

Information Visualization Brings New Opportunities to Public Health

Fengbo Li

INTRODUCTION

Public health is "the science and art of preventing disease, prolonging life and promoting health through the organized efforts and informed choices of society, organizations, public and private, communities and individuals." [1] It plays an irreplaceable role in improving the well-being and health of human beings in local and global communities. However, we are still facing grand challenges in the realm of public health, such as HIV/AIDS, malnutrition, outbreak of contagious diseases, and lack of access to medical care resources. In order to tackle those issues, we need a predictive, preemptive, personalized and participative [2, 3] health system that provides accessible information to the public, calls for individual actions toward health, detects outbreaks at early stages, facilitates health analysis and decision making. Therefore, we need to integrate new communication strategies and information analysis tools. Since information visualization has inborn advantages in communication, analysis, monitoring and prediction, it could have a profound and positive effect on public health.

1 INFOVIS IN PERSONAL AND COMMUNITY HEALTH CARE

A healthy community is consisted of healthy individuals. It is important to encourage everyone to live a healthy lifestyle since prevention is better than cure. Various media platforms advocate how to keep fit; however, people are passively involved in the practice. People understand smoking tends to cause lung cancer, yet some still keep that habit; people are aware that too much sweets or junk food leads to obesity, yet there has been a dramatic increase in obesity in the United States during last decade [10]; people understand regular exercise keeps them healthy both physically and mentally, yet they prefer sitting on the sofa watching TV. To some extent, the problem exists not because of inadequate access to information, but partially due to the lack of effectiveness in message delivers. Being exposed to the vast amount of information, people have difficulty making sense of enormous statistics, thus lack awareness of how important health is in the sense of human development, both to an individual and to an entire community. Therefore, the information doesn't necessarily lead to a behavior change. The communication doesn't affect conduct in a desired way.

To make sure health messages are effective, the Centers for Disease Control and Prevention (CDC) conduct practices of social marketing and health communication [4]. The former makes use of marketing principles to influence human behaviors in order to improve health and to benefit society, while the latter refers to the study and use of communication strategies to inform and influence individual decisions that enhance health. Beyond offering information to the public, we also want to help people make better

life choices, and most importantly, to act upon them. Therefore, we need a creative tool for health communication, and Information Visualization (InfoVis) would be a great fit for that purpose.

InfoVis is an effective means of communication resulting from distillation of important information, visual storytelling of content within a human context, and interactive exploration of a navigable space. All of these aspects facilitate the reception of information and gets messages across. When people understand problems more deeply, those issues matter more to them, thus it's more likely to actively engage people in healthy living practices.

First of all, InfoVis makes it easier to dig valuable information from massive data by expanding the visibility of things that are otherwise invisible. The human vision system is sensitive to certain preattentive visual features [5]. InfoVis takes advantage of that and encodes information selectively according to their significance and relevance to the audience, which not only emphasizes important features, but also unfolds underlying trends and patterns within the data. Additionally, InfoVis designers can hide unimportant features so as to reduce the complexity of the data. Instead of giving people big chunks of raw materials that are hard to comprehend, InfoVis breaks it into pieces and encodes them with a more universal visual language, and organizes the separate fragments in a comprehensive system. By employing InfoVis in health communication, it is not only more obvious what the choices towards better health are, but also what the underlying reasons behind the practice are. Thus people are more likely to accept the concepts in health practice. By leveraging the advantages of InfoVis, we could make information more accessible and also consumable for the public.

InfoVis can correct people's preconceived ideas and draw their attention to problems previously ignored. In 2008, Atlanta ranked 19th in terms of sustainability among all cities in the United State [11], and especially, 11th in "Local Food & Agriculture". However, according to Food Trust, nearly two million Georgia residents – including 500,000 children, are living in "food deserts [14]" and have limited or no access to affordable fresh and nutritious food [12]. Lack of healthy food contributes to diet-related health problems. Georgia has the nation's 2nd highest childhood obesity rate. More than one fifth of Georgia children (10 to 17 years old) are suffering from obesity due to unhealthy food diet [13]. Both pieces of the information mentioned are facts, but the two sound quite contradictory. Without an objective representation of the situation, we might underestimate the complexity of food access problems in Atlanta; we may ignore the tremendous variations in a single city, not to mention nationwide or on a global basis.

