordingly, so users can get much more information in the same time and deeper understanding of the inclination of changes. Also, interface in this way will be much cooler than the previous separated graphs.

7.2 Improvement of line chart

Put a static line showing the tendency of the entire country and a dynamic line representing the inclination a specific state in the same graph. This is the original design of for our project, but we can't finish it timely. If we can achieve this improvement, users will have a better impression about the severity a specific disease in different states comparing with the country level.

7.3 Set suitable legends for the choropleth map

Now in the designing of map, we don't have suitable legends for the users because of the code the use for the map. In our map, we design dynamic changes for the color section, which means the minimum value and the maximum value here will automatically be set as the darkest and lightest colors here. In this way, for every year, users can easily compare the differences among various states. But for the dark sides, if users want to compare various years in this graph, they may be misleading. We are still trying to figure out how to deal with it.

8. ACKNOWLEDGMENTS

Thanks to every group members' effort to achieve our system. Thanks Haoqing Liu for accomplishing line chart and partial choropleth map. Thanks Jun Fu for accomplishing bar chart design. Thanks Menghui Ju for accomplishing choropleth map design. Thanks Jie Chen and Jun Fu for accomplishing interactive designs. Finally, Thanks everyone for writing this final report.

At the same time, we thank Yuru Lin for teaching how to use visualization tools and providing information of dataset. We thank Willem G. van Panhuis, John Grefenstette, Su Yon Jung, Nian Shong Chok, Anne Cross, Heather Eng, Bruce Y. Lee, Vladimir Zadorozhny, Shawn Brown, Derek Cummings, and Donald S. Burke for their previous work on this dataset and their free downloadable dataset.

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