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**Novel insights into views towards H1N1 during
the 2009 Pandemic: a thematic analysis of
Twitter data**

Abstract

Background: Infectious disease outbreaks have the potential to cause a high number of fatalities, and are a very serious public health risk.

Objectives: Our aim was to utilise an in-depth method to study a period of time where the H1N1 Pandemic of 2009 was at its peak.

Methods: A dataset of n=214,784 tweets was retrieved and filtered, and the method of thematic analysis was used to analyse the data.

Results: Eight key themes emerged from the analysis of data: emotion and feeling, health-related information, general commentary and resources, media and health organisations, politics, country of origin, food, and humour and/or sarcasm.

Discussion: A major novel finding was that due to the name 'swine flu' Twitter users had the belief that pigs and pork could host and/or transmit the virus. Our paper also considered the methodological implications for the wider field of library and information science as well as specific implications for health information and library workers.

Conclusions: Novel insights were derived on how users communicate about disease outbreaks on social media platforms. Our study also provides an innovative methodological contribution because it was found that by utilising an in-depth method it was possible to extract greater insight into user communication.

Keywords: public health; qualitative research; social media

Key Messages:

- Our findings suggest that informal terms used to refer to disease outbreaks such as 'swine flu' should be avoided because they lead to confusion.
- Twitter data could be utilised by library professionals for developing a better understanding of public views on health-related topics.
- Using an in-depth qualitative method such as thematic analysis when analysing social media data may lead to greater insights.

Introduction

Infectious disease outbreaks

Infectious disease outbreaks have the potential to cause a high number of fatalities, and are a serious public health risk (Mukherjee, 2017). One of the most high profile infectious disease outbreaks to have occurred in recent history is swine flu because when the outbreak was unfolding it was ranked as having the highest proportion of media coverage in the 21st century (McCandless, 2009; Klemm, Das, and Hartmann, 2016) and was the fastest rising Web search query in Google News (Google Trends, 2017). The swine flu virus was identified in April 2009 in Mexico, and was known as swine flu as it resembled a known influenza virus which can cause illnesses in pigs (Davis, 2015; NHS Choices, 2015). On April 2009, swine flu was declared a Public Health Emergency by the United States government (Hitti, 2009).

Previous research has highlighted the potential of clinical librarians' role during infectious disease outbreaks for providing information (Coats, Sutton, Vorwerk, and Cooke, 2009). Social media platforms potentially provide an opportunity for librarians to disseminate content as well as use the platforms for researching public views and opinions as this article will explore. The swine flu outbreak of 2009 was the first pandemic to occur in the age of Twitter, and therefore drew a lot of attention from Twitter users in the form of tweets.

Twitter is a microblogging platform, formed in 2006 (Love, Himelboim, Holton, and Stewart (2013), which allows users to send '*tweets*' to other users who are registered on the platform. However, it is also important to note that the vast majority of tweets on Twitter are open and can be viewed by anyone with having to register to Twitter.

Twitter is a key communication and public health dissemination tool during outbreak situations (Alonso-Muñoz, Marcos-García, and Casero-Ripollés, 2017; Stokes, and Senkbeil 2017; McClellan, Ali, Mutter, Kroutil, & Landwehr, 2017; Ahmed, 2018; Wekerle, Vakili, Stewart, & Black 2018). Twitter reports as having 316 million monthly active users, there being 500 million tweets per day, and 80% of active Twitter users using a mobile device (About Twitter, n.d.). Twitter provides a method of studying health and related topics at large scale during the peak of an event. This is because tweets are a source of rich data, and by locating patterns in data it is possible derive insight into how people respond to certain events and topics such as infectious disease outbreaks.

Twitter has undergone a number of changes since its inception. That is, Twitter has introduced account verification, has further developed features related to hashtags, Twitter lists, retweeting, promoted tweets, mobile apps, changes to timelines, made alterations to the user-interface, has introduced emergency alerts, streaming videos, and the ability to mute and block other Twitter users (Ahmed, 2018). Our study will be useful to compare to research conducted at different time points as behaviour may have altered due to changes within the platform. Furthermore, Twitter was originally created for personal use; however, since its inception it has become a popular platform to study computer-mediated communication (Sinnenberg et al, 2017). Communication from Twitter can be retrieved and analysed and this can be then utilised as intelligence (Tricco, Zarin, Lillie, Pham, & Straus, 2017) when, for instance, creating plans to disseminate health information (Ahmed, 2018). This is because common misunderstandings and key questions related to health can be rapidly identified and correct information can be consequently disseminated.

