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Epidemic and risk communication: an analysis of strategic and graphic characteristics of infographics

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Epidemic and risk communication:
An analysis of strategic and graphic characteristics of infographics

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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ABSTRACT

This study explores the strategic and graphic characteristics of infographics and data visualizations for epidemic issues and examines their inter-relationships. A content analysis was conducted by using 254 infographics for six epidemic crises (Ebola, SARS, MERS, H1N1, Bird flu, and Zika) from health organizations and news media. Results show that infographics has been used in diverse purposes of communication, not only for delivery of general information but also for persuasion for people's behavior change. Neutral images and graphics are more frequently detected than emotional appeals like fear and humor. Graphic types tend to be used differently by specific communication goal and organization type. The findings indicate the current use of infographics in the context of health and risk communication and offer several suggestions for future studies about infographics.

Keywords: infographics, data visualizations, strategic communication, health and risk communication, epidemic outbreak

CHAPTER 1

INTRODUCTION

In the digital and information age, infographics and data visualizations have been employed and developed in a variety of areas (Siricharoen, 2013). They are used to grab an individual's attention and interests to make them focus on messages (Siricharoen, 2013). They can show a large set of data and information with comprehensive structures in a short space (Dur et al., 2014). As a benefit, visualizations have been considered an effective communication tool to present complex information in a perceivable way (Dur, Filipczak-Bialkowska, Bresciani, Ge, Niu, Othman, & Wils, 2014; Fogel, 2013; Siricharoen, 2013). In the field of health and risk communication, visualizations have been discussed as an important format to convey quantitative health and risk information with these kinds of advantages.

Many scholars suggest using graphics to communicate health and risk-related information with the general public, who oftentimes have obstacles to understanding highly specialized information (Stone, Gabard, Groves, & Lipkus, 2015). In health- and risk-related subjects, statistical information or big data are frequently used to support and clarify their messages. However, the general public has difficulties in interpreting numerical data about scientific issues (Bell, Hoskins, Pickle, & Wartenberg, 2006). Visualizing information is better perceived and comprehended by the general people than text messages, based on the human brain system (Dur et al., 2014; Siricharoen, 2013). In risk situations, it is critical to provide and spread accurate messages quickly because the public can be disturbed by inaccurate information, such as rumors. From this perspective, infographics and data visualizations have focused on useful methods to show complicated and professional health risk information in an easy manner within a short time for both public and health practitioners

(Bell et. al., 2006). Despite the importance of infographics and data visualizations as strategic communication tools, few studies have investigated their characteristics and functions in the field of public relations.

The purpose of this study is to present an overview of the current use of infographics and data visualizations, and offer suggestions for future studies in the context of public relations. This study will serve the characteristics of infographics by focusing on two aspects—strategic and graphical/technical characteristics. Also, the inter-relationship between the characteristic variables will be explored. By providing a broad picture of infographics and data visualizations, this study seeks to identify an effective method for using infographics and data visualizations as strategic communication tools for health organizations in risk and crisis situations.

CHAPTER 2

LITERATURE REVIEW

Infographics

In general, infographics is defined as a graphical representation of information, data set, or knowledge to clarify difficult or complex information and data set quickly and clearly (Lankow, Ritchie, & Crooks, 2012; Smiciklas, 2012). It is a set of graphic factors with text. Infographics is a method to offer visual interpretation of data in a limited space with an aesthetical format as well as visually present a large amount of data and information. It can be called also information visualization and data visualization (Stasko, 2010).

The background for infographics development is the advancement of the digital and information era. Because of emerging technologies to save information on a massive scale, people face a plethora of data and information for communications (Dur et al., 2014). In the digital age, people scan and make judgments on information quickly and share it through social networking sites, such as Twitter or Facebook (Siricharoen, 2013). Following this trend, the way to show and use these large sets of data and complex information have focused as a communication tool to attract people's attention and interests (Dur et. al, 2014; Siricharoen, 2013).

Graphics has been considered an effective method to deliver scientific information. People perceive visuals more quickly and efficiently rather than via verbal or written documents (Dur et al., 2014). Studies show people spend less time thinking about the information and quickly grasping the contents associated with visual stimulations through mental processing (Siricharoen, 2013). As a form of visual expression, infographics has been an effective strategy to convey and share information and enhance the understanding of messages quickly and easily (Siricharoen, 2013).

Infographics is a good format to share a huge amount of information at one time. People and organizations show their information quickly and efficiently through social networking sites. Infographics is one of the fast ways to share lots of data and information without constraints of time and space (Dur et al., 2014). This function of infographics is critically important in risk and crisis situations like an epidemic outbreak because spreading accurate, vital information is the best way to prevent the situation from worsening (Dur et al., 2014).

Infographics help people to understand and perceive information clearly. Statistical information and data are frequently used to support their scientific messages. However, the general public has difficulties to understand these kinds of information. Visualizing data and a graphical display can enhance the public's comprehension about these kinds of information rather than explanations with written statements (Siricharoen, 2013).

People can recognize the visualizations more successfully with some verbal statements to describe the visuals (Dur, 2012). Scientific research shows graphical elements improve viewer's cognition by stimulating the human visual system, which is faster to process information than other human senses (Heer, Bostock, & Ogievetsky, 2010). Based on such studies, scholars suggested well-designed visualizations with brief descriptions are helpful in attracting viewers' interest as well as telling stories via data and information. However, few studies mainly focus on the role of infographics and data visualizations, despite their development as effective communication formats to convey and share information.

Infographics in Health and Risk Communications

In health and risk communication, it is essential for PR practitioners to communicate messages effectively with the public (Schapira, Nattinger, & McAuliffe, 2006). Their communication goals focus on raising awareness and prevention about health risks (Rothman & Kiviniemi, 1999). Health and risk-related information are frequently described using probabilities or other statistical data. People tend to perceive numerical information more trustworthy than other types of sources about health and risk issues (Bell et al., 2006).

However, most people find it difficult to interpret these types of information (Paulos, 1990). They are unfamiliar with the terminologies used in statistical analyses and have no analytical skills to interpret numerical data quickly (Bell et al., 2006). A study found it a challenging task to deliver quantitative health risk information effectively and comprehensibly to the public (Ancker, Senathirajah, Kukafka, & Starren, 2006). Infographics and data visualizations are suggested as one of the useful ways to show numeric information and complicated or large data sets to the public as well as health practitioners (Bell et al., 2009; Stone et al., 2015). Graphics, developed as a communication tool, helps the public's understanding about health and risk information (e.g., Cleveland & McGill, 1984; Houts, Witmer, Egeth, Loscalzo, & Zabora, 2001; Mazur & Merz, 1993; Tufte, 1983).

Several studies have shown the benefits of graphic elements on quantitative risk reasoning, risk assessment, risk estimation, interpretation about the probability of risk, perceptions and behaviors (risk-taking, risk aversion) toward the risk (Ancker et al., 2006; Stone, Yates, & Parker, 1997; Weinstein, Sandman, & Hallman, 1994). Schapira and colleagues (2006) discussed which graphical displays are effective in perception about risk magnitude and quantities. In the risk communications field, the public's perceptions about the amount of risk are important in their overall perception towards risk and strategies for designing risk messages. Schapira et al. argued graphics has significant benefits in

interpreting risk magnitude and credibility about using data by stating the effects are different, depending on the type of graphic format. People perceive risk higher when it is shown as a pictorial display or highlighted symbols than bar graphs. Gurmankin, Baron, and Armstrong (2004) explained numerical displays are perceived more reliable than verbal statements when describing risk-related data set.

Other studies argued a numerical expression has limitations in interpreting its probability or perceptions about risk magnitude (Cosmides & Tooby, 1996; Tversky & Kahneman, 1974). Others also suggested numerical information requires more cognitive processing to understand than other forms of media (Slovic, Peters, Finucane, & MacGregor, 2005). Parrot and colleagues (2005) examined descriptions with text statements about statistical data showing the relationship between disease and genetics are more effective in the public's understanding and perceptions about a disease rather than numerical expressions with bar charts. Schapira and colleagues (2006) noted numeric terms with graphics may enhance the specificity of risk information and its understanding.

Based on these previous studies, this study focuses on the global epidemic outbreaks as a subject of study among numerous health risk issues. A global epidemic outbreak leads to negative outcomes in diverse fields, such as health agencies, travel industry, economic status, and international relationships, among others. With high involvement of many countries, epidemic issues disturb the general public with inaccurate information and rumors, specifically when they had insufficient information about the disease before the outbreak and vaccine development. In such global health-risk situations, it is important for public relations practitioners to communicate with other organizations as well as the public by providing accurate information, including numerical data in a simple and fast way. As mentioned, infographics and data visualizations have been discussed and developed as these types of

tools. Thus, this study concentrates on global epidemic issues as a subject to examine the overview of using infographics in health risk areas.

Strategic Characteristics of Infographics

Based on the previous discussed studies, the following can be considered as strategic characteristics of infographics in health and risk communication. First, there are several communication goals in health and risk communications. A communications goal can be defined, as the intended purpose the sender wants to achieve by providing infographics. Public relations practitioners provide messages to increase awareness, change behaviors, evoke some emotions, or prevent or promote a certain situation (Leshner, Bolls, & Thomas, 2009). Bell et al. (2006) argued a health-related informative map should be developed, depending on its purposes. Other studies also suggested practitioners should choose different graphics elements and formats for strategic communications, based on the purpose of their messages (Ancker et al., 2006).

The target audience can be one of the strategic characteristics of infographics. This refers to the key public sphere that infographics intends to communicate. Many studies explain targeted groups should create strategic messages on different, suitable formats (Ancker et al., 2006; Bell et al., 2006; Leshner et al., 2009). Required messages and effective information processing are influenced by the receiver's background and knowledge. Thus, a targeted group should be considered when designing strategic message contents.

In health and risk communications, severity, vulnerability, and efficacy about the risk issue have been discussed as strategic factors in the message contents that can affect an individual's cognitive perceptions toward the issue (Martin, Bender, & Raish, 2007). Protection Motivation Theory, Extended Parallel Process Model, and Health Belief Model explain people's motivation of health behaviors. These focus on influencing variables to

communicate risk information to the public (e.g., Floyd, Prentice-Dunn, & Rogers, 2000; Rodgers, 1983; Rosenstock, 1960; Witte, 1992). Strong et al. (1993) argued these factors are influential when making persuasive messages. Each type of message contents can influence differently an individual's cognitive process about risks, perceptions, attitude changes, and behaviors toward the issues (Eagly & Chaiken, 1993; Mulilis, & Lippa, 1990).

Severity is the degree to express the seriousness of potential threats of the issues (Hastall & Knobloch-Westerwick, 2013; Martin et al., 2007; Murray- Johnson & Witte, 2003). A message focusing on the severity of health threats may be an effective communication strategy to increase people's awareness of the risks (Kline & Mattson, 2000; Witte, 1992). Thus, severity of the health threat is frequently used as a crucial component when designing health messages to enhance perceptions about the risks and behavior changes (Witte & Allen, 2000).

Vulnerability is defined as the degree of message contents related to the individuals' possibilities of negative consequences by the risk (Chang, 2012). This indicates if individuals do not follow recommendations or change their behaviors toward the risk, they can incur harm to property or self (Martin et al., 2007). This message causes people to elaborate about the severity of threat and motivates recommended actions by perceiving their involvement in the risk situation (Eagly & Chaiken, 1993; De Hoog, Stroebe, & de Wit, 2007). Thus, vulnerability about the risk influences not only assessment about the risk, but also behavior to prevent risks (De Hoog et al., 2007; Strong et al., 1993).

Efficacy of health messages is divided into two types—response-efficacy and self-efficacy (Hastall & Knobloch-Westerwick, 2013). Response-efficacy is the characteristic of messages that express the recommended behavior to avoid the threat and influence one's behavior change about the risk. Self-efficacy is the message that shows individuals' abilities

to perform the advocated behaviors to prevent the risk threat. Efficacy is crucial components of the health message to persuade behavior changes and belief about the risk (Bandura, 2007).

Hastall and Knobloch-Westerwick (2013) found evidence type a determinant of behavior change and characteristic of health messages. They suggested statistical information and exemplar information may have different impacts on individual's behaviors toward health issues. Messages can be designed and supported with either statistics and data or human angles about the health issue (Hinnant, 2009; Viswanath, Meissner, Saiontz, Mull, Hesse, & Croyle, 2008). These types of messages may have different components in health risk perception because statistical evidence can be considered as a valid argument and a personal case can be perceived as a vivid, interesting example. Thus, Zillmann and colleagues noted using exemplar may be more useful evidence if the message creator needs to attract an individual's attention about the issue; whereas, statistical evidence is more powerful to lead behavior change by providing accurate, intense information (Zillmann, 2006; Zillmann & Brosius, 2000).

