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Analysis of Three Twitter Hashtags for Discussion of Personal Electronic Health Records

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Abstract: Electronic health records (EHRs) are an important e-health technology and have the potential to greatly improve the efficiency and quality of health services. However, the implementation of EHRs has had mixed success internationally. Increasingly, governments, health service providers and the public are turning to social networking systems (SNSs) for communicating about EHRs. Social media, including Twitter (twitter.com), have also been used in relation to EHR implementation. Thus, Twitter provides a useful case example for an exploration of the ways that SNSs are being used to communicate information about EHRs. The Australian personally controlled electronic health record, My Health Record (MyHR), is a repository of summary health information about patients which is stored online, and which patients can choose to share with their health providers. In this paper, an investigation of the representation of Australia’s MyHR on Twitter via a data set of 6191 tweets associated with three specific hashtags related to the EHR and reflecting its official names since 2012 (i.e., #PCEHR, #MyHealthRecord and #MyHR) is reported. Time sequence analysis, text analytics and network visualisation were employed to characterise the Twitter activity and content, and to identify influential users and their relationships. The text content of tweets using these hashtags spanned positive/supportive, neutral/factual and negative/opposing themes regarding EHRs. Text visualisation highlighted six accounts that were active and also mentioned frequently in tweets. In particular, three of these accounts were always ranked in the top ten on several measures of activity and interactivity, so could be considered highly influential. Network visualisation of the connections between accounts, represented by tweets from senders to those mentioned, revealed associations between some prominent accounts and their publicly-stated stance on EHRs. This information could be used to inform future use of SNSs, and optimal use of Twitter in particular, in the propagation and distribution of information relating to EHRs and their implementation.

Keywords: Electronic health records, Social media, Twitter, Hashtags, Text analytics, Social network analysis.

1. Introduction

Electronic health records (EHRs) are an important e-health technology in constant evolution, and have the potential to greatly improve the efficiency and quality of health services (Blumenthal, 2011; Ricciardi et al., 2013). While the widespread adoption of EHRs is predicted, the implementation of EHRs has had mixed success internationally (Blumenthal & Tavenner, 2010; Knight et al., 2014). To ensure the standardisation and interoperability of the underlying technologies, and the necessary confidence in EHRs from their users, there is a need for the relevant public authorities to actively promote their use, and provide an appropriate policy and regulatory environment to enable EHR adoption (Blumenthal, 2011; Hripcsak et al., 2014; Ricciardi et al., 2013). Implementation of EHRs is affected by the interplay of several factors, including: i) a rapidly changing environment in the advancement of technologies supporting EHRs; ii) EHRs having high health literacy demands (Hemsley et al., 2018); iii) potential users’ holding several misconceptions about their use (Hemsley et al., online early); iv) public concerns regarding privacy and security (Blumenthal 2011; Byrne et al., 2014); and, v) constant demands for public consultation in regards to changes in legislative frameworks supporting EHR use (McCarthy et al., in press). Therefore, it is vital that public-facing information about EHRs communicates current and accurate information, and that governments and health service providers engage continually with the public in dialogue about their concerns as EHRs develop.

Increasingly, governments, health service providers and the public are turning to social networking systems (SNSs) for communicating about EHRs. SNSs are online platforms (e.g., Facebook, Twitter, blogs) that connect people and facilitate ‘social networking’ of the community, and the creation of ‘social media’ (Eytan et al., 2011). SNSs potentially enhance the exchange of health information for health promotion by providing a platform for health consumers to produce their own information, and for this content to be shared widely via their connections (Thackeray et al., 2008). Neiger et al. (2012) identified five broad purposes for use of social media in public health/health promotion, being to: i) communicate with consumers for market insights; ii)
establish and promote a brand with consumers; iii) disseminate critical information; iv) expand reach to include broader, more diverse audiences; and iv) foster public engagement and partnerships with consumers. To date, there is little information in the literature about how SNSs have been used for these purposes in relation to EHRs.

