

The 2013 US Government Shutdown (#Shutdown) and Health: An Emerging Role for Social Media

In October 2013, multiple United States (US) federal health departments and agencies posted on Twitter, “We’re sorry, but we will not be tweeting or responding to @replies during the shutdown. We’ll be back as soon as possible!” These “last tweets” and the millions of responses they generated revealed social media’s role as a forum for sharing and discussing information rapidly.

Social media are now among the few dominant communication channels used today. We used social media to characterize the public discourse and sentiment about the shutdown.

The 2013 shutdown represented an opportunity to explore the role social media might play in events that could affect health. (*Am J Public Health*. 2014;104:2248–2250. doi:10.2105/AJPH.2014.302118)

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BEHIND THE SUPER BOWL, THE

government shutdown was the second most talked about topic on Facebook in 2013.¹ The October 2013 government shutdown affected and furloughed millions of people in the United States, was the second longest shutdown since 1980, had a projected \$2 billion to \$6 billion lost in output, and stopped or reduced services provided by several departments and agencies that protect and promote health.² Nothing similar was observed during the 1995 to 1996 shutdown when the Internet was emerging as a social medium. The Centers for Disease Control and Prevention (CDC) surveillance support for infectious disease outbreaks (e.g., tuberculosis, hepatitis), annual flu monitoring programs, and vaccine campaigns was reduced.² Approval of medical products, devices, and drugs by the Food and Drug Administration was delayed.² The Vaccine Injury Compensation Claims process directed by the Health Resources and Services Administration was disrupted. Hundreds of new patient enrollments for certain National Institutes of Health (NIH)-sponsored clinical trials were slowed, along with support services for planned, new, and existing trials as three quarters of NIH and two thirds of CDC employees were furloughed.² The Children’s Hospitals Graduate Medical Education Payment Program, which supports the training of future pediatric health care workforce, stopped.^{2,3} Head Start Program grantees, which

provide services for more than 6300 children, had to close centers for nine days before being reopened with funding from private foundations or states.² Because of the broad base of health’s social determinants, including nutrition, education, and employment, the impact of the government shutdown on health was much larger than what would be estimated if only those effects on traditional health care were considered.

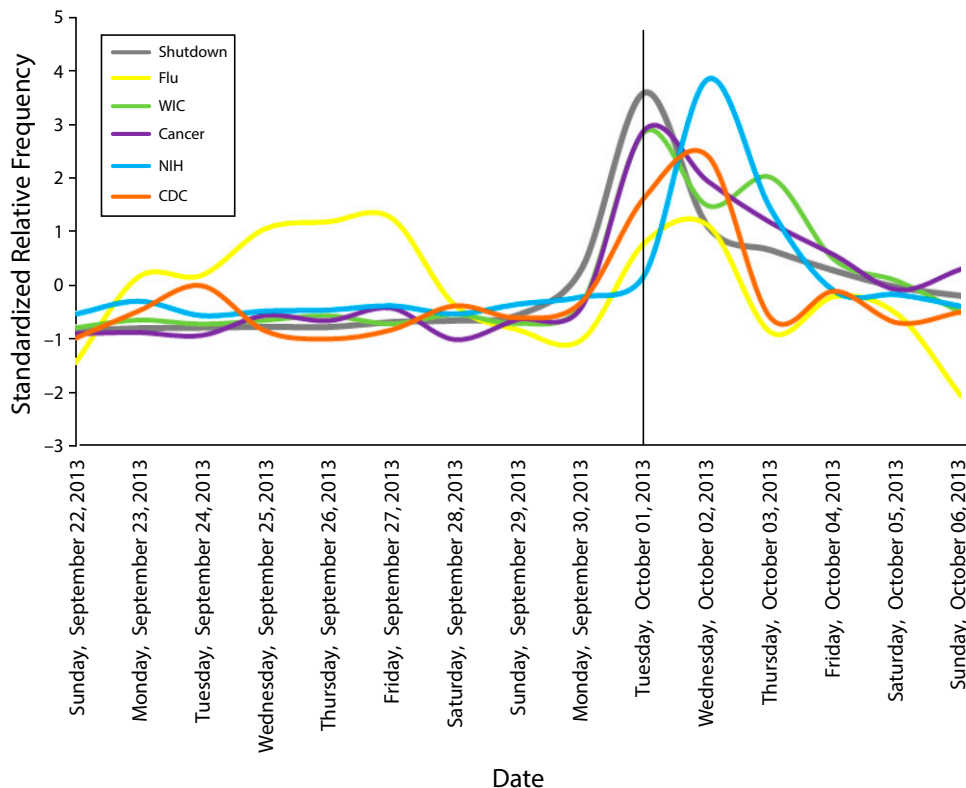
SOCIAL MEDIA AND REAL-TIME SURVEILLANCE

In the hours surrounding the start of the government shutdown, numerous articles were written, tweeted, and posted online that attempted to answer the questions “What will be open and closed?” and “How might the shutdown affect health?” A fog of uncertainty surrounded the disruption of information and trust brought on by the partisan conflict in the government. National Public Radio tweeted, “Are you affected by the #shutdown?” CNN Health asked, “Were you or your child supposed to start a clinical trial that may be delayed b/c of the @shutdown? Let us know.” Early news stories also covered the potential funding loss for the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), which provides nutritional support to low-income women, infants, and children. In response to the National WIC Association’s

Facebook posts about the shutdown, several individuals sought more information by asking questions such as, “How bad will it affect WIC?” These online posts quickly generated their own attention, revealing social media’s reach and ability to clear the fog by providing on-the-ground information.