Rationale

Previous evidence based research has examined the utility of Twitter for gaining insight into infectious disease outbreaks (Chew and Eysenbach, 2010; Signorini, Segre and Polgreen, 2011; Kostkova, Szomszor, and St. Louis, 2014) and Ebola (Oluwafemi, Elia, and Rolf, 2014). However, previous research has made use of quantitative methods. This study offers unique insight because it provides data-driven qualitative insights into tweets related to infectious disease outbreaks. The purpose of this study is to provide an in-depth understanding into public views and opinions during

the height of the 2009 swine flu outbreak, and to outline potential implications for health information and librarians. The overall research question is provided below:

- What types of information was shared on Twitter during the peak of the 2009 swine flu Pandemic?

The results of this study will be of interest to policymakers, stakeholders, health, information, and library workers who disseminate information during infectious disease outbreaks. To the best of our knowledge, this is the first evidence-based research project applying a qualitative methodology (Braun, and Clarke, 2006) to tweets generated during the peak of the 2009 swine flu outbreak. Previous empirical research has found that librarians play a role in meeting the information needs of administrators in health settings due to the ability to gather high quality information during the response phase on an infectious disease outbreak (Featherstone, Boldt, Torabi, Konrad, 2012). The ability to use social media data for consumer insights towards products or organisations known as 'social media listening' has gained in popularity in recent years (Quartey, Ley-Acosta, Pierce, Nguyen, & Ertle, 2018). The methodology applied in this study can be adapted for the analysis of discussions surrounding libraries as well as the profession as a whole. Social media platforms have faced the challenge of misinformation and false news that can cause confusion among users (Bode and Vraga, 2018). This makes it important to carefully study the types of information shared and to devise methods that can be used by health information and library professionals to uncover this information. This study builds upon previous work which has investigated infectious diseases on social media (Ahmed and Bath, 2015; Ahmed, Demartini, and Bath, 2017; Ahmed, 2018).

METHODS

Research Approach

Previous evidence-based research on Twitter for health (Chew and Eysenbach, 2010; Kostkova, Szomszor, and St. Louis, 2014; Signorini, Segre and Polgreen, 2011; Santos and Matos, 2014; Jin et al, 2014; Oluwafemi, Elia, and Rolf, 2014; Scanfled, Scanfled and Larson, 2010; Bosley, Zhao, Hill, and Shofer, 2012; Robillard et al, 2013) used a form of a case study approach. However, only one study explicitly mentions that it utilised this approach (Gupta, Joshi, & Kumaraguru, 2012). In this study a case

study approach was utilised which traditionally consists of studying a particular contemporary phenomenon in its real life context using multiple sources of evidence (Robson, 2002). This study was pragmatic and selected methods that could derive answers to the research questions. An interpretivist epistemological position was used which did not aim to test a hypothesis because the aim of the study was to understand and generate theory rather than to explain and/or prove a hypothesis.

Data Collection

Data was obtained corresponding across a time-period of April 28th and April 29th 2009 using the keywords of '*swine flu*', '*swineFlu*', and '*H1N1*'. This time period was selected as it can be considered the height of the swine flu outbreak, and Google Trends data shows the highest peak during this period of time. Twitter data was retrieved from the Twitter Firehose API via a licensed reseller, Visibrain (n.d). In total there were approximately n=214,784 tweets.

Data Filtering

As there were approximately n=214,784 tweets it was found that the most effective method to conduct an in-depth qualitative analysis on this volume of tweets was to reduce the dataset and extract a sample. In order to reduce the size of the dataset for in-depth qualitative analysis a number of data filtration techniques were applied. Scholars (Bruns and Liang, 2012) have noted that if popular content has not been removed from a dataset, that this risks only examining popular content. Using DiscoverText (n.d), a cloud based text analytics tool, we ran deduplication (identifying identical tweets), and removed identical tweets from the dataset, leaving a total of n=102,852 single tweets. However, it was found that there were still many near-identical tweets which would populate the sample. Therefore, duplicate tweets were removed at a 60% threshold, leaving a total of n=76,783 tweets. Duplicate tweets could include those that had been retweeted by different users, and because near duplicate tweets were eliminated this included tweets that had been modified slightly. The purpose of these filtering methods was to avoid examining only popular tweets on swine flu.