The development of EHRs has progressed in parallel with that of information and communication technology in general, and their use by individuals/patients coincided with the emergence and widespread use of SNSs (Irizarry, DeVito Dabbs, & Curran, 2015). The US Office of the National Coordinator for Health Information has identified a need to respond to the growing role of social media in health (Ricciardi et al., 2013), and EHRs have also featured as topics of discussion in social media, including both positive and negative stories (Eytan et al., 2011). Social media (Shachak & Jadad, 2010), including Twitter (twitter.com), have also been used in relation to EHR implementation (Knight et al., 2014). Twitter is a popular ‘microblogging’ SNS where users can post short messages (up to 140 characters at the time of this study) called ‘tweets’ to their ‘followers’, ‘retweet’ a tweet that appears in their timeline, and attach a ‘hashtag’ to a word, acronym, series of letters and numbers, or phrase that can be used as a search key to find all tweets using a hashtag (Barberá, 2015). Tweets can be directed specifically to other users by including the @User handle of an account (a ‘mention’), or broadcast more generally to all of the sending account’s followers (Honeycutt & Herring, 2009). Debate and promotion of public topics, including public health, regularly occurs on Twitter; and the inclusion of relevant hashtags enables participation in, and tracking of, such social media activity (Sorour & Dey, 2014).

SNSs have become important sources of health information for many people (Barberá, 2015). Many SNS users obtain key elements of their information from a group of ‘elite sources’ who can play a gate-keeping role, so it is important to understand more about these influential network opinion leaders (Xu et al., 2013). Additionally, SNSs have become an avenue for participants to express their feelings about social issues (Zhang & Counts, 2015), potentially to a large number of people, with the possibility of influencing public agendas (Xu et al., 2013). It is often posited that SNSs are ‘echo chambers’ that act to reinforce the beliefs of participants who primarily engage with other parties who already support their views. However, there is a growing body of research that indicates SNSs can play a role in moderating polarisation in public debates. The latter view is based on the argument that SNSs, “facilitate exposure to messages from those with whom individuals have weak ties, which are more likely to provide novel information to which individuals would not be exposed otherwise” (Barberá, 2015, p. 1). General social network theory suggests that larger networks increase the probability of coming into contact with new sources of information (Eveland & Hively, 2009), and research suggests that frequent users of SNSs are likely to have more diverse and heterogeneous networks (Lee et al., 2014). Nonetheless, some researchers caution that there are practical limits to ‘online activism’ via SNSs (Hirst, 2012), as social media activity is not abstracted from peoples’ opinions and beliefs in the real world (Sorour & Dey, 2014).

Despite the growing use of SNSs in the promotion of health issues, research on their use or impact has been limited (Eytan et al., 2011; Neiger et al., 2012), and their use in relation to the implementation of EHRs has not been examined. Evaluation of SNS communication is complex, but can involve frequency of discussion, size of an individual’s network, and aspects related to message content (Eveland & Hively, 2009). Neiger et al. (2012) suggested a range of metrics that could be used to assess the performance of the use of social media in health promotion, including measures in the areas of insights, exposure, reach and engagement. They also noted the value of drawing on ‘secondary’ social media data – harvesting posts from a SNS on a topic of interest to understand the perceptions of stakeholders. In effect, ‘visualising’ the frequency of tweets related to a topic over time can provide insights into the ways that users are interacting on that topic (Xu et al., 2013). Analysis of the text content of social media posts can be used to characterise the nature of the communication on SNSs (Honeycutt & Herring, 2009) and to identify the ‘elite’ or influential sources who might influence wider opinion. Related to this, measures of reach and impact can be derived from the account statistics and activity of Twitter users (Veltri, 2013). For SNSs, it is important to understand how the ‘network’ affects message propagation. If a message reaches the direct followers of the source, they may share it on to their followers, creating an exponential flow-on effect (Eytan et al., 2011).

2. Personal e-health records in Australia

The Australian personally controlled electronic health record (PCEHR), launched in 2012, is a national EHR comprising a repository of summary health information about patients which is stored online, and which
patients can choose to share with their approved health providers. Just prior to the full scale launch of the PCEHR, the sharing of good practice between participants in a trial of the system included weekly ‘tweet ups’, or Twitter hashtag chats, and live tweets from a one-day workshop, and the volume of such social media activity was one of the measures of the trial’s progress (Knight et al., 2014). According to one of the authors (Knight, 2017, personal communication) and Guest (2017, personal communication), the bystander audience, who included members of the government departments responsible for the EHR trial and system design, benefited by reading the Twitter chats to obtain ‘expert user’ views as a form of ‘feedback’ on the system prior to national rollout.

