Influenza; tracking an emerging pathogen by popularity of Google Searches

Background

Influenza is a wide-spread and occasionally fatal disease, typically infecting children and the elderly. Each year, 5-20% of the U.S. population becomes ill with seasonal influenza and 36,000 people will die from flu-related complications (CDC). Common symptoms include body aches, fever, vomiting, sore throat and general malaise. The flu, as it is commonly known, is caused by a membrane-encased RNA-containing virus and is transmitted from person to person through respiratory droplets after coughing or sneezing. The membrane-enclosure, called the envelope, provides protection from the environment, allowing the virus to live for up to 17 days outside of the body. The RNA encodes the gene-coding sequences necessary for the virus to infect a host and replicate. This virus is unique because it consists of 8 segmented RNA strands rather than one long, continuous genome. These segments are responsible for the ability of influenza to change dramatically; if a host is infected with two separate strains of influenza, the two viruses can exchange segments and birth a novel variant. Although we commonly think of the flu as a human virus, the true reservoir of influenza are birds, although pigs often act as an intermediate host before human infection. Each of the different species carries different viruses, which may or may not be more lethal in the natural host or in humans, should the virus prove to be infectious in humans. Influenza viruses are named for their Hemagglutinin (H1-H16) and Neuramindase (N1-N9) types. For instance, if a cell is infected with H1N1 and H5N2 viruses, it can produce H1N2 and H5N1 progeny. This process is called Genetic Shift. The emergence of these novel influenza strains is often the cause of large flu outbreaks, such as the ‘bird flu’ (H5N1) of 2006 or the ‘swine flu’ (H1N1) as the human immune systems have not seem them before and cannot mount a rapid, anti-body based response. Although are aware of the seasonal nature of influenza, it is important to catch major outbreaks of novel and seasonal strains as early as possible so the appropriate resources and state and national stockpiles of anti-viral medications can be doled out and appropriate vaccines developed. To this end, Google has combined its powerful search engine data with its mapping technology to create a new way to alert the Center for Disease Control (CDC) to emerging pathogen outbreaks, specifically influenza outbreaks. The current method of reporting outbreaks relies on physician notification of the CDC, which, when compared to the new Google method, has historically lagged two weeks behind media reports. As most students are knowledgeable and comfortable with Google and its search and mapping technologies, this serves as a nice segue for increased understanding epidemiology.

Activity

Materials;
• Computers with internet access
• [http://www.google.org/flutrends/](http://www.google.org/flutrends/)
• Colored M&Ms or other candy (preferably separated by color)

**Instructor Prep**

• Reserve computers with internet access if needed.
• Print out handout of questions
• Separate M&Ms into snack-sized Ziploc bags/containers with a few M&Ms in each. Label one ‘H’ and the other ‘N’

**Protocol**

• Split students into 5-8 groups and give each group member two bags (‘H’ and ‘N’) of differently colored M&Ms. Warn them not to eat the candy yet. Allow ~5 minutes for the following; each student in the group should take their candy and interact with members of the other groups, deciding to trade or not trade candy colors randomly. Emphasize that ‘H’ can only be traded for ‘H’ – likewise for ‘N’ candy.
• Regroup the students and make a list of the original color combinations and the new color combinations. Relate this to the Hemaglutinin and Nueraminidase proteins and the genetic shift that occurs in influenza. Students can eat their candy.
• Ask students to generate a list of search terms for Google’s search function to investigate the flu, which they have just given to each other. Explain how Google has correlated the number of Influenza-inquires with actual disease data.
• Provide handout with questions
• Ask students to access the Google Flu Trends website.
• Fill in worksheet

**Other considerations**

• Focuses primarily on visual, inquiry-based learning.
• This may be most useful to teach in the fall, during the typical flu-outbreak season.

**Student Assessment**

For this *in silico* exercise, students are expected to think critically about the trends they observe through Google’s displays.

• Investigate historical data for the United States and your state
  o Are there differences between the two? What are they?
• Compare data from 5 years past to current year
  o Are there differences between the two years?
• What month does influenza typically peak in (in the U.S.)?
• Why is this month/season favorable for the spread of influenza?
• Are there any environments where influenza can survive year-round, or environments where the spread of influenza is inhibited by the weather?
• How does influenza spread so quickly between places?
• What steps can be taken to prevent the spread of the flu?
• What is genetic shift and how does it affect the influenza genome?

Conclusion

By harnessing the power of a familiar technology, Google, we can enable students to feel comfortable investigating the nature of newly emerging influenza strains and gain a concrete understanding of both epidemiology and influenza. From this platform, students can interactively investigate hypotheses and come up with their own answers which may vary from year to year. In addition to the current flu-tracking capabilities, Google also has a related search volume function called Google Insight (http://www.google.com/insights/search) which can allow for students to track and compare other inquires. For instance, searching the Insights database for ‘Nobel Prize’ reveals a regular, annual peak in searches whereas ‘horse’ shows fairly consistent search popularity throughout the year. The availability of this meta-data can be used to make students think about the process of thinking; e.g. why is the word ‘photosynthesis’ searched for the least during July and August of every year? Although photosynthesis is not an emerging pathogen, it provides a key piece of groundwork in understanding how this functionality works and how a novel influenza outbreak may differ in search popularity from a seasonal influenza.

Resources

www.cdc.gov/flu/about/disease/
Google and Emerging Pathogens; Influenza

Jenni Davids
Influenza

• Introduce background to students
  – Each year, 5-20% of the U.S. population becomes ill with seasonal influenza and 36,000 people will die from flu-related complications (CDC).
  – Transmitted person to person via droplets
  – Can live for up to 17 days outside of the body.
  – Etc, etc
Hands On “Genetic shift”

• Split students into 5-8 groups and give each group member two bags (‘H’ and ‘N’) of differently colored M&Ms. Warn them not to eat the candy yet.

• Allow ~5 minutes for the following; each student in the group should take their candy and interact with members of the other groups, deciding to trade or not trade candy colors randomly. Emphasize that ‘H’ can only be traded for ‘H’ – likewise for ‘N’ candy.

• Regroup the students and make a list of the original color combinations and the new color combinations. Relate this to the Hemaglutinin and Nueraminidase proteins and the genetic shift that occurs in influenza.
Listing search term

• Make a list of search terms one would use to find information about influenza online
Google Flu Trends

- Certain search terms are good indicators of flu activity
- Correlate IP addresses and search terms to indicate flu-like sickness
Can explore national or state-wide trends over time
Estimates were made using a model that proved accurate when compared to historic official flu activity data. Data current through November 17, 2009.
Students are expected to think critically about the trends they observe

- Investigate historical data for the United States and your state
  - Are there differences between the two? What are they?
- Compare data from 5 years past to current year
  - Are there differences between the two years?
- What month does influenza typically peak in (in the U.S.)?
- Why is this month/season favorable for the spread of influenza?
- How does influenza spread so quickly between places?
- What steps can be taken to prevent the spread of the flu?
- What is genetic shift and how does it affect the influenza genome?
Conclusion

• Students can interactively investigate hypotheses and come up with their own answers which may vary from year to year.

• Bolster understanding with http://www.google.com/insights/search/#

• Enable students to feel comfortable investigating the nature of newly emerging influenza strains and gain a concrete understanding of both epidemiology and influenza.