Graphical/technical Characteristics of Infographics

With potential strategic characteristics, the followings can be considered as graphical/technical characteristics of infographics. Graphic type is defined as types of graphics used in infographics. People perceive risk information differently by the graphical design or format (Leshner, Bolls, & Thomas, 2009). Using suitable graphs, tables, and maps have been considered a strategic method to present health-related statistics and to enhance the understanding of complex data (Bell et al., 2006). Several studies explored different graphic displays have different benefits on the public's perception and interpretation about risk-related numeric data and messages (e.g., Cleveland & McGill, 1984; Stone et al., 1997; Weinstein et al., 1994). Thus, graphic types can be concerned as infographics' characteristics.

Comprehensive easiness is defined as the degree to easily understand infographics at a glance. In studies about the effectiveness of visualizations, many researchers argue visualizations should be as clear and simple as possible (Borkin et al., 2013). They state visualizing information should not include unnecessary things referred to as chart junk for effectiveness. This refers to simplicity, the degree of clarity without unnecessary graphical expressions.

In other research, a well-selected color is also helpful to understand visualizations easily (Bell et al., 2006). This refers to color harmony, how much the selected color reflects the messages or words. It indicates the degree colors are used appropriately in infographics with general conventions about colors to present specific things implicitly or explicitly. For example, people use blue to present water or sky and green to present vegetation. Implicitly, red is frequently used to describe an emergency and danger. Blue is used to express positive, hopeful aspects of something. White indicates cleanness. Likewise, conventionally selected colors enhance the cognitive process about visualizations. In this study, simplicity and color harmony are considered as comprehensive easiness of infographics.

A well-designed visual appeal is helpful in attention, comprehension, and retention. Graphics can help individuals' cognitive processes toward certain health issues by evoking positive or negative feelings (Leshner et al., 2009). Psychological studies have proven the correlation between emotional processing and encoding the messages. Graphics stimulate an individual's emotions and affect their interpretation about the given messages. In the health and risk area, promotion campaigns that use images or graphics to evoke fear appeal are more effective to convey messages and public concerns than using text messages only (Leshner et al., 2009). Related-graphics with text (infographics) can influence emotional processing as well as cognitive processing in health and risk communication.

In the web-based environment, infographics are sometimes constituted with interactive elements that users can control. This is the interactivity of infographics defined as graphical and technological elements on the web-based dimension the audience can control and follow in their desired way (Dur et al., 2014). For example, people select and focus on specific information by controlling screen size, selecting specific information in the multi-layered graphics or windows, animations, pop-ups, clicking buttons, moving images, etc. (Bell et al., 2006; Dur et al., 2014). These can be considered graphical characteristics of infographics.

However, these are not to say that graphical displays are more influential than texts when providing health and risk information (Ancker et al., 2006). These do not claim the practitioner should use graphics dominantly rather than text in conveying health risk messages. Some studies about the effects of visualizations indicated graphics with a small amount of text are more influential than graphics or text alone (Ancker et al., 2006). Other scholars suggest well-balanced descriptions with visuals can be helpful to attract and retain the viewer's attention by increasing comprehension (Borkin et al., 2013). They showed graphics with suitable statements or descriptions with supported graphical elements should be chosen for well-designed visuals. This means the effect of visuals can be influenced by the overall percentage of text and graphic elements, and the degree for matching graphics and text. This study will define these as a graphic-text ratio and relationship.

Based on the literature review, this study suggests the following research questions.

RQ 1: What are the overall characteristics of infographics about epidemic issues in health and risk communications?

RQ 1-a: What are the strategic characteristics of infographics about epidemic issues in health and risk communications?

RQ 1-b: What are the graphical/technical characteristics of infographics about epidemic issues in health and risk communications?

RQ 2: What are the inter-relationships between the strategic and graphical/technical characteristic variables of infographics in health and risk communications?

CHAPTER 3

METHOD

To examine the research questions, this study conducted a content analysis. The samples for this study were composed of infographics about epidemic outbreaks.

Sample

The samples were selected based on the research purposes. The subjects of sample were limited to six epidemic outbreaks (Ebola, SARS, MERS, Zika, H1N1, and Bird Flu) for the following reasons. First, after 2000, they were pandemic or international emergency levels of epidemic outbreaks declared by international or national health organization (e.g. WHO and CDC), among numerous health risk issues. These are substantially serious and on-going health risks in the world. Health organizations and governments have attempted to provide the related information to the public. Even though each outbreak has occurred on specific continents, their information has been shared commonly around the world because of their high fatality rate and no vaccination system in place at the outbreak period. Appendix A (Table A1) describes detailed information about the issues, such as outbreak time, fatality rates, and symptoms. Thus, these six issues were chosen as a subject of contents for this study.

The samples were collected from health organization and new organizations' websites, and through a Google search. The search term, "(epidemic name) infographics," was utilized on the website. Among various health organizations, this study focused on trustworthy sources, such as government-affiliated health organizations, large national health organizations, and international health organizations; for example, the Center for Disease Control and Prevention (CDC), the World Health Organization (WHO), and (specific country's) Ministry of Health or Department of Health. Likewise, the samples were selected

from well-known news stations and magazines, such as the *New York Times*, *USA Today*, and BBC news. The full list of sample sources is described in Appendix A (Table A2).

Infographics made for private benefits or by private graphic companies were excluded in this study. Those with an unclear source and consist of text only were also excluded from this analysis. This study is based on the definition of infographics discussed in the literature review and the unit of analysis was one infographic about the epidemic outbreak.

The total number of infographics was 254. For each epidemic, the number of Ebola infographics was 90, SARS infographics were 5, MERS infographics were 51, Zika infographics were 88, H1N1 infographics were 16, and Bird Flu infographics were 4.

Inter-coder Reliability

Two coders were recruited from the graduate school in a large Midwestern research university. To achieve acceptable inter-coder reliability, a pre-test was conducted using the coding scheme. Two coders were trained using 10% of infographics from collected samples for this study, until inter-coder reliability for each category was satisfied with the appropriate level of reliability in the social sciences. After training, each infographic was analyzed by the coders independently using codebook (see Appendix B). The tested infographics were excluded in the final analysis.

Inter-coder reliability was determined by computing Krippendorff's alpha:

$$\text{Krippendorff's alpha} = 1 - \frac{\text{Observed disagreement}}{\text{Expected diagreement}}$$

The higher value of Krippendorff's alpha indicates the more agreement between the coders. Table 1 provides the results for inter-coder reliability of all variables coded in this study. Both coders obtained a highly acceptable level of inter-coder reliability, ranging from .80 to 1.00.

Table1. *Results of inter-coder reliability*

Variable name	Krippendorff's alpha
Epidemic type	1.00
Source	1.00
Targeted audience	1.00
Communication goal	0.90
Protection motivation strategy	0.85
Evidence type	0.97
Graphic type	1.00
Interactivity	1.00
Comprehensive easiness	0.80
Visual appeal	0.85
Graphic-text ratio	0.95
Graphic-text relationship	0.90

Coding Scheme

Based on the literature review, two types of characteristics were used as a coding scheme. First, for strategic characteristics, the following variables were coded: communication goal, target audience, protection motivation strategy, and evidence type. Second, for graphical/technical characteristics, the following variables were coded: graphic type, interactivity, comprehensive easiness, visual appeal, graphic-text ratio, and graphic-text relationship.

Strategic Characteristic Variables

Communication goal was coded as 1 = inform, 2 = persuasion, and 3 = both. 'Inform' includes infographics that represent messages about the issue, such as general facts or knowledge, symptoms, epidemic progress, and so on. 'Persuasion' includes infographics that show any messages that lead an individual's behavior, such as preventive and recommended actions. 'Both' is the infographics containing both general information and persuasive messages.

Target audience was coded as 1 = health care workers, 2 = general public or potential patient, and 3 = both. 'Health care workers' includes infographics for doctors, nurses, emergency center, hospitals, other health organizations, etc. 'General public or potential patients' includes any messages not targeting solely health professionals. 'Both' is infographics applied to both general public and health care workers or in the case the target audience is unclear in the infographics.

Protection motivation strategy is defined as the influencing factors for health protection behaviors intended in infographics. This variable has four sub-categories—severity, vulnerability, response-efficacy, and self-efficacy.

Severity was coded as 0 = absence and 1 = presence. 'Presence' is the infographics containing the messages related to the seriousness of potential threats or negative outcomes by the disease. For example, the following information can be included: "The cumulative number of deaths caused by Ebola is 2,461," "Ebola causes serious symptoms, such as intense weakness, muscle pain, and sore throat followed by vomiting, diarrhea, rash, and bleeding," "The tourism industry will be negatively affected by the disease," "The U.S. egg export has decreased 20% by avian flu," and "The death rate from SARS is 15%." 'Absence' is infographics without any messages about the seriousness of potential threats.

Vulnerability was coded as 0 = absence and 1 = presence. 'Presence' is the infographics with the messages about the possibility that individuals are easily infected by or exposed to the disease. For instance, the following messages are included: "People in (specific region) should be careful to be infected by the disease," "If you travel to (specific country), you are exposed to the disease so you should be careful," "If you have (specific kind of disease), you have a greater possibility of infection by the disease," and "Pregnancy is more vulnerable toward the virus." 'Absence' is infographics without any messages about the possibility of negative consequences.

Response-efficacy was coded as 0 = absence and 1 = presence. 'Presence' is infographics containing messages related to the ability of recommendation to protect from the disease. For example, the following information is included: "Following the instructions is effective to prevent the Ebola" and "The guidelines to reduce the likelihood of contacting SARS." 'Absence' is infographics without any messages about recommendations to prevent the risks.

Self-efficacy was coded as 0 = absence and 1 = presence. 'Presence' is infographics with messages about an individual's ability to perform recommendations for preventing outbreaks. For example, the following messages can be included: "You are capable to preventing the SARS by washing your hands after going out" and "You can avoid further infection from Ebola if you follow these safety precautions." 'Absence' is infographics without any messages about an individual's ability to perform recommendations for preventing the disease.

Evidence type is defined as kind of information utilized for infographic messages. This variable has two sub-categories—statistical evidence and exemplar evidence.

Statistical evidence was coded as 0 = absence and 1 = presence. 'Presence' is infographics with any numerical information about the disease, such as number of deaths and rate of spreading the disease. 'Absence' is infographics without numerical information.

Exemplar evidence was coded as 0 = absence and 1 = presence. 'Presence' is infographics with messages based on a personal case or experiences about the disease. For instance, any information focusing on a particular group of people facing the health threat as an example of the disease crisis is included. 'Absence' is the non-existence of such information.

Graphical Characteristic Variables

Graphic type has eight sub-categories and coded as 0= absence and 1 = presence for each category. 'Time line' refers to visuals that express time-series or sequences. 'Graphs/charts' include diagrams and diverse types of charts or graphs, such as bar, pie, and line. 'Maps' refers to satellite pictures as well as mapping figures. 'Matrix' includes an array of similar or consistent graphic expressions (e.g., array of numerical graphics, symbols, or any graphical elements). 'Network' refers to figures that point or nodes interconnected by paths or lines. 'Comic drawings' includes any drawings of cartoon/animation style or array of drawings interrelated to each other with narratives. For each category, 'presence' is the existence of each element and 'absence' is the non-existence of these items.

Interactivity was coded as 0 = absence and 1 = presence. 'Presence' is infographics with the following graphical and technological elements on the web-based dimension users can control—controlling screen size, selecting specific information in the multi-layered graphics or windows, animations, pop-ups, click-buttons, moving images, etc. 'Absence' is infographics without the above items on the web-based dimension.

Comprehensive easiness is the degree of how an audience easily understands the contents at a glance in the visual perspectives. This variable was categorized by color harmony and simplicity.

Color harmony was coded as two levels, 1 = low and 2 = high. 'High' is infographics with well-selected colors that present objects universally. For example, the following can be included: cases where white is used to express cleanliness, red for blood or emergency, and green and white for hospital or health care centers. 'Low' is infographics with colors that people do not generally use to express these objects.

Simplicity was coded as two levels, 1 = low and 2 = high. 'High' is infographics without unnecessary, unrelated, or complicated graphics about the messages. For example, if

the infographics look easily comprehensive, the messages' contents with simple graphic elements, it is considered a high level of simplicity. 'Low' is the case with any graphics not useful to deliver key information. For example, if the infographics are composed of complicated or unnecessary graphics unhelpful to understand the main messages, it is considered as a low level of simplicity.

Visual appealing is the values of design qualities and attractions that graphics create for audiences. This variable has three sub-categories—artistic beauty, stimulating, and humorous.

Artistic beauty was coded as 0 = absence and 1 = presence. 'Presence' is infographics with a well-balanced design, colors, or format. For example, if infographics have a well-balanced structure with consistent graphic figures, sizes, or colors, it is considered as presence of artistic beauty. 'Absence' is infographics without the above items. If infographics does not visually attract a viewer's attention with their format, colors, or design, it is coded as 'absence'.