Following a national review of the system (Australian Government, 2013), several recommendations were made to improve PCEHR implementation, including that the system be re-named the My Health Record (MyHR) and that the legislation be changed to support an ‘opt out’ trial of registration. Following the success of the opt-out trials in 2016 (Siggins Miller, 2016), the MyHR is set to switch from an opt-in system of registration to an opt-out system by April 2018. Thus, the need for public-facing information and public dialogue about MyHR is expected to rise rapidly and exponentially, particularly as: i) all eligible Australians will have a MyHR unless they opt out, and will need to know how to use it (Hemsley et al., 2016); ii) the usability of the MyHR itself is problematic and potentially exclusive of minority groups owing to its high health literacy demands and problems with usability (Walsh et al., 2017; Walsh et al., online early); iii) the switch to an opt-out system is contentious and accompanied by continuing concerns about the legal and ethical issues; and, iv) the secondary use of data within the MyHR for research and health service purposes is under public consultation (Department of Health, 2017). Understanding more about how Twitter is currently being used in relation to the MyHR, and for what purposes (Neiger et al., 2012) would be useful in order to guide optimal use of Twitter for: communicating with health consumers about MyHR, establishing and promoting the ‘brand’ of MyHR, disseminating critical information and the growing evidence-base relating to MyHR, expanding reach to a broader and more diverse audience affected by MyHR, and fostering public engagement and collaboration between healthcare consumers and health providers in the MyHR system.

3. Aim

To date, little is known about the public discourse appearing in Twitter relating to EHRs. Twitter provides a useful case example for an exploration of the ways that SNSs are being used to communicate information about EHRs. The aims of this study was to: (a) investigate the representation of Australia’s MyHR on Twitter via a data set of 6191 tweets associated with three specific hashtags related to the EHR and reflecting both of its official names since 2012 (i.e., #PCEHR, #MyHealthRecord and #MyHR); (b) employ time sequence analysis, text analytics and network visualisation to characterise the Twitter activity and content; and, (c) identify influential users and their relationships. This information could be used to inform future use of SNSs, and optimal use of Twitter in particular, in the propagation and distribution of information relating to EHRs and their implementation.

4. Methodology

The relevant institutional human research ethics committee ruled that the collection and use of publically accessible Twitter data were exempt from formal ethics approval for research purposes. Using a commercial Twitter data service, all tweets containing at least one of the three identified hashtags during the period 1 August 2016 to 31 August 2017 inclusive were collected. The time sequence of recorded Twitter activity was graphed using Microsoft Excel (Microsoft, 2013). The use of hashtags in the Twitter data collected was examined, tabulated and visualised as network using the Gephi software package (The Gephi Consortium, 2012). To protect the privacy of individuals tweeting with the tags, no Twitter handles are reported, visualisations have been de-identified, and no quotes are provided in support of the results.

The text analytics software package KH Coder (Higuchi, 2016) was used to analyse and visualise the text content of the Twitter data to show the major themes present via multidimensional scaling (MDS). The text analysis process included stop word removal — removing those parts of English speech that occur frequently (e.g. ‘a’, ‘an’, ‘as’, etc.) but add little to the analysis. Consolidation of inflected words to their root form (e.g., ‘tweets’, ‘tweeted’, etc. to ‘tweet’) was performed via lemmatisation (Bolden & Moscarola, 2000). MDS computes a measure of ‘distance’ between all pairs of text terms, and then seeks a lower (here two) dimensional representation of the terms, such that original distance values between all term pairs are displayed with the least possible error (Namey et al., 2007). Here we used the Jaccard distance measure.
(Netzer et al., 2012) and the Kruskal method for dimensional reduction (Chen & Buja, 2009). Based on specifying the minimum frequency of occurrence of a term for inclusion in the MDS analysis and visualisation, terms appear as circles/bubbles in the plot, and the relative frequency of terms is indicated by the size of their bubble. The resultant MDS visualisation contained the names of some people and organisations — these were de-identified using unique generic identifiers (e.g., ‘Person_a’, ‘Organisation_a’).

