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Understanding Vaccine Refusal:

Why We Need Social Media Now

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The recent Disneyland measles outbreak brought national attention to a growing problem: vaccine refusal—herd immunity is no longer a reality in many communities. Only 70% of children aged 19–35 months are up to date on immunizations,¹ and in some communities, more than a quarter of school age children have exemptions on file (www.doh.wa.gov/Portals/1/Documents/Pubs/348-247-SY2014-15-ImmunizationMaps.pdf). Although they vary across the ideological spectrum, vaccine refusers tend to be well educated, white, and more affluent than people who typically experience health disparities.¹ Prior studies^{2,3} have found that a diversity of motivations drive vaccine refusal, including fear that vaccines cause autism, concerns over toxins, beliefs about the benefits of measles to the immune system, distrust of government, distrust of pharmaceutical companies, and preference for a “natural” lifestyle. Arguments recommended by physicians’ groups and public health agencies to counter these beliefs do not always change minds⁴; even parents who indicate high trust in their pediatricians may not follow doctors’ recommendations.¹ Ultimately, people “persuade themselves to change attitudes and behavior”⁵ and communicators must tailor messages to the beliefs, attitudes, and motivations of particular audience segments.⁶ Effective health communication about vaccines requires answering three questions:

1. How do individuals’ vaccination adherence⁷ and vaccine refusal patterns vary with their beliefs? We cannot assume that rationales for religious exemptions to vaccination are rooted in the same beliefs as those driving advocates of “natural cures.”

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2. How do beliefs vary by community or social group? We cannot assume that a liberal Democrat in Los Angeles refuses vaccinations for the same reasons that a staunch Texas conservative might do so.
3. Which persuasive strategies used by vaccination advocates and vaccine refusers are most effective? We cannot assume that the same types of arguments will be compelling to members of different groups.

It is difficult to answer these research questions using traditional methods,^{8,9} such as telephone surveys. Traditional survey methods have limitations. A typical phone survey of 1,000 participants based on random-digit dialing might cost roughly \$70,000. If we want to survey vaccine refusers, who may be 5% of the general population, we need to make 20,000 phone calls—a twentyfold increase in cost. Furthermore, surveys are limited in their ability to track changes in nuanced beliefs among different populations over time. Finally, surveys often require months to implement and struggle to deliver timely information, especially during an outbreak. Traditional methods can fall behind an emerging public health crisis. We can't afford to use last year's strategies to combat this year's outbreak.

Enter social media, which provide unprecedented, real-time access to the attitudes, beliefs, and behaviors of people from across demographic groups. Social media have increasingly been a hotbed of activity for anti-vaccination activists.¹⁰ In fact, the journal *Vaccine* devoted an entire 2012 issue to social media, which they defined as “websites such as Facebook, Twitter, Wikipedia, LinkedIn and YouTube.”¹¹ Furthermore, social media can fill in many gaps left by traditional research methods on vaccine refusal, and novel computational methods can break new ground in social media at Big Data scale. Social media platforms increasingly represent people across age, income, education, and racial/ethnic groups.¹² Twitter, in particular, has already demonstrated its value for many areas of public health,¹³ but there is still vast potential.¹⁴ For example, though Twitter remains disproportionately popular among minorities, the poor, and people aged younger than 30 years,¹⁵ this is a strength: These data provide critical insight into the attitudes and behaviors of people who often fall outside the sampling frame provided by traditional random-digit dialing or address-based sampling. These same groups are also at greatest risk for health disparities. Although other major social networks, such as Facebook, may be more popular among the general population, Twitter's popularity has overtaken Facebook among precisely these hard-to-reach groups—namely, teenagers and young adults.¹⁶ Twitter is also one of the more accessible social media platforms, with fewer privacy settings (twitter.com/tos?lang=en) when compared with Facebook (www.facebook.com/legal/terms) and more fully public posts or messages, making it an ideal observational data collection site. Using social media in concert with traditional research methods, we can better capture the opinions of vaccine refusers, allowing researchers to find and investigate public messages broadcast by members of communities of interest.