Stimulating was coded as 0 = absence and 1 = presence. 'Presence' is infographics with any images, graphics, or colors that evoke fear appeals. For example, the following can be included: realistic descriptions or sensational images of serious symptoms, such as vomiting and hematuria, actual pictures of people suffering from the disease. 'Absence' is the infographics without any fear appealing factors.

Humorous was coded as 0 = absence and 1 = presence. 'Presence' is infographics with images or graphics that evoke humor. For example, the following can be included: funny images or cartoons to explain the information and witty descriptions that attract the audience's interest. 'Absence' is infographics without any humorous images, explanations, graphics, and figures.

Graphic-text ratio was coded as 1 = text-centered, 2 = graphic-centered, 3= similar ratio, and 4= graphic only. 'Text-centered' includes infographics mainly focused on text instead of graphics or consists of text with over half percentage of contents. 'Graphic-centered' includes infographics mainly focused on graphics instead of text or consists of graphics with over half percentage of contents. 'Similar ratio' includes infographics of balanced graphics and text without emphasizing one specifically. 'Graphic only' includes infographics consisting of graphical factors without text.

Graphic-text relationship was coded as 0 = no relationship, 1 = low, and 2 = high. 'No relationship' includes the case where graphics are expressed to only attract attention without supporting the messages. 'Low' includes infographics not showing key meanings of the text when the graphic is related to the text messages. 'High' includes infographics lead a key meaning when graphic and text is related to support each other.

CHAPTER 4

RESULTS

This study examines the current use of infographics and data visualizations in the context of health and risk communications by asking two main research questions. The first research question is to examine the overall characteristics of infographics by focusing on the strategic and graphical characteristics. To answer this question, descriptive statistics were utilized for data analysis using SPSS software program. The second research question examines the inter-relationships between the strategic and graphical characteristic variables of infographics. To answer this question, a cross-tabulation test was conducted to analyze the data using SPSS software program.

Strategic Characteristic Variables

Table 2 shows the frequency for each strategic characteristic variable. The total number of infographics was 254. For some variables, such as message strategy and evidence type, multiple coding was adopted and the total number of each variable is the sum of the count.

Target audience. Most infographics did not specify a target audience in the message content. Eighty-one percent of infographics have messages that can be applied to both the general public and specific group (e.g., health care workers). Sixteen percent of infographics indicate general public directly as their target audience. Only 2.8% of the infographics indicate health care workers as their audience group.

Communication goal. The most frequently detected communication goal for infographics was to ‘inform’. About 60% of the infographics delivered general information about epidemics, such as basic facts, symptoms, and epidemic cases in specific countries.

Table 2. *The frequency of strategic characteristic variables*

Variables		Count	Percent (%)
Target audience	Health care workers	7	2.8
	General public	41	16.1
	Both	206	81.1
	Total	254	100.0
Communication goal	Inform	152	59.8
	Persuasion	55	21.7
	Both	47	18.5
	Total	254	100.0
Message strategy	Severity	113	28.7
	Vulnerability	83	21.1
	Response-efficacy	105	26.6
	Self-efficacy	93	23.6
	Total	394	100.0
Evidence type	Statistical	91	35.3
	Exemplar	5	1.9
	None	162	62.8
	Total	258	100.0

Note: 'Count' is the number of infographics corresponding to each variables.
'Percentage' is the proportion of the total number of infographics.
Multiple coding was used in 'message strategy' and 'evidence type' variables.

Twenty-two percent were 'persuasive' messages about behavioral changes, such as prevention or recommended action. Nineteen percent have both information and persuasion as a communication goal.

Protection motivation strategies. Each message strategy detected a similar percentage for the total infographics, around 20%. The most frequently detected message strategy for infographics was 'severity'. About 29% of infographics have messages about seriousness of the epidemics, such as symptoms, fatality rate, and serious level of infection. Twenty-seven percent of infographics contains response-efficacy information related to recommended behaviors to prevent the disease. Twenty-four percent have information about self-efficacy and 21% of infographics intend messages about vulnerability.

Evidence type. There were more cases of infographics based on statistical data rather than exemplar stories. Thirty-five percent of the total infographics have statistical information or numerical data as an evidence type for describing the issues. Only 2% of the infographics used personal stories to explain or support message contents. In most of the infographics, over 50%, there was no statistical or exemplar evidence as supporting information.

To summarize, most infographics did not directly indicate the target audience in their message contents and this can be applied to health care workers as well as the general public. In some infographics created by health organizations, infographics were categorized as information materials for the public. But, they also included materials for health professionals and a specific target audience was not included in the text in infographics. Thus, the variable, target audience, was coded based on its materials.

For the communication goal, both 'persuasion' and 'both' categories can be considered as messages containing persuasive contents. If these two categories' counts are combined, infographics with general information and those that lead to people's behavior change have no dramatic difference in terms of proportion (Inform: 59.8%, Persuasion and Both: 40.2%).

For message strategies, each variable was detected with similar proportions. This means infographics were created to increase people's awareness of risk and to motivate them to perform preventive actions. This result is consistent with the results of the communication goal. For evidence type, only a few infographics were utilized as exemplar types to support their information; whereas, statistical evidence was used more frequently. This means epidemic infographics have a tendency to employ or describe numerical data, which are more powerful to lead to behavior change by providing accurate, intense information rather than exemplar type, which is effective to attract people's attention about the issues.

Graphical/technical Characteristic Variables

Table 3 shows the frequency for each graphical/technical characteristic variable. The total number of infographics was 254. For some variables, such as graphic type and visual appealing, multiple coding was adopted and the total number is the sum of the count.

Graphic type. 'Mapping' type was most frequently detected in the infographics with 32.9% of total infographics. 'Matrix (array of graphical elements)' was second with a frequency of 19%. Seventeen percent of infographics had some graphics showing a time line, time series, or some sequences of the disease. About 13% of infographics was chart or graph type. Nine percent of infographics used comic drawings to convey their information. In this case, most were created by the Singapore Ministry of Health in the H1N1 outbreak (see Appendix D1). Fewer than 10% of the infographics have other types of graphics, such as tables and networks.

Interactivity. Fourteen of the total numbers of contents have interactivity in their infographics. Most were from news organizations. For example, there were the following types of interactivity elements (see Appendix D2): video clips by clicking play buttons, scroll button, animation effects (e.g., moving images), graphical effects (e.g., bolding, viewing specific region or information in the map, controlling map size) by buttons, pop-up windows by selecting information in the graphs, controlling time line, showing detailed information by clicking the graphic elements, etc.

Comprehensive easiness. For comprehensive easiness, two sub-variables were coded: color harmony and simplicity. Most infographics (70.9%) are a high level of color harmony, which means they used well-selected or general conventional colors to present their objectives. A majority of the infographics (91.7%) are a high level of simplicity with necessary graphical elements to convey the information. Some infographics (8.3%) composed complicated graphics or contained unnecessary graphical elements. In general, most

Table 3. *The frequency of graphic characteristic variables*

Variables			Count	Percentage (%)
Graphic type	Timeline		54	17.1
	Charts/graphs		40	12.6
	Tables		14	4.4
	Maps		104	32.9
	Matrix		60	19.0
	Networks		16	5.1
	Comic		28	8.9
	Total		316	100.0
Interactivity	Absence		240	94.5
	Presence		14	5.5
	Total		254	100.0
Comprehensive easiness	Color harmony	Low	74	29.1
		High	180	70.9
		Total	254	100.0
	Simplicity	Low	21	8.3
		High	233	91.7
		Total	254	100.0
Visual appealing	Beauty appeal		236	90.4
	Stimulating (fear)		3	1.2
	Humorous		6	2.3
	None (other)		16	6.1
	Total		261	100.0
Graphic-text ratio	Text-centered		80	31.5
	Graphic-centered		73	28.7
	Similar ratio		74	29.1
	Graphic-only		27	10.6
	Total		254	100.0
Graphic-text relationship	No relationship		29	11.4
	Low relationship		23	9.1
	High relationship		202	79.5
	Total		254	100.0

Note: 'Count' is the number of infographics corresponding to each variables.
'Percentage' is the proportion of the total number of infographics.
Multiple coding was used in 'graphic type' and 'visual appealing' variables.

infographics have a high level of color harmony and simplicity, so they could be considered as comprehensive easiness visualizations.

Visual appealing. Over 90% of the infographics were well-balanced color graphics or graphical formats considered as artistic beauty. Only a few infographics had humorous or stimulating graphical elements, such as fear appealing images (1.2 and 2.4%, respectively).

Graphic-text ratio. About 31.5% of the infographics were text-centered, 28.7% were graphic-centered, 29.1% were similar ratio of graphics and texts, and 10.6% were composed of only graphics.

Graphic-text relationship. A majority of the infographics (79.5%) have a high level of relationship between graphics and text. This means graphics and text well support each other to lead key meanings of messages in the infographics. About 9% of infographics have a low level of graphics and text relationship. The remainder (11.4%) were coded 'no relationship.' They were composed of graphics only with titles of graphic elements so there was no special relationship between graphics and text.

In summary, mapping type of graphics was frequently used for epidemic infographics and other types (e.g., matrix, timeline, and charts/graphs) were also employed to describe this information. Most infographics were easy to comprehend the message's contents with a high level of color harmony and simplicity. For visual appealing, only a few infographics contained images or graphics to evoke emotions, such as fear and humor. Most infographics have a well-balanced format, design, and/or color with neutral graphic elements. In the graphic-text relationship, over 70% of infographics are composed of a high level of graphics-text relationship. This means graphics were appropriately used to lead the key meaning of text and text descriptions are highly related to graphics in the infographics.

Inter-relationship between the Variables

To answer the second research question, all possible cases of relationships between the variables are conducted a cross-tabulation test. Among them, based on the literature review, five significant and meaningful relationships are described in this section: (1) communication goal by source, (2) graphic type by source, (3) graphic type by communication goal, (4) communication goal by epidemic types, and (5) message strategies by epidemic type.

Communication goal by source

Communication goal was significantly different by source (Figures 1-a, 1-b). Within infographics from news organizations, 83.7% of the messages were general facts or knowledge about the disease. Health organizations have similar ratios for communication goals, messages with only general facts and those with contents related to behavior changes. Detailed statistical results are shown in Appendix C (Tables C1, C2).

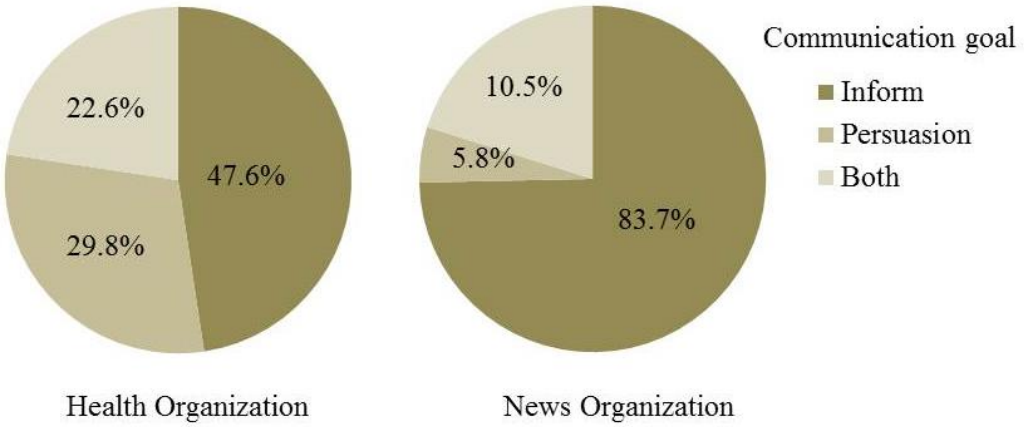

Figure 1-a. *Communication goal by source.*

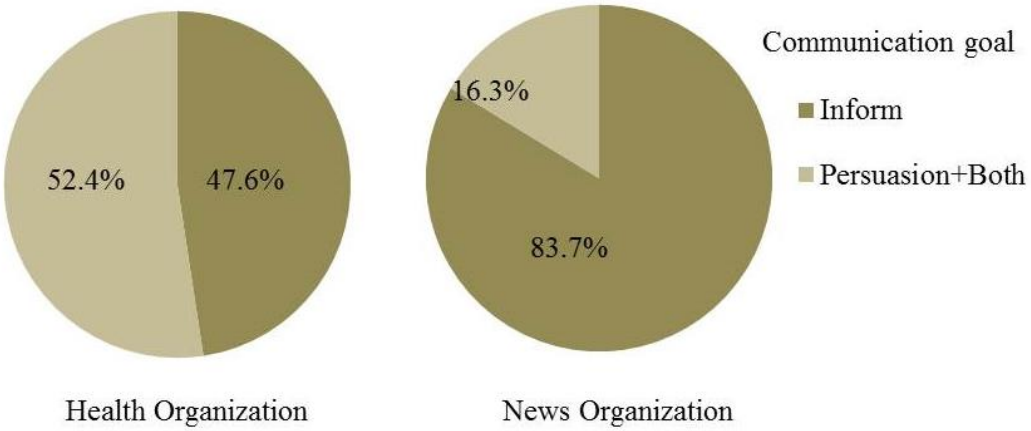

Figure 1-b. *(Recoded) communication goal by source.*

Graphic type goal by source

There was a significant difference between health organizations and news organizations in terms of graphic types they used (Figure 2). From the analysis, news organizations used a charts/graphs and mapping type of graphics more frequently in their infographics than health organizations. As shown in Tables C3-C7 (see Appendix C), about 16% of the total infographics contained charts or graphs, 10.6% were from news organizations and 5.1% were from health organizations. With almost the same percent, both organizations used map type of graphics in their infographics. However, within each organization, news stations utilized mapping graphics, over 50%, and health organizations used them with 32%. Compared to news stations, health organizations have a tendency to use diverse types of graphics, such as timelines, matrices, and comic drawings as well as maps and charts/graphs. This result can be explained with the previous inter-relationship results for communication goal and source. Health organizations created various infographics with these graphic types not only to inform, but also to persuade, public behavior change; whereas, news organizations focused on infographics as supporting materials for numerical information described as maps or charts/graphs.