As measures of Twitter influence, the data were inspected to identify the most frequently tweeting users and the most mentioned users. In addition, for every uniquely identified user in the data set, their total number of tweets multiplied by their average number of followers, during the period under investigation, was computed as an empirical measure of Twitter ‘reach’. Network visualisation of the Twitter data was used to reveal the communication structures embodied in the data. The data were imported into the Gephi software package. Gephi can be used to represent Twitter user accounts as ‘nodes’, and the communication path (representing one or more tweets) between two nodes as an ‘edge’. Gephi provides a range of algorithms for laying out networks, here we used the Fruchterman-Reingold (F-R) algorithm (Fruchterman & Reingold, 1991). Nodes were sized according to the number of edge connections (indicating number of unique communication paths to-and-from them), and edge widths were proportional to number of tweets on that path.

5. Results and discussion

For the period 1 August 2016 to 31 August 2017 inclusive, 6,191 tweets were recorded that contained at least one of the subject hashtags for this study (i.e., #PCEHR, #MyHealthRecord and #MyHR). Figure 1 shows the weekly sequence of tweets during that period.

![Figure 1: Twitter data time sequence – weekly totals commencing 1 August 2016](image)

Figure 1 shows that the overall level of Twitter activity was not uniform over time in the sample. In particular, a large spike in activity can be seen during week 31. Closer inspection of the daily Twitter activity revealed that 87 per cent of the tweets in week 31 occurred on 3 March 2017 and were associated with a research seminar on the Australian MyHR system, and represented ‘live tweeting’ or a ‘real time event’ in Twitter (Dann, 2015). Thus, the time sequence visualisation indicates that significant events in the data set can be identified. The recorded Twitter data came from 1279 unique user accounts. While many users employed only one hashtag, some used two or three of the hashtags.

Figure 2 presents a network visualisation of the Twitter accounts included in the data set, and their use of the three hashtags, showing the persistent relevance of the three terms used to refer to the MyHR system in Twitter. Individual users are shown as small nodes, connected to a larger hashtag node by a link (edge), if they ever used that hashtag in the period under consideration. Each tweet containing a particular hashtag increases the width (weight) of the edge between the user and the respective hashtag node. Node size is proportional to the total weight of the edges connected to that node, hence providing a qualitative indication of relative use hashtags by individual users, and the overall relative use of the three hashtags. 4739 tweets mentioned #MyHealthRecord, 1524 tweets mentioned #MyHR and 195 tweets mentioned #PCEHR. The Yifan Hu network
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layout algorithm (Hu, 2005) used in Figure 2 emphasises node clustering through common connections, and creates a network of seven clusters – one for each combinations of use of the three hashtags. Where Figure 2 can be displayed in colour, a colour scheme has been applied to identify node clusters as given in Table 1. The vast majority of users employed the #MyHealthRecord hashtag only. Conversely, only a small number of users used the #PCEHR only hashtag in any context. #MyHealthRecord was present in just over three quarters of tweets, the shorter acronym #MyHR was used in about a quarter of tweets, and the older name acronym for the system #PCEHR was used in 3.1 per cent of tweets. Combinations of hashtags were used infrequently – in only 3.6 per cent of tweets.

Figure 2: Network visualisation of the use of the three hashtags by Twitter accounts