Data Analysis

A 10% simple random sample (n=7,679) of the filtered data of tweets was entered into NVivo in order to conduct a systematic in-depth thematic analysis of tweets, using the stages of Braun and Clarke (2006). A simple random sample ensures that there is an equal chance of selecting any single tweet. One of the authors [WA] carefully coded the entire dataset of n=7,679 tweets over a 3 month period, in discussion with the co-authors (GD, PB, LS). There were a total of n=1075 nodes that were created from a total of n=7,679 tweets. These nodes were entered in Microsoft Excel evaluated and grouped into over-arching themes, and sub-themes in discussion with the authors of this project (WA, GD, PB). Themes and sub themes were not mutually exclusive.

Inter-Coder Reliability

A coder, with an academic background, who was independent to the research project was sourced in order to code a subset of tweets in order to generate an intercoder reliability statistic. Inter-coder reliability percentage agreement was 99.96%, and $\kappa = 0.53$.

Test-Retest Reliability

The author who coded the initial study (WA) re-coded a sub-set of data after a 3 month period in order to assess test-retest reliability. The percentage agreement was 99.94%, and $\kappa = 0.85$.

RESULTS

Overview of themes

This section provides an overview of the results of this study. There were eight prominent themes that were found to emerge from the data, and these are described below:

- Theme 1: **Emotion and Feeling**
- Theme 2: **Health Related Information**
- Theme 3: **General Commentary & Resources**
- Theme 4: **Media and Health Organisations**
- Theme 5: **Politics**
- Theme 6: **Country of Origin (Mexico/Travel)**
- Theme 7: **Food**
- Theme 8: **Humor and/or Sarcasm**

Table 1- Overview of Themes and Sub-Themes

Theme (N/%)	Sub-themes (N)
A. Emotion and feeling (253/4.4%)	A.1 General Fear (174/3.0%) A.2 Fear of Travel (54/0.9%) A.3 Anger (17/0.3%) A.4 Worry (8/0.1%)
B. Health Information (609/10.6%)	B.1 Transmission (22/0.4%) B.2 Prevalence Monitoring (158/2.8%) B.3 Prevention Techniques (134/2.3%) B.4 Prevention Products (126/2.2%) B.5 Symptoms (80/1.4%) B.6 Speculative Diagnosis (18/0.3%) B.7 Medication (14/0.2%) B.8 References to Other Infection or Disease (57/1.0%)
C. General commentary & Resources (2467/43.0%)	C.1 General Discussions (1826/31.8%) C.2 Information Seeking (145/2.5%) C.3 Economic Impact of swine flu (62/1.1%) C.4 Voice of Reason (109/1.9%) C.5 Frightening Scenarios (13/0.2%) C.6 Name Discussion (26/0.5%) C.7 Resources (42/0.7%) C.8 Images used in Tweets (36/0.6%) C.9 Unfollowing Users (2/0.03) C.10 Other Discussions (206/3.6%)
D. Media and Health Organisations (675/11.80%)	D.1 Health Organisations (general) (136/2.4%) D.2 Health Organisations (critical) (7/0.1%) D.3 Media Organisations (general) (444/7.7%) D.4 Media Organisations (critical) (88/1.5%)
E. Politics (124/2.2%)	E.1 Political Reference (81/1.4%) E.2 Obama (43/0.75%)
F. Country of Origin (Mexico/Travel) (211/3.7%)	F.1 Reference to Mexico and/or Mexico City (162/2.8%) F.2 Reference to Mexicans (43/0.8%) F.3 Reference to Borders (6/0.10%)
G. Food (428/7.5%)	G.1 Pork Consumption (336/5.9%) G.2 Food Humour (92/1.6%)
H. Humour or Sarcasm (975/ 17.0%)	H.1 Humour Related to Pigs (100/1.8%) H.2 Nervous Humour (18/0.3%) H.3 Popular Culture/Understanding (221/3.9%) H.4 Miscellaneous Humour/Trolling (378/6.6%) H.5 Sarcasm (258/4.5%)