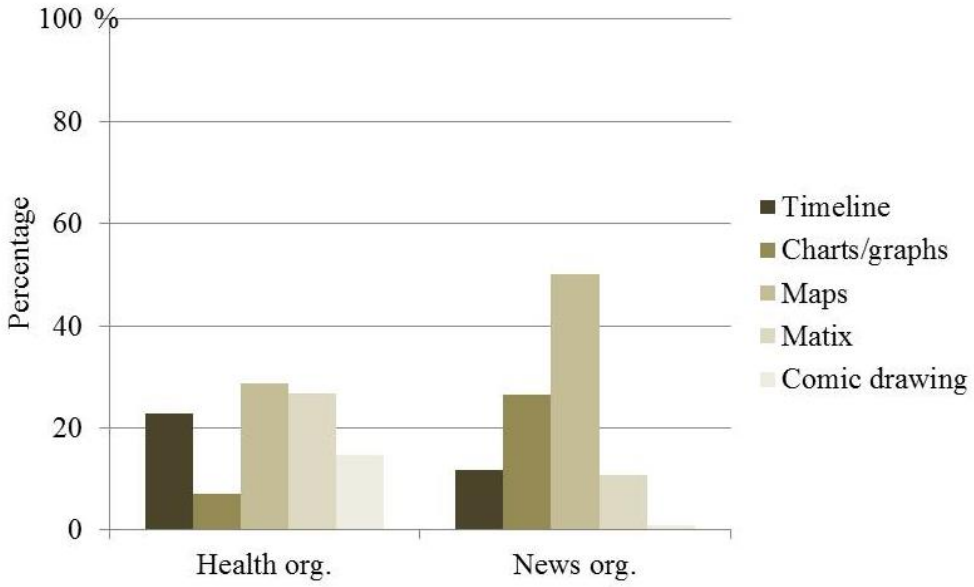

***Figure 2**. Graphic type by source*

Note: The figure was created by combining the statistical results (see Appendix C; Table C3-C7).

Graphic type by communication goal

Graphic types showed significantly different by communication goal (Figure 3). Maps are mostly used for conveying general information about the disease, such as the number of cases or infected people in each country. As shown in Tables C8-C13 (see Appendix C), 41% of the total infographics contained a map type of graphics. Among them, 34% provided general facts of the epidemic. Only 7% were for persuasive messages. Timelines and charts/graphs are also common types of graphics to show facts about the issues with numerical information. For persuasive messages, such as prevention and recommendation, not only time-series or sequences, but also arrays of similar type of images (matrix), are used. Twenty-four percent of infographics included matrix graphics. Among these, about 15% were for messages containing persuasive contents. For the delivery of both general information and persuasive messages, matrix types were frequently employed in the infographics. Appendix D3 shows the infographics examples of differences between graphic types and communication goal.

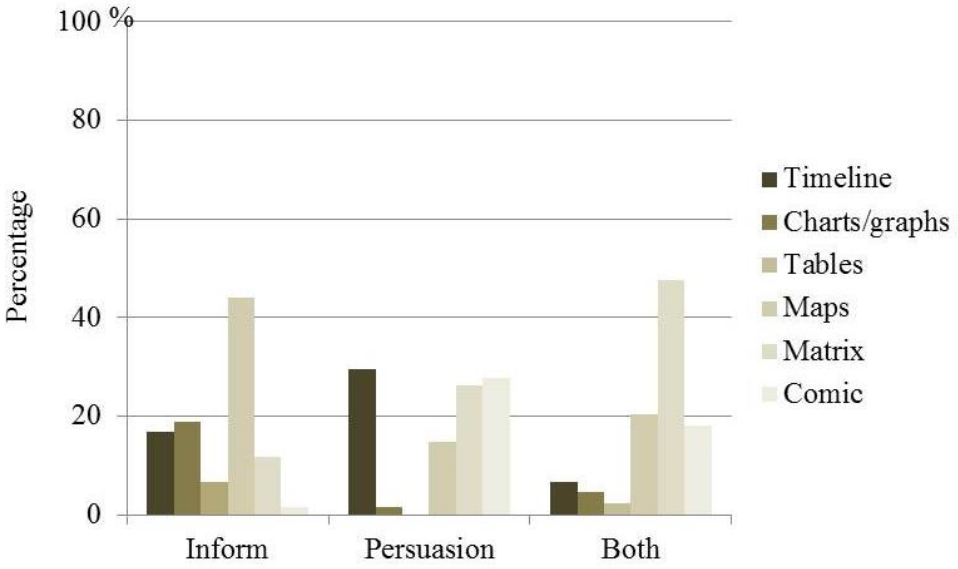

***Figure 3**. Graphic type by communication goal*
Note: The figure was created by combining the statistical results (see Appendix C; Table C8-C13).

Communication goal by epidemic type

Communication goals were significantly different by epidemic types (Figure 4). First, as shown in this graph, the number of infographics was a large difference between the issues occurring before 2010 and those occurring after 2010. Compared to SARS, H1N1, and Bird flu, which occurred before 2010, recent epidemics (Ebola, MERS, and Zika) have more infographics to inform general facts about the disease and persuasive messages to prevent it. Within Ebola cases, informative communication goal was more employed than the persuasive goal, with 75.6% of total Ebola infographics (see Appendix C; Table C14). Within MERS and Zika cases, informative contents and messages containing persuasive items were similarly used in infographics (MERS: Inform 49%, Persuasion+Both 51%; Zika: Inform 51.5%, Persuasion+Both 48.9%).

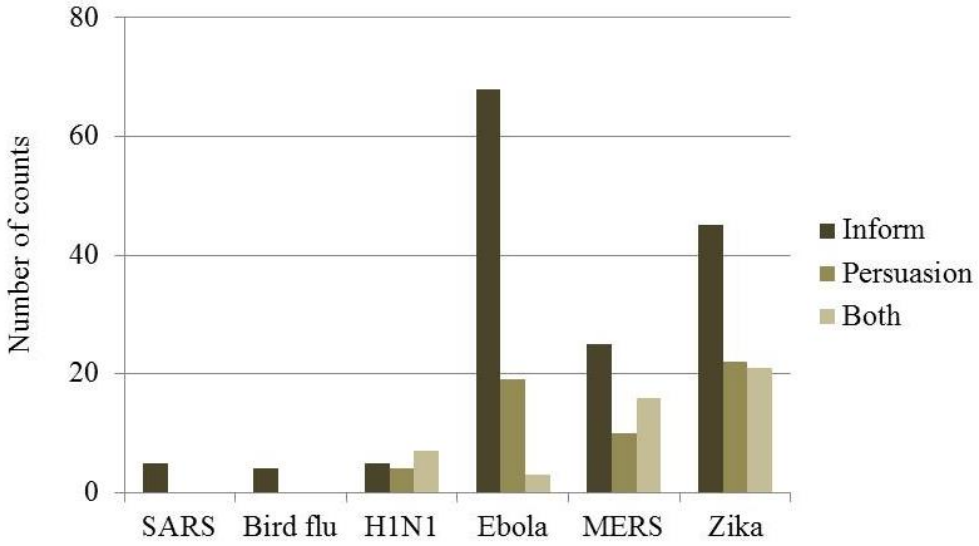

Figure 4. *Communication goal by epidemic type*
Note: The figure was created by combining the statistical results (see Appendix C; Table C14).

Message strategies by epidemic type

There were significant differences between message strategies, except for vulnerability, in terms of epidemic types (Figure 5). As shown in the results (see Appendix C; Tables C15-C18), the severity of strategic messages was 44.5% of the total infographics. Most were about recent epidemic issues (Ebola: 14.6%, MERS: 13.4%, and Zika: 11.4%). Other types of strategic messages showed similar patterns. Vulnerability messages were 33% of the total infographics and most were from the Ebola, MERS, and Zika cases (Ebola: 10.2%, MERS: 8.7%, and Zika: 10.2%). The response-efficacy messages were 41% of the total infographics and most were from the recent outbreak cases (Ebola: 9.4%, MERS: 11.0%, and Zika: 16.5%). The self-efficacy messages were 37% of the total infographics and most were from the Ebola, MERS, and Zika cases (Ebola: 8.7%, MERS: 7.9%, and Zika: 16.1%). Within recent epidemic issues, the Zika case has more infographics to show prevention and recommended behaviors; whereas, Ebola and MERS infographics most frequently showed severity of the disease.

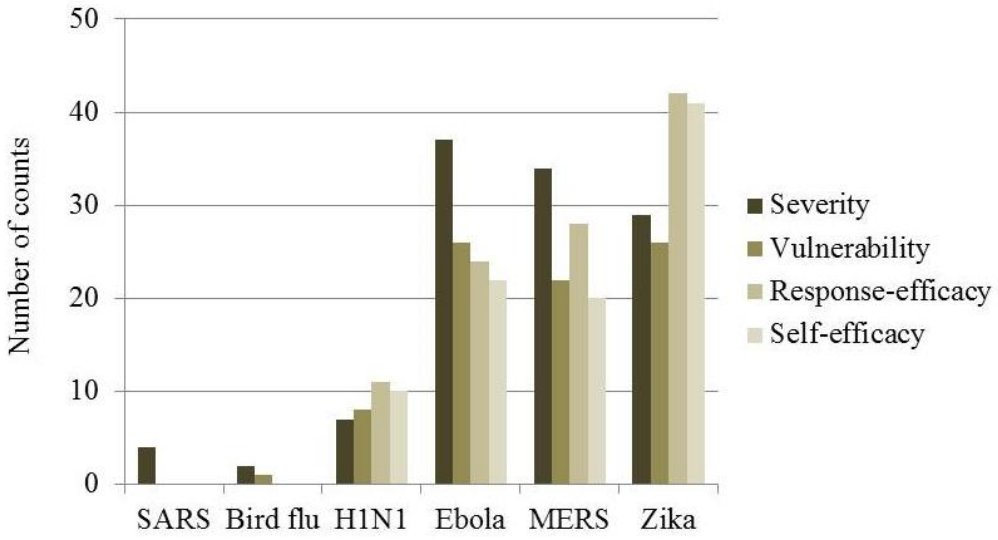

Figure 5. *Message strategies by epidemic type*

Note: The figure was created by combining the statistical results (see Appendix C; TableC15-C18).

CHAPTER 5

DISCUSSION

Significance of the Study

With a limitation of generalization due to convenience sampling of infographics, this study provided several implications to consider. First, from a strategic communication perspective, the general public needs more attention as a target audience because infographics about epidemics did not specify health care workers and the general public. A tailored information campaign has proven more effective. Persuasive function of infographics should be adopted by health organizations. Infographics, as the name says, was dominantly used as an information campaign tool. However, it shows a great potential to deliver persuasive messages for epidemic prevention to target the general public (see Appendix D4). As for message strategy, severity, vulnerability, response-efficacy, and self-efficacy were evenly adopted to inform and persuade the public about health risks.

Second, there was a significant difference in terms of the number of infographics by time range. For SARS, H1N1, and Bird flu, there were fewer than 30 infographics; whereas, over 200 infographics were created for Ebola, MERS, and Zika. The later cases occurred after 2010 when infographics and data visualizations were developed and frequently used, based on technologies related to data saving and mining. In particular, during these epidemic periods, health organizations and news organizations utilized a mapping system to track the data related to the epidemic and make graphics to show recent situations of the disease (e.g., health map system; see Appendix D5). Based on this trend, infographics will be more frequently used and play an important role in conveying information about epidemic issues over time.

Third, communication goal has changed over time. Before 2010, most communication goals of infographics were to inform. Infographics were used in specific type of graphics, such as charts and maps to show data related to the disease. For example, graphs and charts were used in describing the number of cases the disease had occurred by a time line. Maps were utilized to show the number of infected people in each country or which countries were highly exposed to the disease. Generally, graphic elements were used to explain numerical data in a simple way during this period (see Appendix D6). However, after 2010, infographics developed and were used in a variety of ways by emerging technologies of big data and data visualization (see Appendix D7). Organizations generated infographics for various purposes armed with new, advanced skills to visualize large-scale data and information. For example, they have created infographics to lead to the public's behavioral change as well as to inform general facts about the disease.