Table 1: Details of hashtag use clustering displayed in Figure 2

<table>
<thead>
<tr>
<th>Used tags</th>
<th>Colour</th>
<th>No. nodes</th>
<th>Used tags</th>
<th>Colour</th>
<th>No. nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>#MyHealthRecord only</td>
<td>Red</td>
<td>993</td>
<td>#MyHR only</td>
<td>Blue</td>
<td>107</td>
</tr>
<tr>
<td>#PCEHR only</td>
<td>Yellow</td>
<td>10</td>
<td>#MyHealthRecord &amp; #MyHR</td>
<td>Purple</td>
<td>95</td>
</tr>
<tr>
<td>#MyHealthRecord &amp; #PCEHR</td>
<td>Orange</td>
<td>22</td>
<td>#MyHR &amp; #PCEHR</td>
<td>Green</td>
<td>8</td>
</tr>
<tr>
<td>All three tags</td>
<td>Black</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The 6,191 recorded tweets contained 105,171 words. Figure 3 shows the MDS plot based on the tweet text content, and the colour coding of clusters is indicative only. Terms appearing close together in the resultant MDS visualisation are found more frequently close together in the source text, and may reveal key themes in the Twitter posts. The three hashtags associated with this investigation can be seen – noting that the analysis process removes their ‘#’ header. #MyHealthRecord has the largest bubble, #MyHR appears at the lower middle, and #PCEHR at the lower mid-right. The relative size of the hashtag bubbles reflects the node sizing in Figure 2. #MyHealthRecord and #MyHR can be seen in close proximity to other terms, while #PCEHR is comparatively isolated, reflecting its relatively infrequent use. Organisation_a has a relatively large bubble, and is the government body with responsibility for improving health outcomes via e-health. Organisation_a can be seen close to the hashtag #MyHealthRecord (the official title of the Australian EHR system) and the relatively large term ‘digitalhealth’, as well a range of neutral/factual terms such as ‘data’, ‘access’, ‘use’, ‘provider’, ‘upload’, ‘gp’, and ‘clinical’. Organisation_b is a non-government advocate for the privacy rights of Australian citizens whose stated position is that they do not support the MyHR system. They appear near terms such as ‘information’, ‘info’, ‘share’, ‘privacy’, and ‘know’. Organisation_c is the account of a sub-group of Organisation_b specifically concerned with health issues. In line with Organisation_b, they do not support the MyHR system, but have been much more active in encouraging people to exercise their right to opt out of
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the system. Person_a is an advocate for citizen privacy in general, and has been vocal on Twitter in opposition to the MyHR system. They encouraged people to be aware if they were in a trial zone for the system, to attend scheduled public consultations about the system, and to opt out of using the system — these views are visible in terms appearing close to Person_a. Person_b is a clinical researcher who is supportive of the potential benefit of the MyHR system and patients' rights to use the system. Person_b appears near such terms as ‘patient’, ‘need’, ‘healthcare’, and ‘people’. Person_d is an e-health commentator who runs a blog on e-health, uses Twitter to promote the blog and its activities, and regularly uses Twitter to draw attention to the potential risks, problems in design, and negative impacts of using the MyHR system.

Figure 3: Multidimensional scaling plot of the tweet text associated with #PCEHR, #MyHealthRecord and #MyHR

Generally, the content and form of Figure 3 are consistent with what is known about the identified hashtags and users in terms of their public positions on MyHR implementation. In addition, based on their relatively large centrally-located bubbles, we can infer that ‘health’ is a key/common theme of the tweet text content, and that a significant level of retweeting (as indicated by the ‘rt’ term) is occurring. For the three individuals and three organisations identified as prominent in Figure 2, Table 2 presents their number of tweets, number of mentions, and product of number of tweets by number of followers. Table 2 also indicates their rank on these three measures, within the pool of all users included in the data set.
Table 2: Indicators of influence for Twitter accounts prominent in Figure 2

<table>
<thead>
<tr>
<th>Tweets</th>
<th>Count</th>
<th>Rank</th>
<th>Mentions</th>
<th>Count</th>
<th>Rank</th>
<th>Tweets x Followers</th>
<th>Count</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person_d</td>
<td>529</td>
<td>1</td>
<td>Organisation_a</td>
<td>1036</td>
<td>1</td>
<td>Person_a</td>
<td>438447</td>
<td>1</td>
</tr>
<tr>
<td>Organisation_c</td>
<td>379</td>
<td>2</td>
<td>Person_d</td>
<td>454</td>
<td>2</td>
<td>Organisation_a</td>
<td>381684</td>
<td>2</td>
</tr>
<tr>
<td>Person_b</td>
<td>377</td>
<td>3</td>
<td>Person_b</td>
<td>325</td>
<td>3</td>
<td>Person_b</td>
<td>269328</td>
<td>4</td>
</tr>
<tr>
<td>Organisation_a</td>
<td>371</td>
<td>4</td>
<td>Organisation_c</td>
<td>272</td>
<td>4</td>
<td>Person_d</td>
<td>364481</td>
<td>9</td>
</tr>
<tr>
<td>Person_a</td>
<td>83</td>
<td>12</td>
<td>Person_a</td>
<td>268</td>
<td>5</td>
<td>Organisation_c</td>
<td>64051</td>
<td>38</td>
</tr>
<tr>
<td>Organisation_b</td>
<td>41</td>
<td>20</td>
<td>Organisation_b</td>
<td>240</td>
<td>6</td>
<td>Organisation_b</td>
<td>54899</td>
<td>41</td>
</tr>
</tbody>
</table>