Theme 1: Emotion and Feeling

This theme included tweets which expressed emotions, or feelings towards the swine flu outbreak such as: fear, fear related to travel, worry, and anger. The swine flu outbreak would evoke fear in a number of Twitter users:

'swine flu is scary'

Additionally, Twitter users who were scheduled to be travelling to Mexico referred to how the outbreak of swine flu could potentially affect their holiday:

'I travel a lot and I am really concerned with the swine flu outbreak'

There were a small number of tweets which expressed anger towards swine flu or pigs by use of vulgar language. For instance, one user directed an expletive towards swine flu:

*'swine flu can go f**k itself!'*

There were tweets that expressed user's worries about swine flu which stemmed from the symptoms of the virus of the outbreak situation such as the spread of the virus:

'I am worried about the swine flu'

At the time of the outbreak, Twitter users may have been receiving information from a number of sources, which may have had the potential to cause anxiety and fear on Twitter and among the general public. The users in the tweets above may have been attempting to perpetuate fear rather than being genuinely afraid. However, given the immediacy of Twitter, and the exaggerated vocabulary that was observed within the dataset of tweets, it is possible that users were experiencing a high level of fear, but were tweeting in such a way that their fear, and the actual risk, were exaggerated beyond normal proportions

Theme 2: Health Related Information

Tweets which discussed medical concepts such as transmission, incidence monitoring, prevention, symptoms, medication and diagnosis were branched among the health information category. A number of Twitter users would discuss the transmission of swine flu in very general terms. However, a large number of Twitter users were reporting on the number of diagnosed cases and/or the location of a reported case:

“swine flu reported in California – that’s 40 miles from me”

This form of prevalence monitoring of swine flu may also play a role on the understanding that Twitter users may have when it comes to the spread of infectious diseases during outbreaks. By monitoring prevalence in this manner, users may feel safe and in control, and following news about the spread of swine flu may offer a sense of security. There were a number of users who were sharing information related to that of prevention:

“Best way to prevent swine flu – wash your hands”

There were tweets which referred to diagnosed cases of swine flu such as in the workplace, school, or, a friend and/or family member who had been diagnosed with the virus. There were also tweets which mentioned a number of medications:

“Tamiflu can protect against the swine flu”

Twitter users would also refer to previous infectious disease outbreaks and/or other diseases or infections such as the Spanish Flu, SARS, Mad Cow, Anthrax, Avian Flu, Rabies, Influenza, HIV, and also specific dates such as 1975, 1976, and 1978. These time periods relate to a decade (the 1970’s) where there were outbreaks of swine flu, and/or a heightened risk of an outbreak.

Theme 3: General Commentary & Resources

There are a number of Twitter users which make very general comments and mention swine flu, and/or use the swine flu hashtag. Tweets in this category were varied, and may not have expressed an opinion towards the swine flu outbreak in itself:

“My 500th Tweet is on swine flu – Hurray!”

There were some tweets which would reference frightening scenarios in their tweets such as biological warfare, bio warfare, and bio-weapons which may harness swine flu:

‘swine flu is a type of beta test for bio warfare’

There were tweets which discussed the term ‘swine flu’ in of itself with some users finding the name humorous:

‘I am bored by swine flu – but at least the name is funny’

Other Twitter users suggested that health authorities should have come up with a better name, and other users discussed the debate around whether the name was offensive as Israel had renamed the outbreak ‘*Mexican Flu*’.

Theme 4: Media and Health Organisations

This theme included tweets which mentioned a media organisation such as the BBC, CNN, ITN, FOX News, MSNBC among others and/or expressed a view towards the media. For example, there were a number of tweets which were critical towards the media:

‘Media has just been blowing the swine flu out of proportion’

It is possible that the mainstream media may have published articles related to swine flu with sensationalist headlines with the sole aim of attracting more readers. This theme also included tweets which referenced health organisations such as the Centres for Disease Control (CDC) or the World Health Organisation (WHO). Tweets in this theme may also have included information from health organisations and some users would also provide a URL alongside a tweet which would link to the information:

'CDC says you should frequently wash your hands [URL to CDC website]'

There were also Twitter users who were critical towards the WHO, for example, by suggesting that the WHO were a step behind reporting on the outbreak, that they were too laid back, and how reports of the alert level being raised to level 4 were meaningless without an explanation.