InfoVis could be exploited to present who those people are and what it is like to live out of full nutritional spectrum, in a form of visual story-telling. It can offer clear and effective representation of what the problems these neighborhoods are tackling on a daily basis, what negative effects limited food access has on their health, and what can be done to alleviate their suffering. It can also draw the public's attention to those previously ignored issues, and arouse pioneering activists dive into the problems and make a real difference in people's daily life. InfoVis is a powerful narrative tool with concise and interactive visual language. Instead of overwhelming the audience with massive and obscure figures, the

• Fengbo Li is with Georgia Tech, email: fengboli@gatech.edu

•

story serves as a human context of what the data is grounded on, which aggregates, summarizes and explains where the information comes from and why it matters to the target population. This human-centered approach challenges us to start with empathy for the related population.

Moreover, InfoVis is not only about visual representation but also participatory interaction. Users are empowered to manipulate data directly. They can zoom in and out to explore information at different granularities easily. Offering immediate feedback based on users' operations helps people building connections between different variables, which are beneficial in identifying correlations among different attributes. With InfoVis, we can elaborately illustrate what benefits a certain healthy practice will bring to people, what will happen if they can't have enough fresh products, what they are going to lose once ignoring that, as well as a clear path of options toward better health, which all contribute to creating the environment where game-changing decisions could be situated.

One thing people might feel frustrated about is their personal medical report. It takes a long time to figure out what those numbers stand for, what is happening within our body, and what could be done to fix it. The user requirements for patients are different from the doctors: we don't need explicit numbers to know how our physical mechanism works, but only a statement of our current situation and instructions on how to improve our health. Therefore, if we were offered a well-designed medical report demonstrating just the right information we need rather than an unorderly spreadsheet-like document, we will probably feel more confident in appreciating the information and making applicable decisions.

Granting patients access to their medical report is not enough. We need to assist patients in understanding what the data stands for, how it is going to be used, and how the patients themselves could make use of it. If the delivered information is a clear interpretation of health practices in the long run of everyone's life,

people might be more inclined to change their attitude and modify their behaviors.

The Wired US magazine once hosted a design competition to redesign a cholesterol level blood test. The winning design (Figure 1) [9] presents four sections in the re-envisioned test report: About the test, Your results, Your risk, and What now. It not only points out the patient's current health condition based on the test index, but also informs the latent loss if the situation continues, and most importantly, suggests what the patient can do to attain better health. The new design not only makes information more digestible, but actionable. By equipping individuals with refreshing knowledge of what benefits their health and what doesn't, and clearly showing them the path towards better health, people are more likely to modify their unhealthy lifestyles and adopt new behaviors.

2 INFOVIS AND SOCIAL MEDIA IN EPIDEMICS SURVEILLANCE

Each individual plays a significant role in public health practice, while at the same time, interventions from the government or health organizations are not ignorable. The principle of disease detection and control is early detection, rapid response. It emphasizes on identifying epidemics as early as possible and eradicating them before they get a chance to spread. Therefore, we need a highly responsive surveillance system that actively involves everyone to keep track of disease activities, characterize future infectious epidemics, foresee potential outbreak in advance and give out early warnings.

Nevertheless, it takes weeks for traditional outbreak surveillance systems to react, due to the delay in data collection process and lack of effective tools to help public health officials make decisions [15]. Old-fashioned disease detection mechanisms mainly rely on outpatient reporting through official health agencies and governmental reporting systems. It might take a long time for gathering adequate supportive cases, validating authenticity of the data, and reporting through hierarchal organizations. The inefficient workflow hinders immediate epidemiologic assessment and diagnosis. However, the patients can't wait because they need timely treatment and social support for confidence; clinicians can't wait because they need to allocate resources and get prepared for potential outbreaks; public policy makers can't wait because they need to give authenticated guidelines and solutions to the public to tackle the epidemic. As a result, we need an innovative approach to complement current epidemic surveillance methods to keep the entire community constantly alert and ready to respond to the advent of outbreaks.