As indicators of Twitter influence, there are differences in the rank orderings of users for the three measures shown in Table 2, however in some cases the actual differences are relatively small (e.g., rank 2-4 in number of tweets and rank 3-5 in number of mentions). All of the six accounts included are within the top 3.2 per cent of all users on all measures. Person_b, Person_d and Organisation_a are always in the top ten ranked users, so can be considered particularly influential users in the context under consideration. Figure 4 presents the network visualisation of the tweet mention links between users in the data set. Twitter data contain undirected tweets (i.e., tweets from a user not mentioning any other account) and a way must be found for dealing with them in analyses (Honeycutt & Herring, 2009). Here, all undirected tweets are allocated as directed to a notional Twitter user identified as ‘@undirected’. Figure 4 indicates the six accounts identified as prominent in Figure 2.
A large number of undirected tweets can be observed, including a significant number coming from Person_d and Organisation_a. The relative size of the labelled user nodes is in line with the count and rank of mentions in Table 2. While Person_d ranked first on tweets and second on mentions, it can be seen that many of their tweets are undirected, and many of their mentions actually come from another single user, so their ‘influence’ is probably more accurately represented by their ninth rank in tweets x followers. The F-R layout algorithm used here locates closer together those nodes most strongly connected via common links. While Figure 2 suggested that the tweet text content from Organisation_b and Organisation_c were relatively distinct (being positioned on opposite sides of the plot), Figure 4 reveals their strong association through their close positioning, and also to Person_a, as three users actively advocating on Twitter against participation in the MyHR system. Organisation_a and Person_b, offering counter perspectives, are positioned on the opposite of the network.

6. Conclusion

This paper investigated the representation of personal e-health records on Twitter via a data set of 6191 tweets associated with the hashtags #PCEHR, #MyHealthRecord and #MyHR. Time sequence analysis, text analytics and network visualisation were employed to characterise the Twitter discussion activity and content, and to identify influential users and their relationships. Most tweets used only a single hashtag, with #MyHealthRecord being the most common. The text content of tweets using these hashtags spanned positive/supportive, neutral/factual and negative/opposing themes regarding EHRs. Text visualisation highlighted six accounts that were active and also mentioned frequently in tweets. In particular, three of these accounts were always ranked in the top ten on several measures of activity and interactivity, so could be considered highly influential in this context. Network visualisation of the connections between accounts, represented by tweets from senders to those mentioned, revealed associations between some prominent accounts and their publicly-stated stance on EHRs.

This work provides insights regarding how EHRs, in an Australian context, are currently represented in social media (specifically Twitter), and offers a detailed methodology to those interested in further research in this area. Considering the forthcoming move to an opt-out system, it is apparent that the Twitter platform is under-utilised as a public health intervention for engagement about this national EHR. With little evidence of significant interactions occurring between influential tweeters with diverse views, additional strategies (e.g., live tweeting of evidence presented at health conferences, hashtag chats for engagement of diverse views, using Twitter to teach users about the system, and the promotion of credible sources providing correct and current information on the EHR) could be used to increase competence and confidence in use of the system, address user concerns about privacy and confidentiality, reach minority groups at risk of exclusion, and hear the views and experiences of users as they engage with the EHR over time.

Future research could include additional text analytics and visualisations of the tweet text data gathered in this study to understand more about the content of Twitter interactions occurring in relation to MyHR in Australia. The further collection of tweets to and from the six influential Twitter accounts in this study, particularly in the context of the opt-out system being introduced nationally, might also be useful to examine how individuals engage with their audience to create and disseminate information about EHRs. An appreciation of the credibility of the content distributed (e.g., in links posted in tweets) and the information being correct, misinformation, or disinformation would also be of interest in public health research.

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