Theme 5: Politics

Tweets which made reference to politics were collapsed into a theme 'politics' and included the sub-theme of 'political reference', and another second level theme for tweets which referred to the then U.S. president Obama. Users who supported one particular political party and/or political figure may have used swine flu to attack the opposition party:

'We only get swine flu when the democrats are in power'

Obama was mentioned by a number of Twitter users during the swine flu outbreak as the mainstream media were reporting statements by Obama, and these articles were tweeted by Twitter users following the outbreak:

'swine flu cases up 40 - Obama asks for calm [URL]'

Perhaps these findings indicate that U.S. presidents, or other political leaders, are influential figures during infectious disease outbreaks.

Theme 6: Country of Origin

There were a number of Twitter users that made reference to country of origin of swine flu and this theme included sub-themes of Mexico, Mexicans, borders, and/or which were offensive towards Mexico and/or Mexicans more generally:

'Just heard about swine flu – not cool from Mexico'

There were a number of tweets which referred to Mexicans generally, for instance, the Mexican population, or the Mexican government:

'Dad called tonight and was warning me about dangerous swine flu from dirty Mexicans'

The swine flu virus originated in Mexico City and this may explain why Twitter users and media outlets were mentioning Mexico and Mexico City in relation to swine flu. This sub-theme could also reflect Twitter users' interpretations of Mexico-US. Relations. The findings might indicate that the country of origin of an infectious disease outbreak will generate interest from Twitter users, and this information could be utilised by health authorities who disseminate information during outbreaks. Additionally, certain information needs may arise from citizens related to the country of origin of an infectious disease outbreak.

Theme 7: Food

Tweets which referred to food such as Bacon and or Pork, or alluded to food by mentioning kosher, halal meat, vegans and vegetarians were included in the pork consumption sub-theme. There were a number of Twitter users which referred to consuming Pork or Bacon. For example, Twitter users asked other users whether it was acceptable to eat Pork, as illustrated below:

'swine flu is so disgusting – so glad I stopped eating Pork'

Other Twitter users stated that eating pork does not transmit swine flu:

'Eating pork does not transmit swine flu'

There were also a number of Twitter users which referred to the dietary requirements of Muslims, Jews, Vegans, and Vegetarians, in their tweets i.e., that neither of these group consumes any type of meat which comes from pigs. Twitter users created a link between not eating meat derived from a pig, and a reduced risk of swine flu.

The information related to users questioning whether it was possible to catch swine flu from eating pork could be used by health authorities to disseminate information to address this information need, (i.e., that it is not possible to develop swine flu from

eating pork). A potential implication of these results is that when Twitter users are unsure of whether a specific food product can transmit a disease, this uncertainty should be addressed swiftly.

Theme 8: Humour and/or Sarcasm

This theme included tweets which referred to general humour and sarcasm and which mentioned swine flu, and included sub-themes of specific humour related to pigs, nervous humour, popular culture and understanding, as well as that of sarcasm and general humour including trolling. There were a number of jokes involving pigs, as illustrated below:

'swine flu – sounds like the revenge of the world's tastiest meat'

A Twitter user questioned whether the humour on Twitter was in fact nervous humour:

'A lot swine flu Jokes – wonder if this is nervous humour by users?'

There were a number of Twitter users which referred to popular culture and these references were varied and ranged from Hollywood films, television programs, characters from film or television. Twitter users would also reference zombies, a zombie apocalypse and flesh eating zombies:

'I am so ready for when the swine flu starts to turn people into flesh eating zombies'

Typically, in Hollywood movies or television programs which depict zombies, uninfected humans use their resources to eliminate the infected, as referenced in H3.8. This type of thinking portrayed in popular culture may have been unpleasant to read for those who were suffering with swine flu. This sub-theme also highlights that Hollywood film narratives may influence how the general public understands infectious disease outbreaks. A potential reason for this may be that, as Twitter users initially hear the term pandemic in TV and movies, this becomes their only reference point for real infectious disease outbreaks. Health authorities may be interested in these results as they demonstrate the influence popular culture has on Twitter users, and may wish to monitor popular culture for potential misinformation, and to disseminate information on Twitter that would correct this.

Evidence of Themes across the Outbreak

Twitter's advance search feature was utilised in order to find tweets from across the pandemic from when Google Trends (Google, 2017) showed there to be an increased interest in web search queries, and this was from January 2009 until November 2009. Themes were selected if they were not specific to the 2-day time period, were not reported in previous literature, and which were searchable by using keywords.