Fourth, previous studies about visual effects in health and risk communications showed fear and humor appeals are effective to persuade behavioral change. This study explored cases of fear and humor appeals in infographics. However, there were very few cases that fit emotional appeal. Most infographics used neutral visual appeal about the disease (see Appendix D8). It is assumed this is related to some strategies of organizations in an epidemic outbreak. If the first case of an epidemic occurs with no vaccination, there are many rumors about the disease. Under an uncertain, fearful situation, governments and health organizations try not to scare people and emotion appeal is not a good option. However, an exception for the H1N1 outbreak, the Singapore Ministry of Health used humorous comic drawings in their infographics, even though the situation was serious in the Asia region (see Appendix D1). It was uncertain how people perceive this humor appeal, but it deserves a future study.

Lastly, for public relations practitioners, this study implies infographics have been created as information materials for health care workers as well as the general public over time. They should be mainly used for diverse communication purposes with complicated or large sets of information in a simple and fast way. However, practitioners should consider factors, such as type of appropriate graphic, best images or colors for comprehensive easiness, and what cultural factors should be considered, when they target specific regions or a public sphere with their purposeful messages in the infographics. Moreover, it is needed to diversify appeal factors used for message strategies for attracting people's attention. As shown in the Singapore infographics, humorous graphic elements could be effective to engage individual's attention in information campaign. Not only just for interests but also for conveying accurate information, to grab people's attention is critical point in risk situations. Thus, various appealing elements in infographics need to be used and developed.

Limitations of the Study

This study has limitations in methodology. First, there was no sample frame for infographics when selecting samples from the population. Instead of random sampling, the sample for this study was collected from well-known health organizations and news organizations as described in the method section using convenience sampling. In addition, this study focused on the infographics of six epidemic outbreaks. The results of the characteristics of infographics were influenced by epidemic types and geographic locations of outbreaks (see Appendix A). Thus, there are some limitations to generalize this study to the population of infographics.

Second, health organizations are integrated to a centralized system to control globalized disease and share related information. In most cases of epidemic issues, the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC)

function as a control tower to manage outbreaks. There is a tendency that other health organizations or each country's government share, transform, or reproduce information materials, including infographics from these global health organizations. Thus, the contents of infographics are not specialized to a specific audience group, environment, or regions.

Finally, this study is an exploratory research to analyze infographics. There have been several studies to discuss the characteristics of infographics. For investigating the characteristics of infographics, this study referred to studies about graphics or visualizations in the communications field. Content variables for this study might have some further understanding of the overall characteristics of infographics. Thus, other variables to show the infographics' features should be identified and elaborated in a future study.

Suggestions of the Study

For the scholarly community, this study implies several suggestions. First, previous studies have shown fear appeal is one of the effective ways to promote and persuade individuals' behavior change in health campaigns. However, this study shows that most epidemic infographics used neutral graphics rather than images to evoke special emotions, such as fear or humor. Future research could determine the types of graphics or images that attract people's attentions and are effective in infographics for specific health risk issues.

Second, this study focused on only two characteristics of infographics, strategic and graphical/technical aspects. If mediating, moderating, or outcome variables (e.g., cultural variables or other variables related to the effects of infographics) are detected, audience studies or hypothesis testing can be conducted.

Third, as mentioned in the limitations section, this study selected samples from well-known health and news organizations. When searching infographics on the web, there were many infographics generated by private companies or web sites. As observed, infographics

have been industrialized and created as commercial products. These infographics look different from infographics made by public organizations and news media. The competitive and innovative nature of commercial markets might influence characteristics of infographics. If the study includes more diverse sources of infographics, researchers can investigate the differences of infographics between public organizations and private companies.

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APPENDICES

APPENDIX A

SAMPLE INFORMATION

Table A1. Information of six epidemic outbreaks

	Time	Region	Fatality	Symptoms/Risks	Vaccination
Ebola	08/2014	Africa	50-90%	Fever, muscular pain, headaches, sore throat, vomiting, diarrhea, etc.	No
SARS	03/2003	China	10%	Fever, cough, sore throat, other flu-like symptoms	No
MERS	05/2015	Asia	30-50%	Fever, cough, shortness of breath, etc.	No
Zika	01/2016	Oceania, Mexico, Central America, South America, Caribbean, etc.	(not exact) dangerous for pregnant	fetal death, fetal growth restriction, negative impact on fetal development	No
H1N1	06/2009	World-wide	Lower than 0.05%	Flu-like illness (e.g., cough, fatigue, nasal secretions, decreased appetite, etc.)	Yes
Bird flu	2003-2008	World-wide	60%	Flu-like symptoms (e.g., muscle pain, fever, runny nose, etc.)	Yes

Note: 'Time' is the period that national or international health organization (e.g., WHO and CDC) issued global alert toward the outbreak or declared the epidemic is an international emergency status. 'Region' is the main contingent or country that the outbreak occurred. 'Fatality' is the approximate rate of death for those infected. 'Vaccination' is the existence of protective vaccine for the disease at the outbreak period. All outbreaks are on-going issues.

Table A2. The lists of sample source

Health organizations	News organizations
CDC (Centers for Disease Control and Prevention)	USA today
WHO (World Health Organization)	Washington Post
ECDC (European CDC)	The New York Times
Korean CDC	CNN news
Saudi Ministry of Health	ABC news
PAHO (Pan American Health Organization)	The Economist
Korea Ministry of Health	The times
American Red Cross	BBC news
Philippines Department of Health	Forbes
Singapore Ministry of Health	CBC news
Pennsylvania Department of Health	NPR news
Michigan Department of Health and Human Services	CNBC news
Malaysia Ministry of Health	The week
Public health agency of Canada	VOA news
Japan National Institutes of Health	CBS news
	South China morning post
	CCTV
	Newsweek
	The Huffington Post
	Al Jazeera
	Chiang Rai Times (Thailand news)
	(Korean newspapers)

APPENDIX B

CODEBOOK FOR CONTENT ANALYSIS OF INFOGRAPHICS

Variable Name	Theoretical definition	Operational definition	Examples
ID	Unique four digit number assigned to each infographic		
Epidemic type	Epidemic type that infographic focuses on	1 = Ebola 2 = SARS 3 = MERS 4 = H1N1 5 = Bird Flu	
Source	Organization to create infographics	1 = Health organizations 2 = New media	1 = CDC, WHO, etc. 2 = NY Times, The Guardian, etc.
Target audience	Key public who infographic intends to communicate with	1 = Health care workers 2 = General public or potential patient 3 = Both	
Communication goal	What infographic intend to achieve	1 = Inform 2 = Persuade to perform behavior or behavioral change 3 = Both inform and persuade	
(Protection motivation) Strategy 1. Severity 2. Vulnerability 3. Response-efficacy 4. Self-efficacy	Influencing factors to health protecting behaviors 1. Seriousness of potential threats of health risk 2. Possibility of negative consequences by health risk 3. Ability of recommendation to	0 = absence 1 = presence	

	protect risk 4. Individual ability to perform recommendation		
Evidence type 1. Statistical evidence 2. Exemplar evidence	What type of information that infographic messages base on 1. Message based on quantitative/numerical data 2. Message based on personal case or experience	0 = absence 1 = presence	
Graphic type 1. Time line 2. Charts/Graphs 3. Tables 4. Maps 5. Matrix 6. Networks 7. Comic strips 8. Other	Types of graphics used in infographic 1. Visuals that express time-series or sequences 2. Bar, pie, line charts/graphs or diagrams 3. Tables 4. Mapping or satellite pictures 5. Array of numbers, symbols, or any expressions 6. Figures that points or nodes are interconnected by paths/lines 7. Array of drawings that interrelated each other with containing narratives 8. Other	0 = absence 1 = presence	
Interactivity	Graphical and technological elements on the website that audience can control and follow in their desired	0 = absence 1 = presence	Controlling screen size, multi-layered information/graphics,

	way		animations, pop-ups, click button, etc.
Comprehensive easiness 1. Color harmony 2. Simplicity	Easily understand at a glance 1. The degree of selected color reflected the general conventions about colors implicitly or explicitly 2. The degree of clarity without unnecessary graphical elements	1 = low 2 = high	
Visual appeal 1. Artistic beauty 2. Stimulating 3. Humorous 4. Other	Design qualities and attractions that graphics cause 1. Well-balanced, color harmony, format 2. Fear appealing graphics 3. Humorous graphics 4. Others	0 = absence 1 = presence	
Graphic-text ratio	Overall percentage of text and graphic elements in infographic	1 = text-centered 2 = graphic-centered 3 = Similar ratio 4 = graphic only	
Graphic-text relationship	Matching degree of graphic and text; whether graphic leads a key meaning or doesn't show key meanings of texts	0 = no relationship 1 = low 2 = high	

APPENDIX C

TABLES FOR CROSS-TABULATION TEST

Table C1. Cross-tabulation of communication goal by source

		Source		*Total*
		Health organization	News organization	
Communication goal	Inform	80 47.6% 31.5%	72 83.7% 28.3%	152 59.8% 59.8%
	Persuasion	50 29.8% 19.7%	5 5.8% 2.0%	55 21.7% 21.7%
	Both	38 22.6% 15.0%	9 10.5% 3.5%	47 18.5% 18.5%
	Total	168 100.0% 66.1%	86 100.0% 33.9%	254 100.0% 100.0%

Note: $\chi^2 = 31.995$, df = 2, p = 0.000.

In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each source, and the third row is the percent of infographics in total number of infographics. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 15.91.

Table C2. Cross-tabulation of recoded communication goal by source

		Source		*Total*
		Health organization	News organization	
Recoded communication goal	Inform	80 47.6% 31.5%	72 83.7% 28.3%	152 59.8% 59.8%
	Persuasion and Both	88 52.4% 34.6%	14 16.3% 5.5%	102 40.2% 40.2%
	Total	168 100.0% 66.1%	86 100.0% 33.9%	254 100.0% 100.0%

Note: $\chi^2 = 30.850$, df = 1, p = 0.000.

In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each source, and the third row is the percent of infographics in total number of infographics. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 34.54.

Table C3. Cross-tabulation of graphic type (timeline) by source

		Source		*Total*
		Health organization	News organization	
Graphic type (Timeline)	Absence	126 75.0% 49.6%	74 86.0% 29.1%	200 78.7% 78.7%
	Presence	42 25.0% 16.5%	12 14.0% 4.7%	54 21.3% 21.3%
	Total	168 100.0% 66.1%	86 100.0% 33.9%	254 100.0% 100.0%

Note: $\chi^2 = 4.146$, df = 1, p = 0.042.
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each source, and the third row is the percent of infographics in total number of infographics. 0 cells (0.0%) have expected count less than 5.The minimum expected count is 18.28.

Table C4. Cross-tabulation of graphic type (charts/graphs) by source

		Source		*Total*
		Health organization	News organization	
Graphic type (Charts/graphs)	Absence	155 92.3% 61.0%	59 68.6% 23.2%	214 84.3% 84.3%
	Presence	13 7.7% 5.1%	27 31.4% 10.6%	40 15.7% 15.7%
	Total	168 100.0% 66.1%	86 100.0% 33.9%	254 100.0% 100.0%

Note: $\chi^2 = 23.994$, df = 1, p = 0.000.
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each source, and the third row is the percent of infographics in total number of infographics. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 13.54.

Table C5. Cross-tabulation of graphic type (maps) by source

		Source		*Total*
		Health organization	News organization	
Graphic type (Maps)	Absence	115 68.5% 45.3%	35 40.7% 13.8%	150 59.1% 59.1%
	Presence	53 31.5% 20.9%	51 59.3% 20.1%	104 40.9% 40.9%
	Total	168 100.0% 66.1%	86 100.0% 33.9%	254 100.0% 100.0%

Note: $\chi^2 = 18.121$, df = 1, p = 0.000.
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each source, and the third row is the percent of infographics in total number of infographics. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 35.21.

Table C6. Cross-tabulation of graphic type (matrix) by source

		Source		*Total*
		Health organization	News organization	
Graphic type (Matrix)	Absence	119 70.8% 46.9%	75 87.2% 29.5%	194 76.4% 76.4%
	Presence	49 29.2% 19.3%	11 12.8% 4.3%	60 23.6% 23.6%
	Total	168 100.0% 66.1%	86 100.0% 33.9%	254 100.0% 100.0%

Note: $\chi^2 = 8.455$, df = 1, p = 0.004.
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each source, and the third row is the percent of infographics in total number of infographics. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 20.31.