As a nearly real-time information portal, social media can play an important role in disease detection. People tend to share the latest news of infectious cases they hear of through social media, thus yielding large quantity of information that could be elaborated for epidemic detection. Information posted on these near real time online media normally precedes insights generated via official approaches. In 2010, people used Twitter to detect the start and early progress of the deadly cholera in Haiti after the



Figure 1: The winning design for a cholesterol level blood test hosted by Wired US magazine. It presents four sections in the re-envisioned test report: About the test, Your results, Your risk, and What now. It not only points out the patient's current health condition based on the test index, but also informs the latent loss if the situation continues, and most importantly, suggests what the patient can do to attain better health.

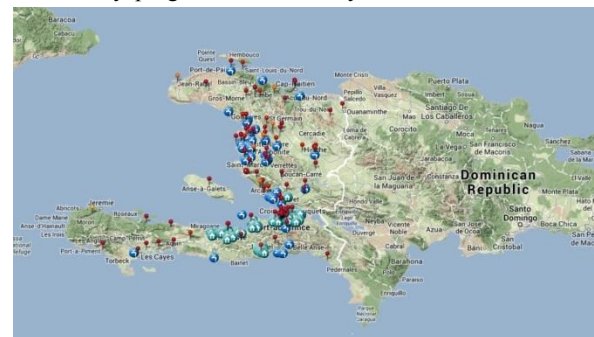


Figure 2: Screen shot of the HealthMap website showing Twitter Cholera reports in Haiti and new safe water installations and emergency shelters.

disastrous earthquake in January 2010 [6]. HealthMap (Figure 2) [7, 8], an automated online surveillance platform, took news feed containing the keyword “Cholera” and related media news on Twitter, and created a real-time updated map by visualizing the geographical and quantitative data collected. Taking a look at a map like this, people clearly see how many cases are found at a certain location at a certain time. It offers valuable information to get a timely estimate of disease dynamics and plans a response accordingly, sometimes before things got out of control.

Moreover, InfoVis is good at showing diverse data in one comprehensive view. We can aggregate information such as categories of disease, numbers of cases, demographic of patients, time, and geo-locations of infected areas into one system. Furthermore, since social media collects massive information of human behaviors and interpersonal relationships, it helps shed light on how disease is spread among human beings. By playing with different combination of parameters, we are more likely to understand the related facts about an epidemic and gain insightful ideas on its evolvement. In 1854, Dr. John Snow successfully took the InfoVis approach to trace the source of a terrifying cholera breakout in London [16]. By drawing the clusters of cholera cases in a map, Dr. Snow verified his hypothesis that the disease was transmitted via water rather than air. When used properly, InfoVis can contribute to facilitate the analysis of the cause of the epidemic, the patterns of disease spreading, and to craft visions on how to prevent the worsening of the situation. This visual representation makes best of the data gathered within a limited time.

Thirdly, social media engages the whole community in the fight with epidemics rather than a small group of medical researchers or government officials. Many people update their posts if they become aware of new cases of sickness, which helps to eliminate uphill jobs of professionals in data collection and early processing. The workforce involved in the practice is dramatically enlarged. With more people playing emergent role in the process, we can shorten the response time and start taking actions as soon as possible. InfoVis has a much more powerful impact when it is put into the hands of every civic participant.

CHALLENGES

InfoVis is a promising addition to our current public health ecosystem; however, it is not a miracle cure. Public health is a complex system that requires the collaboration between individuals, local communities, health related organizations, governments, etc. Even though effective information visualization is applied in health communication, there are other factors that will determine people’s decision and behaviors. For instance, for people who live in “food deserts”, they might be fully aware that fast food does more harm than good to their health, but they are not able to afford fresh produce from a nearby farmers’ market. Besides, it is difficult for the elderly to go to grocery store without a car, although the store might be within 5 minutes’ walk from where they live. Furthermore, people from low-income communities are more likely to be employed with heavy manual labor work. They need more calories to support their daily activities, thus a plate of salad will not suffice.