By running a number of searchers on Twitter's Advance Search it was found there were tweets from across the pandemic (May to November) that expressed opinions which were identified in the following themes: A.1 General Fear, C.4 Voice of Reason, C.6 Name Discussion, D.4 Media Organisations Critical, F.2 Reference to Mexicans, and G.1 Pork Consumption. Appendix 1 contains tweets from the beginning middle and end of each month from May 2009 to November 2009 associated with the themes above.

Table 2 – Themes across the outbreak

Themes	May	June	July	Aug	Sep	Nov
A.1 General Fear	x	x	x	x	x	x
C.6 Name Discussion	x	x	x	x	x	X
D.4 Media Organisations Critical	x	x	x	x	x	x
F.2 Reference to Mexicans	x	x	x	x	x	x
G.1 Pork Consumption	x	x	x	x	x	x
H.3 Popular Culture/ Understanding	x	x	x	x	x	x

These results provide evidence that certain themes may have occurred throughout the outbreak.

Discussion

There were a number of interesting and surprising results across the themes and sub-themes identified across the data not reported in previous literature. It appeared that due to the name '*swine flu*' many users had the belief that pigs and pork could host and/or spread the virus. This belief appeared across other themes and sub-themes

such as *Food*, and sub-themes *C.8 Images Used or Referenced in Tweets*, and *B.3 Prevention*. However, the A/H1N1pdm09 virus is known as swine flu because the virus resembles a known influenza virus which causes illness in pigs, and not because pigs host and/or transmit the virus. The belief most likely influenced the beliefs people held i.e., that avoiding Pork would put them in a decreased risk of developing swine flu. The Health Belief Model (Becker, 1974; Janz and Becker, 1984), is a popular social cognition model, which suggests that if the perceived threat of a disease is high then people are more likely to change their behaviour to try to avoid developing the disease. The perceived threat of a disease will be influenced by a number of factors such as whether you are susceptible i.e., whether you are likely to get the disease as well as the seriousness of a disease. Twitter users also suggested that health authorities should have come up with a better name, and other users discussed the debate around whether the name was offensive as Israel had renamed the outbreak 'Mexican Flu'. It was also found that swine flu caused Twitter users to evoke a number of feeling and emotions, and some users were also aware that this could have been nervous humour. There was also stigma directed to Twitter users who had travelled to Mexico, and towards Mexico, and Mexicans which has not been reported in previous work. We also found that a number of Twitter users would refer to popular culture in order to shape their understanding of the virus not reported in previous literature. Hollywood film narratives may influence how the general public understands infectious disease outbreaks, and this may be a further point of research.

Our study provides new qualitative insights into how Twitter users responded to the swine flu outbreak of 2009 on Twitter. That is, for instance, related to the amount of health related information that was shared on Twitter, and related to that of how citizens actively engage with the platform for incidence monitoring. As the swine flu virus was spreading rapidly across a number of countries, and as people were not immune (Davis, 2015) users may have wished to track the location of the virus in order to feel a sense of security. The symptoms of A/H1N1pdm09 include sudden fever, a temperature of 38C or above, tiredness, aching muscles or joint pain, a headache, and/or a runny or blocked nose (Davis, 2015; NHS Choices, 2015). These symptoms are similar to that of the regular Flu, and users whom experienced any of the above symptoms feared they may have contracted swine flu.

The theoretical framework of the Health Belief Model (Becker, 1974; Janz and Becker, 1984) can be applied to understand how users may have behaved during the outbreak. The Health Belief Model purports that, if the perceived threat of a disease is high, then people are more likely to change their behaviour to avoid developing the disease. The perceived threat of a disease will be influenced by a number of factors such as whether a person is likely to get the disease as well as the seriousness of the disease. Additionally, a number of demographic variables as well as the personality and intelligence of a person will also affect the decision making process when evaluating whether a disease has a high perceived threat, susceptibility and seriousness, and when weighing up the perception of barriers and benefits in taking a certain action. For instance, in the case of swine flu, the likelihood that someone would change their behaviour might be very high as the perceived seriousness of swine flu is high. Increased media coverage may lead to the perceived seriousness of a disease increasing and the general public may be more likely to alter their behaviour as a result. However, a risk of increased media coverage is that users may begin to stigmatise those whom develop swine flu, and people from specific regions and of particular races may become targeted. The Health Belief Model may serve as a useful theoretical framework to aid the understanding and interpretation in how Twitter users were responding to the swine flu outbreak.