Table C7. Cross-tabulation of graphic type (comic) by source

		Source		*Total*
		Health organization	News organization	
Graphic type (Comic)	Absence	141 83.9% 55.5%	85 98.8% 33.5%	226 89.0% 89.0%
	Presence	27 16.1% 10.6%	1 1.2% 0.4%	28 11.0% 11.0%
	Total	168 100.0% 66.1%	86 100.0% 33.9%	254 100.0% 100.0%

Note: $\chi^2 = 12.890$, df = 1, p = 0.000.
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each source, and the third row is the percent of infographics in total number of infographics. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.48.

Table C8. Cross-tabulation of graphic type (timeline) by communication goal

		Communication goal			*Total*
		Inform	Persuasion	Both	
Graphic type (Timeline)	Absence	119 78.3% 46.9%	37 67.3% 14.6%	44 93.6% 17.3%	200 78.7% 78.7%
	Presence	33 21.7% 13.0%	18 32.7% 7.1%	3 6.4% 1.2%	54 21.3% 21.3%
	Total	152 100.0% 59.8%	55 100.0% 21.7%	47 100.0% 18.5%	254 100.0% 100.0%

Note: $\chi^2 = 10.553$, df = 2, p = 0.005.
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each communication goal, and the third row is the percent of infographics in total number of infographics. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.99.

Table C9. Cross-tabulation of graphic type (charts/graphs) by communication goal

		Communication goal			*Total*
		Inform	Persuasion	Both	
Graphic type (Charts/graphs)	Absence	115 75.7% 45.3%	54 98.2% 21.3%	45 95.7% 17.7%	214 84.3% 84.3%
	Presence	37 24.3% 14.6%	1 1.8% 0.4%	2 4.3% 0.8%	40 15.7% 15.7%
	Total	152 100.0% 59.8%	55 100.0% 21.7%	47 100.0% 18.5%	254 100.0% 100.0%

Note: $\chi^2 = 21.184$, df = 2, p = 0.000.
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each communication goal, and the third row is the percent of infographics in total number of infographics. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.40.

Table C10. Cross-tabulation of graphic type (tables) by communication goal

		Communication goal			*Total*
		Inform	Persuasion	Both	
Graphic type (Tables)	Absence	139 91.4% 54.7%	55 100.0% 21.7%	46 97.9% 18.1%	240 94.5% 94.5%
	Presence	13 8.6% 5.1%	0 0.0% 0.0%	1 2.1% 0.4%	14 5.5% 5.5%
	Total	152 100.0% 59.8%	55 100.0% 21.7%	47 100.0% 18.5%	254 100.0% 100.0%

Note: $\chi^2 = 6.941$, df = 2, p = 0.031.
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each communication goal, and the third row is the percent of infographics in total number of infographics
2 cells (33.3%) have expected count less than 0. The minimum expected count is 2.59.

Table C11. Cross-tabulation of graphic type (maps) by communication goal

		Communication goal			*Total*
		Inform	Persuasion	Both	
Graphic type (Maps)	Absence	66 43.4% 26.0%	46 83.6% 18.1%	38 80.9% 15.0%	150 59.1% 59.1%
	Presence	86 56.6% 33.9%	9 16.4% 3.5%	9 19.1% 3.5%	104 40.9% 40.9%
	Total	152 100.0% 59.8%	55 100.0% 21.7%	47 100.0% 18.5%	254 100.0% 100.0%

Note: $\chi^2 = 38.343$, df = 2, p = 0.000.
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each communication goal, and the third row is the percent of infographics in total number of infographics. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 19.24.

Table C12. Cross-tabulation of graphic type (matrix) by communication goal

		Communication goal			*Total*
		Inform	Persuasion	Both	
Graphic type (Matrix)	Absence	129 84.9% 50.8%	39 70.9% 15.4%	26 55.3% 10.2%	194 76.4% 76.4%
	Presence	23 15.1% 9.1%	16 29.1% 6.3%	21 44.7% 8.3%	60 23.6% 23.6%
	Total	152 100.0% 59.8%	55 100.0% 21.7%	47 100.0% 18.5%	254 100.0% 100.0%

Note: $\chi^2 = 18.538$, df = 2, p = 0.000.
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each communication goal, and the third row is the percent of infographics in total number of infographics. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.10.

Table C13. Cross-tabulation of graphic type (comic) by communication goal

		Communication goal			*Total*
		Inform	Persuasion	Both	
Graphic type (Comic)	Absence	149 98.0% 58.7%	38 69.1% 15.0%	39 83.0% 15.4%	226 89.0% 89.0%
	Presence	3 2.0% 1.2%	17 30.9% 6.7%	8 17.0% 3.1%	28 11.0% 11.0%
	Total	152 100.0% 59.8%	55 100.0% 21.7%	47 100.0% 18.5%	254 100.0% 100.0%

Note: $\chi^2 = 36.589$, df = 2, p = 0.000.
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each communication goal, and the third row is the percent of infographics in total number of infographics. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.18.

Table C14. Cross-tabulation of communication goal by epidemic type

		Epidemic type						
		Ebola	SARS	MERS	Zika	H1N1	Bird flu	*Total*
Communi-cation goal	Inform	68 75.6% 26.8%	5 100.0% 2.0%	25 49.0% 9.8%	45 51.1% 17.7%	5 31.2% 2.0%	4 100.0% 1.6%	152 59.8% 59.8%
	Persuasion	19 21.1% 7.5%	0 0.0% 0.0%	10 19.6% 3.9%	22 25.0% 8.7%	4 25.0% 1.6%	0 0.0% 0.0%	55 21.7% 21.7%
	Both	3 3.3% 1.2%	0 0.0% 0.0%	16 31.4% 6.3%	21 23.9% 8.3%	7 43.8% 2.8%	0 0.0% 0.0%	47 18.5% 18.5%
	Total	90 100.0% 35.4%	5 100.0% 2.0%	51 100.0% 20.1%	88 100.0% 34.6%	16 100.0% 6.3%	4 100.0% 1.6%	254 100.0% 100.0%

Note: $\chi^2 = 37.336$, df = 10, p = 0.000.
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each epidemic type, and the third row is the percent of infographics in total number of infographics. 8 cells (44.4%) have expected count less than 5. The minimum expected count is 0.74.

Table C15. Cross-tabulation of strategy (severity) by epidemic type

		Epidemic type						*Total*
		Ebola	SARS	MERS	Zika	H1N1	Bird flu	
Strategy (severity)	Absence	53	1	17	59	9	2	141
		58.9%	20.0%	33.3%	67.0%	56.2%	50.0%	55.5%
		20.9%	0.4%	6.7%	23.2%	3.5%	0.8%	55.5%
	Presence	37	4	34	29	7	2	113
		41.4%	80.0%	66.7%	33.0%	43.8%	50.0%	44.5%
		14.6%	1.6%	13.4%	11.4%	2.8%	0.8%	44.5%
	Total	90	5	51	88	16	4	254
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		35.4%	2.0%	20.1%	34.6%	6.3%	1.6%	100.0%

Note: $\chi^2 = 17.920$, df = 5, p = 0.003.
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each epidemic type, and the third row is the percent of infographics in total number of infographics. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 1.78.

Table C16. Cross-tabulation of strategy (vulnerability) by epidemic type

		Epidemic type						*Total*
		Ebola	SARS	MERS	Zika	H1N1	Bird flu	
Strategy (vulner-ability)	Absence	64	5	29	62	8	3	171
		71.1%	100.0%	56.9%	70.5%	50.0%	75.0%	67.3%
		25.2%	2.0%	11.4%	24.4%	3.1%	1.2%	67.3%
	Presence	26	0	22	26	8	1	83
		28.9%	0.0%	43.1%	29.5%	50.0%	25.0%	32.7%
		10.2%	0.0%	8.7%	10.2%	3.1%	0.4%	32.7%
	Total	90	5	51	88	16	4	254
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		35.4%	2.0%	20.1%	34.6%	6.3%	1.6%	100.0%

Note: $\chi^2 = 8.232$, df = 5, p = .144.
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each epidemic type, and the third row is the percent of infographics in total number of infographics. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 1.31.

Table C17. Cross-tabulation of strategy (response-efficacy) by epidemic type

		Epidemic type						*Total*
		Ebola	SARS	MERS	Zika	H1N1	Bird flu	
Strategy (response-efficacy)	Absence	66 73.3% 26.0%	5 100.0% 2.0%	23 45.1% 9.1%	46 52.3% 18.1%	5 31.2% 2.0%	4 100.0% 1.6%	149 58.7% 58.7%
	Presence	24 26.7% 9.4%	0 0.0% 0.0%	28 54.9% 11.0%	42 47.7% 16.5%	11 68.8% 4.3%	0 0.0% 0.0%	105 41.3% 41.3%
	Total	90 100.0% 35.4%	5 100.0% 2.0%	51 100.0% 20.1%	88 100.0% 34.6%	16 100.0% 6.3%	4 100.0% 1.6%	254 100.0% 100.0%

Note: $\chi^2 = 24.639$, df = 5, p = 0.000.

In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each epidemic type, and the third row is the percent of infographics in total number of infographics. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 1.65.

Table C18. Cross-tabulation of strategy (self-efficacy) by epidemic type

		Epidemic type						*Total*
		Ebola	SARS	MERS	Zika	H1N1	Bird flu	
Strategy (self-efficacy)	Absence	68 75.6% 26.8%	5 100.0% 2.0%	31 60.8% 12.2%	47 53.4% 18.5%	6 37.5% 2.4%	4 100.0% 1.6%	161 63.4% 63.4%
	Presence	22 24.4% 8.7%	0 0.0% 0.0%	20 39.2% 7.9%	41 46.6% 16.1%	10 62.5% 3.9%	0 0.0% 0.0%	93 36.6% 36.6%
	Total	90 100.0% 35.4%	5 100.0% 2.0%	51 100.0% 20.1%	88 100.0% 34.6%	16 100.0% 6.3%	4 100.0% 1.6%	254 100.0% 100.0%

Note: $\chi 2 = 19.4859$, df = 5, p = 0.002

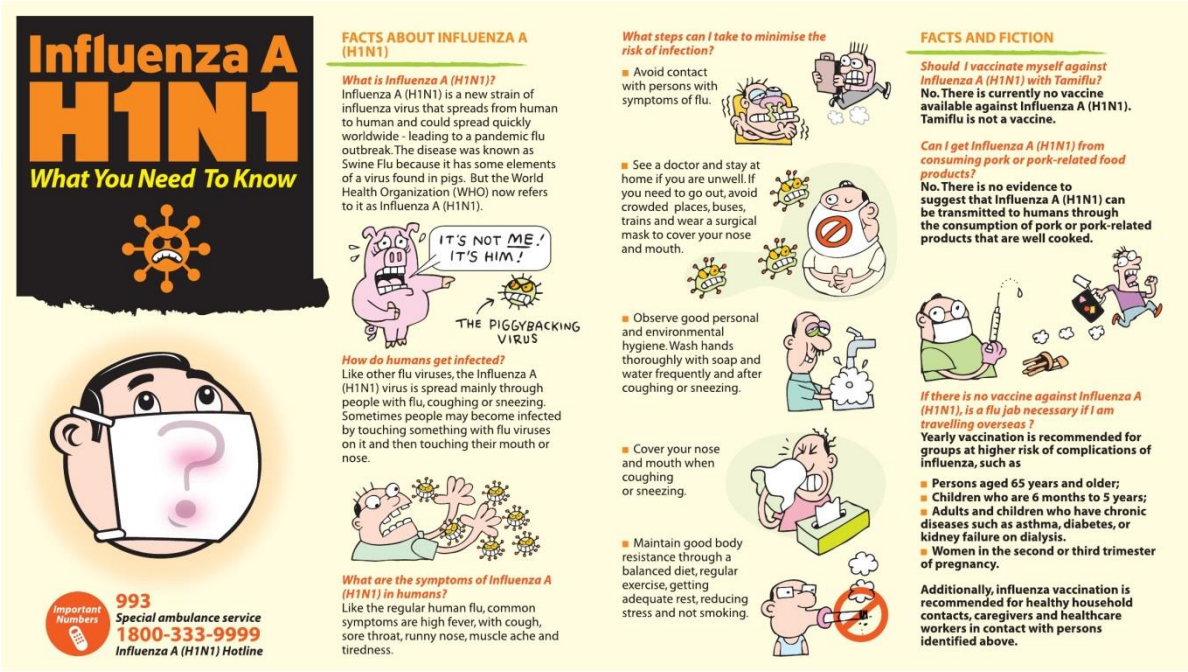
In each cell, the first row is the number of infographics (count), the second row is the percent of infographics within each epidemic type, and the third row is the percent of infographics in total number of infographics.