As for a surveillance system based on social media, it highly depends on people’s accessibility to electronic devices and internet. People living in low-income communities might not be able to afford a small phone or personal computer to get updated news or report information. Thus, it is challenging to get everybody participate in the practice. Moreover, social media has its own limitations as well. Some information could be highly redundant and it can be difficult to verify the reliability of information shared on social media.

CONCLUSION

With the rapid development of information visualization and its strengths in monitoring, detecting, exploring, analysis and communication, we could see the promising future of applying InfoVis into real world public health practice, so as to bring a personalized, predictive, preemptive and participative public health ecosystem.

REFERENCES

- [1] Winslow, C-EA. “The untilled fields of public health.” *Science* 51.1306 (1920): 23-33.
- [2] Hood, Leroy E., and David J. Galas. "P4 Medicine: Personalized, Predictive, Preventive, Participatory A Change of View that Changes Everything." (2009).
- [3] Hesse, Bradford W., et al. "Social participation in health 2.0." *Computer* 43.11 (2010): 45-52.
- [4] Glanz, Karen, and Barbara K. Rimer. "Theory at a glance: A guide for health promotion practice." (1997).
- [5] Nothdurft, Hans-Christoph. "The role of features in preattentive vision: Comparison of orientation, motion and color cues." *Vision research* 33.14 (1993): 1937-1958.
- [6] Chunara, Rumi, Jason R. Andrews, and John S. Brownstein. "Social and news media enable estimation of epidemiological patterns early in the 2010 Haitian cholera outbreak." *American Journal of Tropical Medicine and Hygiene* 86.1 (2012): 39.
- [7] Freifeld, Clark C., et al. "HealthMap: global infectious disease monitoring through automated classification and visualization of Internet media reports." *Journal of the American Medical Informatics Association* 15.2 (2008): 150-157.
- [8] Brownstein, J. S., and C. C. Freifeld. "HealthMap: the development of automated real-time internet surveillance for epidemic intelligence." *Euro Surveill* 12.11 (2007): E071129.
- [9] McCandless, David. "Visualizing Bloodtests." *Information Is Beautiful*. David McCandless, 21 Dec. 2010. Web. 03 Sept. 2013. < http://infobeautiful2.s3.amazonaws.com/wired_bloodwork_pdf.pdf >
- [10] "Adult Obesity Facts." Centers for Disease Control and Prevention. Centers for Disease Control and Prevention, 16 Aug. 2013. Web. 03 Sept. 2013. <<http://www.cdc.gov/obesity/data/adult.html>>.
- [11] Aster, Nick. "Most Sustainable Cities in the US: SustainLane’s Annual Ranking Is Out!" *Triple Pundit RSS*. N.p., 22 Sept. 2008. Web. 07 Oct. 2013.
- [12] "Food for every child: the need for more supermarkets in Georgia". http://policylinkcontent.s3.amazonaws.com/Georgia_mappingHighRes.pdf.
- [13] Saporta, Maria, and Amy Wenk. "Arthur Blank Intends to 'make a Difference' in Vine City, English Avenue." *SaportaReport*. N.p., 16 Dec. 2012. Web. 07 Oct. 2013.
- [14] "USDA Defines Food Deserts." *USDA Defines Food Deserts | American Nutrition Association*. N.p., n.d. Web. 07 Oct. 2013.
- [15] St Louis, Connie, and Gozde Zorlu. "Can Twitter predict disease outbreaks?." *BMJ: British Medical Journal* 344 (2012).
- [16] Johnson, Steven. *The Ghost Map: The Story of London's Most Terrifying Epidemic _ and how it Changed Science, Cities, and the Modern World*. Penguin. com, 2006.