This study analysed tweets from a two-day period, hence the findings are not applicable to all Twitter activity related to swine flu during the 2009 pandemic. However, Table 2 does provide some evidence that certain narratives identified in this study were expressed by users across the outbreak. When analysing tweets and Twitter data, a further known limitation among the research community is that Twitter data does not reflect the national offline population. However, the aim of this study was to examine content that was shared on Twitter from a public health informatics perspective, rather than to generalise findings to the offline population. Certain age groups (i.e., younger people) and geographical locations (i.e., the U.S.) may be over-represented on Twitter (Pew Research Center, 2016). It must also be noted that people might behave differently online compared in real-life situations, and people may behave differently on Twitter compared to what they might do in a research interview. For example, views in tweets may be exaggerated as a reaction to an event. However, strength of analysing Twitter data is that it avoids the potential of interviewer bias. Due

to the qualitative nature of the study there may be slight variations in the themes and sub-themes that could have emerged if the study was repeated by another researcher. This is because tweets may be interpreted differently by different researchers and this can affect the types of themes and sub-themes identified. However, measures were taken to ensure the validity and reliability of results, such as by performing test re-test and inter-coder reliability.

Implications for Practitioners

Those in the library and information science field, particularly health and clinical librarians, could utilise the methods outlined in this study to better-understand discussion around infectious disease outbreaks. Health librarians working with hospitals and the medical community may be tasked with collating information related to emerging pandemic diseases (Featherstone, Boldt, Torabi, Konrad, 2012). Moreover, early research has noted the potential of social media and Web 2.0 technologies for developing knowledge and disseminating information as a library professional (Giustini, 20016). Furthermore, our results indicate that social media data can be a fruitful source of information. More generally, social media platforms offer great potential to libraries because they may not have the resources to devise surveys and/or interviews. Social media platforms, therefore, provide an opportunity to gain insight into public views and opinions of members of the public on a range of topics. This is not to suggest that data from social media could replace surveys but that data from social media platforms could complement surveys. Or that when it is not possible to conduct a survey, for instance, due to a lack of resources then data from social media could be used for the real-time monitoring of public views and opinions. By utilising this information libraries have the potential to disseminate reliable information on social media platforms such as Twitter. By developing new knowledge on common concerns and issues during infectious disease outbreaks libraries will be in a better position to create campaigns at the community level in order to eradicate fears and myths. Although our specific focus was on analysing Twitter data for gaining insight into a health-topic, our findings also have implications for social listening within the library domain. Up to 74% of individuals who have used a library or bookmobile over the previous year are also social media users (Rainie, 2016). Henceforth and, as highlighted by Stewart, Atilano, and Arnold (2018), by analysing social media content

related to libraries it would possible to strengthen customer relationship management by sharing information that is more relevant to social media users who use libraries and to address any concerns and/or issues that library users may post on social media. Our study has outlined a detailed methodology of how librarians could collect data on public views related to a range of topics which could include the library profession as well as specific libraries. This data could then be analysed using the method of thematic analysis and the results used as intelligence and could feed into strengthening and tailoring social media marketing campaigns.

Conclusion

Our study found a number of important themes that emerged from the analysis that had not been reported in previous literature (as highlighted in Table 2). Misunderstandings of medical advice can lead to dangerous consequences and must be understood carefully. Our study outlines a methodology of filtering a large quantitative dataset which may serve as a useful guide for health organisations as well as clinical and health librarians who wish to sample and analyse tweet content during the height of an outbreak. Our results are likely to inform public health strategies for future infectious disease outbreaks, as well as current outbreaks such as the Middle East respiratory syndrome (MERS), the Zika virus, and H5N1.

Appendix 1

A.1 General Fear

The search terms that were used were: 'Afraid OR Scared OR Fear AND swine flu' for each month of the outbreak, and the table below highlights their occurrence.