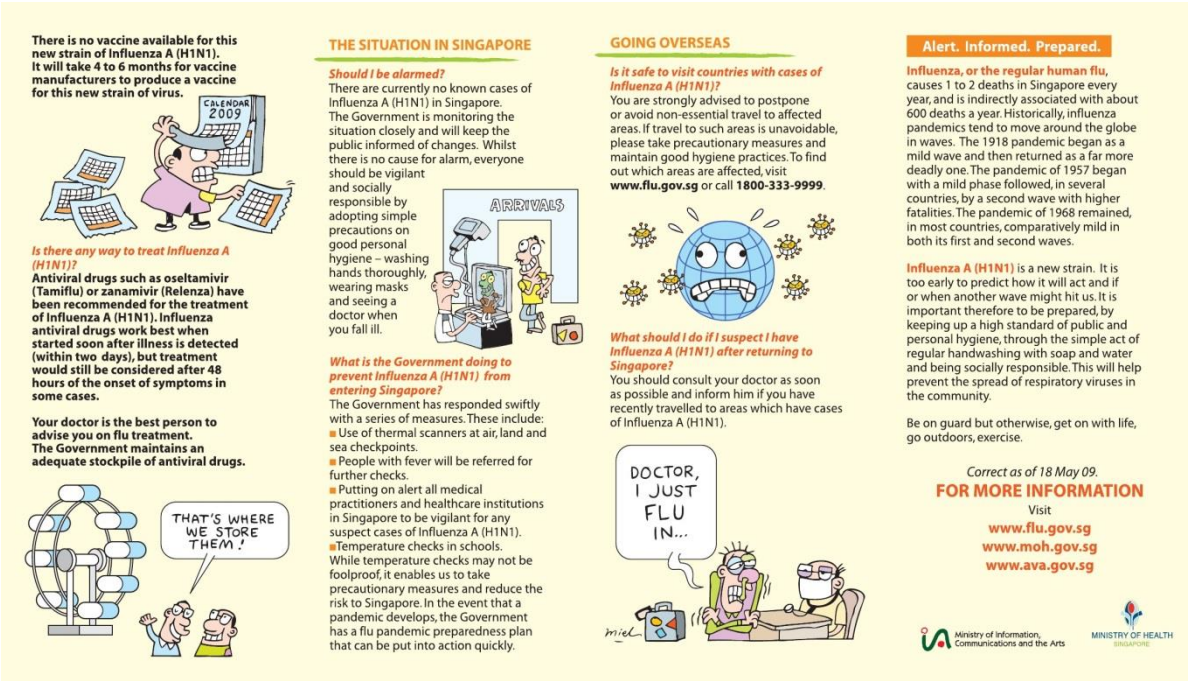
4 cells (33.3%) have expected count less than 5. The minimum expected count is 1.46.

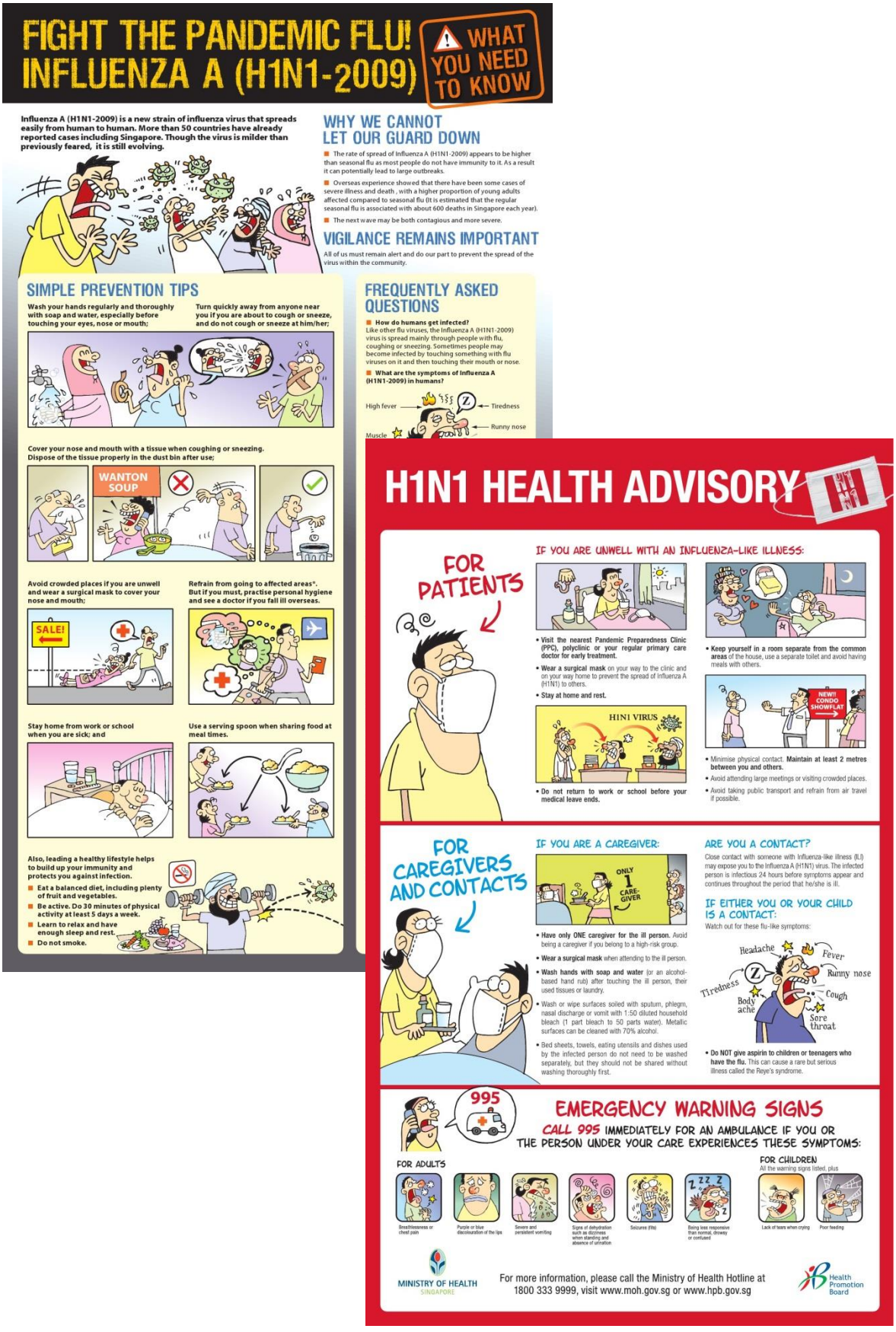
APPENDIX D

INFOGRAPHICS EXAMPLES

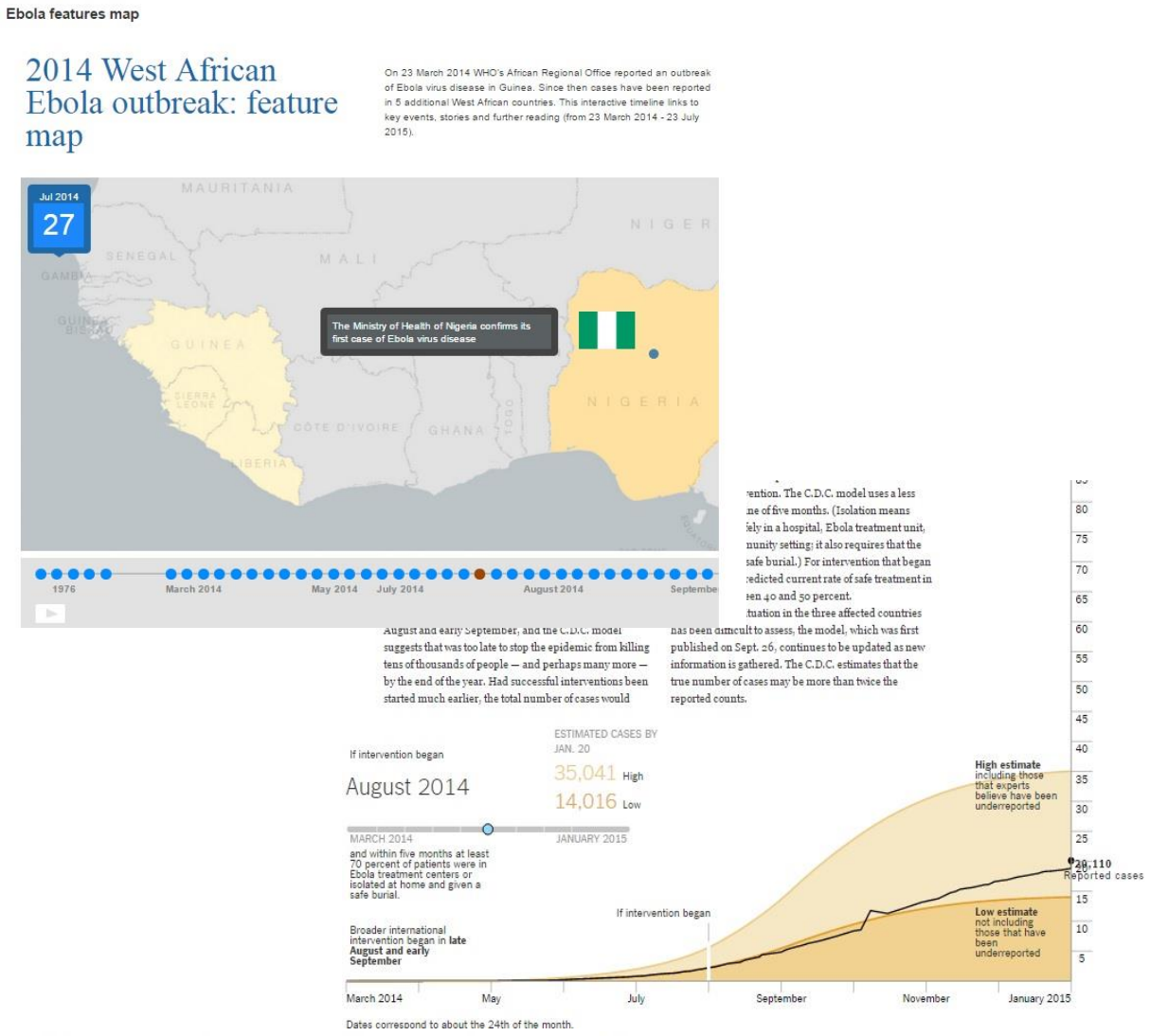
D1. Examples of infographics using humor and comic drawings
(source: Singapore ministry of health)





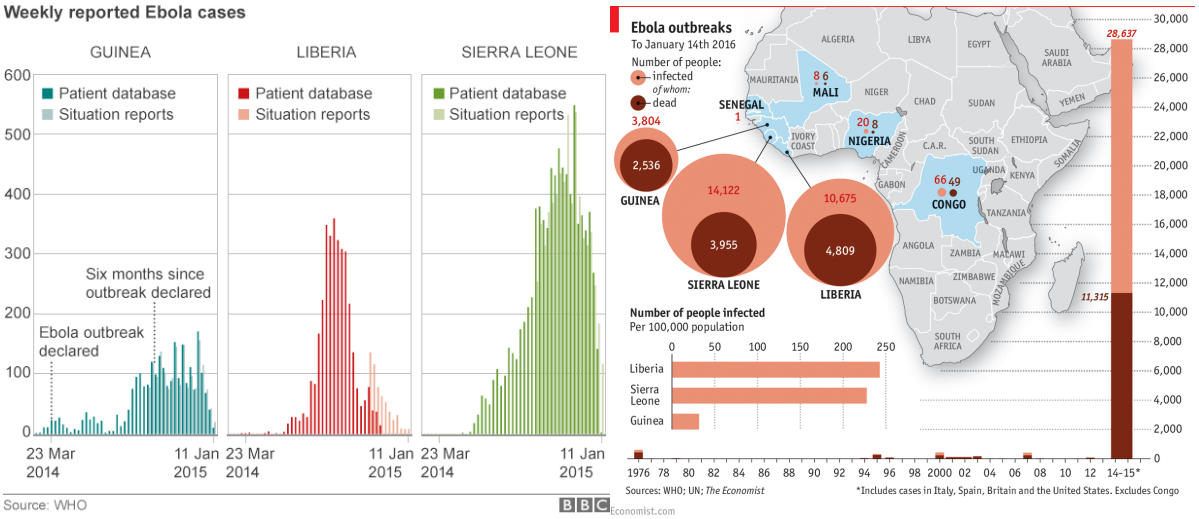


D2. Examples of infographics with interactivity on the web-based environment (source: WHO, The New York Times, Washington Post)