Additionally, new computer science research can infer traditional demographics directly from the data, allowing alignment between social media and traditional surveys.^{17,18} Furthermore, computational methods can go beyond traditional demographics, identifying fine-grained cultural groups such as users of “natural” or “holistic” cures, a precision that is

both costly and time consuming with typical surveys, yet critical to understanding vaccine refusal.

At least 80% of Internet users seek health information online, and 16% of those seek online information about vaccination.¹⁰ Although it is not clear how many of these Internet users specifically seek or incidentally get vaccination information from social media, we do know that people regularly share vaccine information on social media platforms, and that the anti-vaccination movement uses social media as one of its primary communication tools. Likewise, an important component of social media is the sharing of news articles and blog posts. Increasing numbers of people obtain a majority of their news from social media, including millennials, who get 61% of their political news from social media.¹⁹ The messages observed and shared there can provide a real-time, detailed picture of public attitudes toward vaccination. For example, though perceived links between autism and the measles, mumps, and rubella vaccine have persisted for years, concerns about the presence of putative toxins have gained recent attention.¹⁰ Indeed, because the Internet allows such rapid spread of anti-vaccine arguments,¹⁰ it is essential to harness the strength of the Internet to combat them. Moreover, by observing these messages directly, researchers can circumvent a common concern about surveys, focus groups, and interviews—namely, that participants tend to respond in ways that they believe are expected (“social desirability bias”), especially in the context of topics like patient adherence to recommendations and dosages. For sensitive and controversial topics, such as vaccines, asking people directly may be less accurate than observing their behavior on social media. Finally, social media can help us understand which elements of pro-vaccination messages seem to resonate most with the public and, importantly, how vaccine refusers persuade others. Effective health communication must combat these anti-vaccination persuasion campaigns. Similarly, we must understand how the population at large **reacts** to vaccine refusal. Social media can be used to track how specific news stories circulate. At the same time, those who support vaccination often criticize and deride “anti-vaxxers,” despite decades of research showing that external attacks can reinforce closely held beliefs.²⁰ Therefore, we must understand the “how” of both pro- and anti-vaccine communications. This topic remains largely unstudied because it is unsupported by traditional surveys; social media can change that.

The volume of data to support this research is vast. Consider the authors’ analysis of Twitter messages, based on statistical natural language processing, during the recent measles outbreak (Figure 1). The authors collected Twitter data continuously throughout the outbreak using more than 50 keywords associated with vaccines, such as vaccine, immunization, and measles. Tweets were then labeled for relevance to the topic of vaccines, as well as their sentiment towards vaccines: positive, negative, or neutral. Three supervised machine learning classifiers (algorithms that can automatically categorize text) were trained on these tweets: relevance, sentiment bearing (neutral versus opinion) and, for those containing an opinion, sentiment polarity. Using the resulting classifiers, all collected data were automatically labeled to measure the daily rates of vaccine tweets and their sentiment. The authors observed an increase in the number of vaccine-related Twitter messages during the outbreak, with positive messages dramatically increasing. These millions of messages suggest a golden research opportunity.

Social media data are no more valid than any other data source; but, in the case of understanding vaccine refusal, the strengths of social media data may greatly outweigh their weaknesses. Importantly, approaches based on social media complement traditional methods, aligning with the opinion of top methodologists that the most valid, reliable research comprises mixed methods and data sources.²¹

Vaccine refusal is a danger to the public health. We are living in a time when children and other vulnerable populations are contracting vaccine-preventable illnesses years after these diseases were thought to have been eliminated in the developed world. As public opinion and policy turn against vaccine refusers and drives them into increasingly vulnerable communities of like-minded individuals, the situation may only grow worse. To combat this epidemic, we need additional, and more-effective, mechanisms for understanding the critical questions of vaccine refusal. We must turn to social media now before the next outbreak.

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Figure 1.

Tweets expressing positive and negative vaccine attitudes (right y-axis), and overall vaccine related tweets (left y-axis), around the January 7, 2015 outbreak.

Note: Vaccine tweets are normalized using the maximum number of relevant tweets in a 140 day window. Tweets are categorized using statistical natural language processing methods. Gaps in the data collection are smoothed by using a surrounding 2 week average for the missing values.