Time Period	Tweet illustration
May 2009	'I am unable to sleep always thinking about swine flu' [4 th May]
June 2009	'I am still ill and feel it could be swine flu' [29 June]
July 2009	'Don't want to be thinking about swine flu – it scares me' [7th July]
August 2009	'Since I heard that there was swine flu at work I feel scared' [28 August]
September 2009	'swine flu has been observed here! I am so scared now' [15 September]
October 2009	'Person next to me is coughing – I hope I don't catch swine flu' [October 8]
November 2009	'My child has a fever, and now scared about swine flu!' [November 28]

C.6 Name Discussion

The search terms that were used was 'swine flu AND Name'.

Time Period	Tweet illustration
May 2009	'Wonder if H1n1 needs a better name' [29 May]
June 2009	'We should name diseases after politicians rather than poor pigs!' [28 June]
July 2009	'If I was a pig I would like the name swine flu!' [21 July]
August 2009	'Does anyone know how H1H1 influenza got to be known as swine flu?' [26 Aug]
September 2009	'swine flu is a very bad name' [24 Sep]
October 2009	'I have a new name for swine flu – pig flu!' [25 Oct]
November 2009	'The name swine flu is disgusting – hope I don't get it' [13 Nov]

D.4 Media Organisations (critical)

The search term used in order to locate tweets which mentioned swine flu and which were critical of the media were: 'swine flu AND Media'.

Time Period	Tweet illustration
May 2009	'All this exaggeration over swine flu by the media is scary' [28 May]
June 2009	'swine flu appears to be a big media scare' [29 June]
July 2009	'Media are hyping up the swine flu vaccine again' [30 July]
August 2009	'Media scare tactics continue!' [21 Aug]
September 2009	'Difference between regular flu and swine flu – is panic by media' [4 Sep]
October 2009	'I have to say I think the media has really blown this swine flu way out of proportion' [30 Oct]
November 2009	'Actually it might be harder to catch swine flu as what the media make out!' [29 Nov]

F.2 Reference to Mexicans

The search term used in order to locate tweets were: 'swine flu AND Mexicans'.

Time Period	Tweet illustration
May 2009	'A tiny Mexican girl is sitting next to me – she stinks! Now I know the smell of swine flu' [22 May]
June 2009	'The people affected by swine flu were young Mexicans according to this [URL]'
July 2009	'I am in love with a Mexican girl – of all countries it had to be Mexico where the swine flu is!' [22 July]
August 2009	Back from a Mexican break – was sweating like a pig when over there – seems right for a place with swine flu [30 Aug]
September 2009	'Just arrived back from Mexico, I don't have swine flu and I was kissing so many Mexicans!' [25 May]
October 2009	'Saw a Mexican, he was dressed informally – open toe sandals! Then they worry why they have swine flu' [28 Oct]
November 2009	'Survived the swine flu – F*** the Mexicans!' [8 Nov]

G.1 Pork Consumption

The search terms used were 'swine flu AND Pork'.

Time Period	Tweet illustration
May 2009	I have not eaten Pork since swine flu began! Yesterday I had bacon ribs and I am still alive. [26 May]
June 2009	'I have a cough , it could be swine flu – I will eat some more Pork to spite those pigs' [29 June]
July 2009	'Someone I know believed that if they ate Pork they would get swine flu!' [29 July]
August 2009	'Even after a swine flu outbreak – people still are not giving up their Pork!' [Aug 3]
September 2009	'I bet Pork sales are dropping! Was going to get a tacos and was told not to because I'd get swine flu' [Sep 18]
October 2009	'Wow – with all of this swine flu news – I need to stop eating Pork' [28 Oct]
November 2009	'I got my swine flu vaccine! Now I can have Pork' [20 Nov]

H.3 Popular Culture/Understanding

The search term used was 'swine flu AND Zombies OR zombie apocalypse OR apocalypse'.

Time Period	Tweet illustration
May 2009	'I am definitely convinced that the swine flu outbreak is the start of the Zombie apocalypse' [4 May]
June 2009	'swine flu alert increased and now it is time for the zombie apocalypse!' [11 June]
July 2009	'Just heard about a swine flu death! Let us all get ready for the zombie apocalypse' [10 July]
August 2009	'When swine flu finally mutates – then it will be the start of the zombie apocalypse' [4 Aug]
September 2009	'Many of my colleagues have either the Zombie Apocolypse or the swine flu. I need to find myself a gun' [11 Sep]
October 2009	' swine flu outbreak is beginning to sound a lot like a zombie apocalypse' [7 Oct]

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