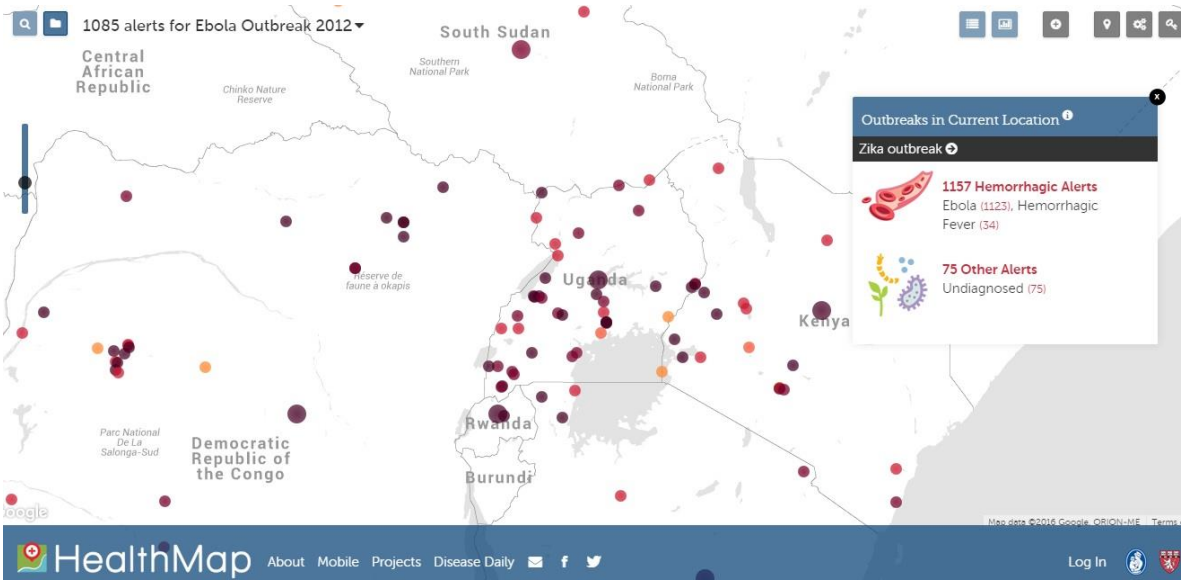
D3. Examples of differences between graphic types by communication goal (source: BBC news, The Economists, WHO)

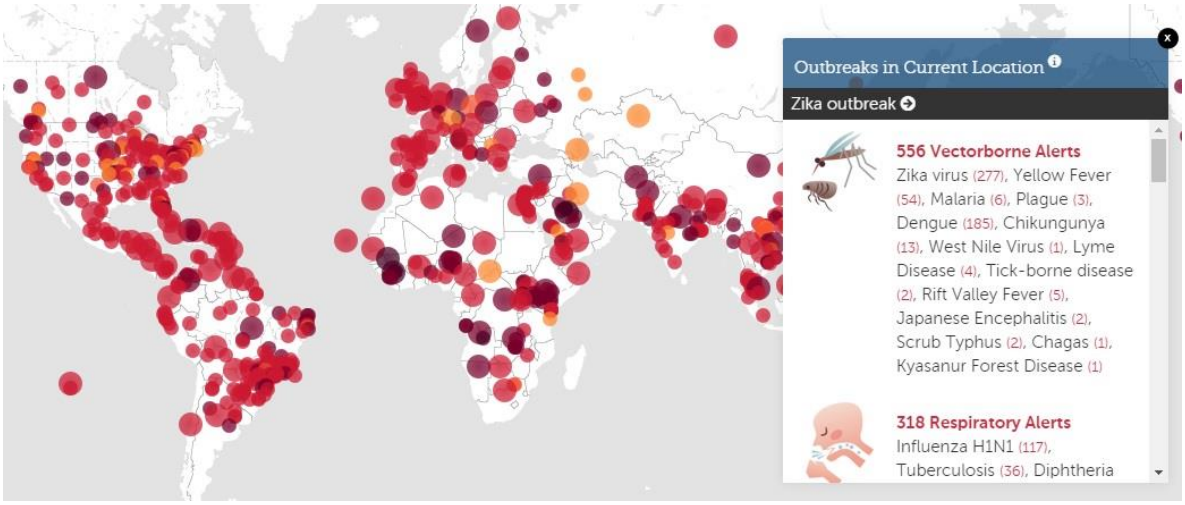
(Maps, timeline, and charts/graphs are frequently used to inform general information/situation about the disease. For persuasive messages, matrix type of graphics was used to convey the information.)



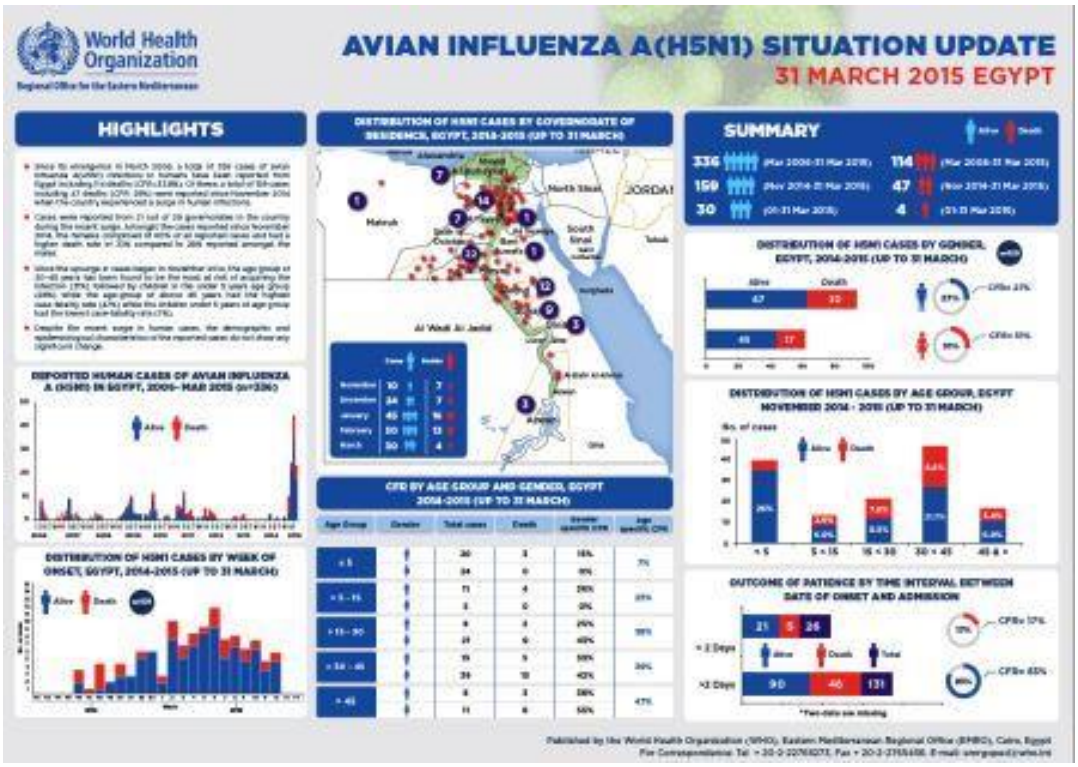
D4. Examples of infographics containing persuasive messages
(Source: CDC & UNICEF, PAHO & WHO)

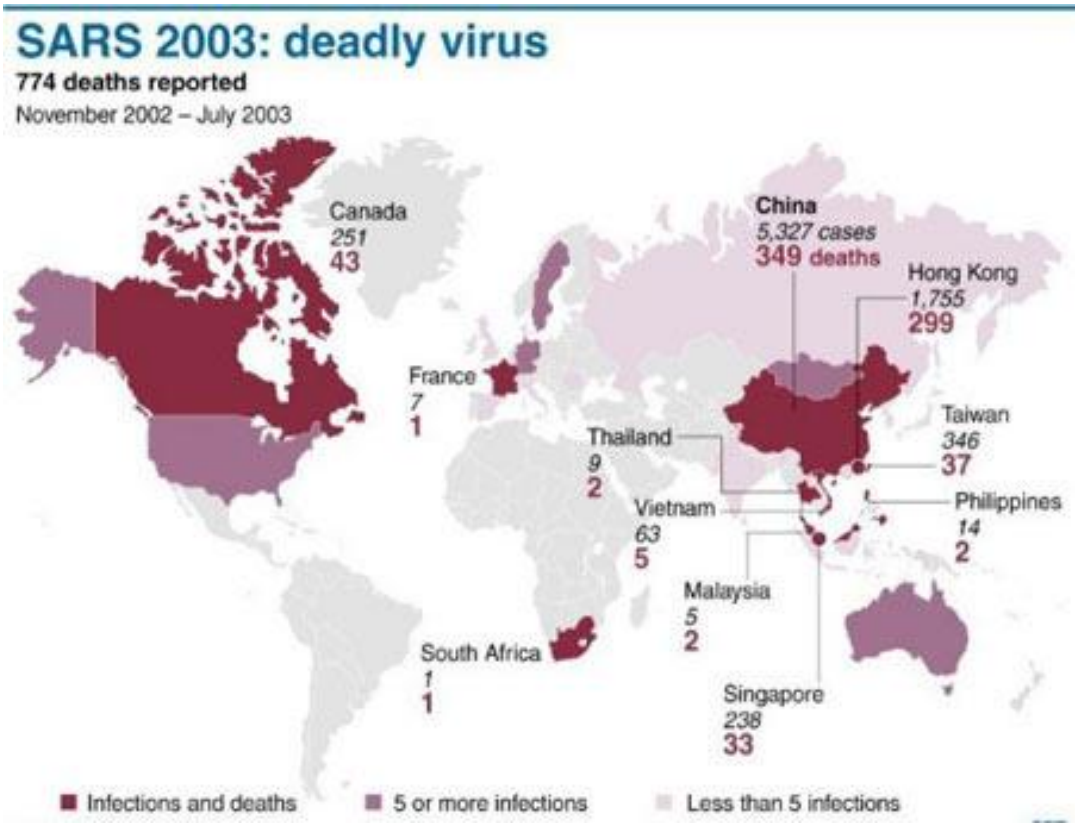
D5. Health map (www.healthmap.org)



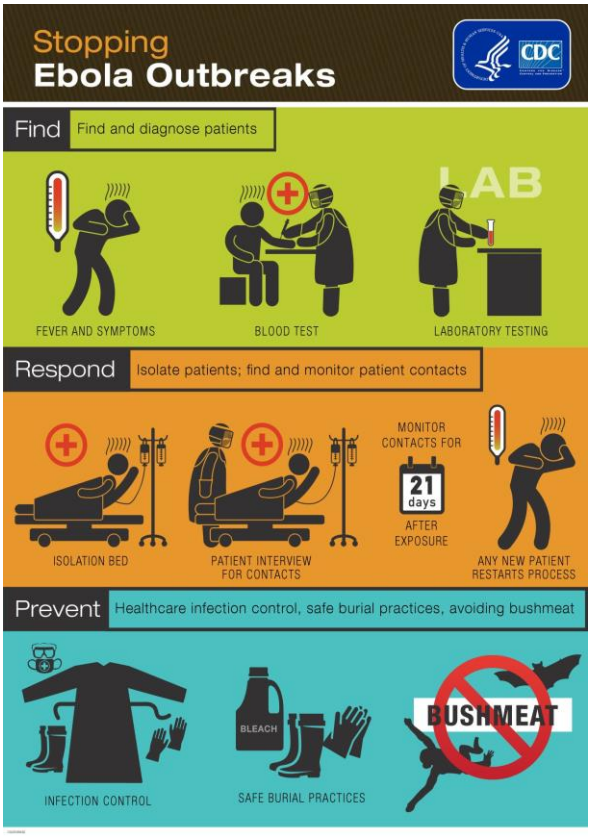


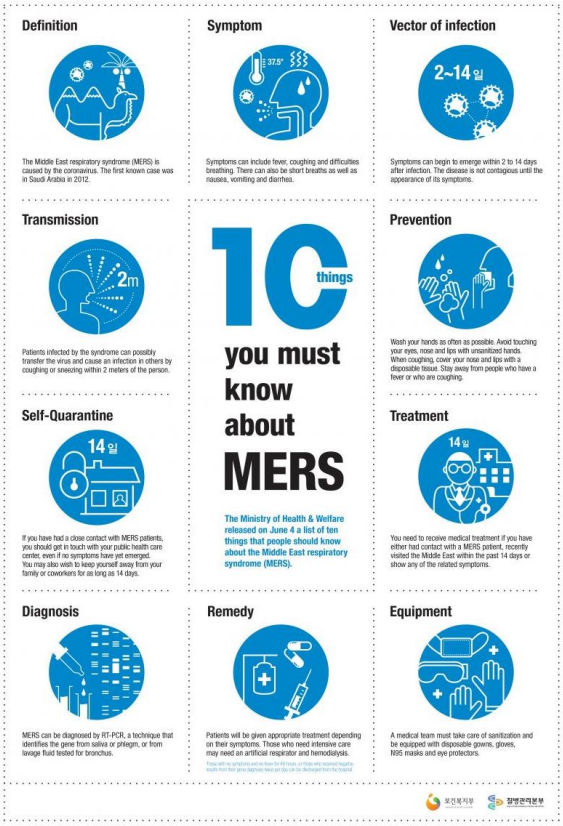
D6. Examples of infographics to show the numeric data before 2010 (source: WHO)





D7. Examples of infographics for various purposes after 2010
(source: CDC, Korea CDC, USA today, WHO)





D8. Examples of infographics using neutral graphics/images (source: CDC)