CHARACTERIZING PUBLIC DISCOURSE AND SENTIMENT

Using an observational study design and data publicly available through the Twitter application programming interface (<https://dev.twitter.com> and keyword search), we identified 2 998 285 English language tweets geocoded in the United States (mapped by state, county, or city coordinates), beginning with the first increase in mentions of “shutdown” and “#shutdown” from September 22 to October 6, 2013. Relative to the week before the shutdown, mentions of several health-related terms and agencies (flu, WIC, cancer, NIH, CDC) increased significantly on or after October 1, 2013 (Figure 1). Other related terms (e.g., US Department of Agriculture, food safety, clinical trials) did not have enough mentions to conduct a time-series analysis. To characterize the emotions associated with the content generated on Twitter, we performed sentiment analyses using sentiment lexicons and natural language processing.⁴ This approach identified the mean positive



Note. CDC = Centers for Disease Control and Prevention; NIH = National Institutes of Health; WIC = Women, Infants, and Children. The volume of select health-related content generated on Twitter around the start of the US government shutdown. The x-axis shows days preceding and following the start of the shutdown on October 1, 2013. The y-axis represents the standardized relative frequency, computed as the standardized percentage of tweets for each day that contained a given term across all days in the sample timeframe. The vertical line represents the start of the shutdown on October 1, 2013.

FIGURE 1—Health-related terms and agencies discussed on Twitter around the time of the US government shutdown.

or negative valence of words mentioned in tweets at the onset of the shutdown. In this timeframe, the sentiment associated with health terms of interest was primarily negative. For example, terms associated with negative valence and WIC included terms such as, “shameful,” “horrible,” “poor,” “abuse,” and “smh” (shaking my head). This suggested Twitter could be used for tracking public discussions in real time and their associated sentiments around disruptive events that affect health. Further information about the volume of people engaged in a topic (e.g., number of followers), topic dissemination

(e.g., retweets), and concerns about a topic (e.g., content analysis) could also provide additional information that health care agencies could use to follow public discourse during disruptive events.

RAPIDLY LINKING RESOURCES WITH UNMET NEEDS

In the hours immediately following the start of the shutdown, a major unmet need was the public’s access to detailed information regarding which federal health programs were affected. As updates from some federal health

departments and agencies became limited or absent from the social media discussion, other health care organizations stepped up to provide both information and services. HealthMap.org tweeted, “Help us track the #flu while the CDC is temporarily not allowed to do so. Join @FluNearYou here: flunearyou.org #shutdown #alert.” Use of social media by federal health agencies varied; some posted that they would not be updating their accounts, some stopped posting, and some posted throughout the shutdown. The Veterans Health Administration, for example, used its Facebook (> 92 000 likes) and

Twitter (> 40 000 followers) accounts to specifically inform patients about their current status, status of previous arrangements, and how to find additional information via nonsocial media channels.

All VA medical centers and clinics will remain fully operational and will continue to provide health care services to our nation’s Veterans during the government shutdown. Previously scheduled VA health care appointments are not affected.

These messages were accompanied by telephone numbers and links to Web sites with additional information. The Veterans Health Administration and others’ use of social media for providing timely communication about services in a disruptive event could serve as a model for the several other health agencies that were not able to use their “last tweets” to provide resources about where the public could turn for answers or assistance if needed. Previous work highlighted best practices and lessons learned for social media communication during disruptive events, and further work is still needed to evaluate optimal messages and message platforms.⁵

LIMITATIONS OF SOCIAL MEDIA

Although social media can play a unique and important role during disruptive events that affect the health care infrastructure, social media also present unique challenges.^{5–7} Determining the best approach to detecting a true signal from the noise can be challenging. Terms used on social media may carry multiple meanings, depending on the context in which they are used. In addition, social media users may not represent a national sample of the public, limiting the generalizability of

discussions and sentiments. Although the “crowd” often identifies and dispels misinformation and misinterpretation, incorrect information can spread rapidly, and identifying how authoritative sources can best moderate these online forums is still being determined. Finally, although social media data have been extracted and analyzed to improve public health emergency response or recovery by government agencies,^{5,8} determining how these data-mining approaches can be scalable for a multitude of public health organizations requires further study. The Department of Health and Human Services and other departments and agencies have launched innovation challenges to partner with public and nongovernment groups to use social media for tasks such as tracking local health trends, improving emergency preparedness of individuals with durable medical equipment, and creating a Facebook app for disaster preparedness and response.⁹

While the impact of the US Government shutdown of 2013 on actual health outcomes may not become evident for some time, the ability to understand the public's perceptions and identify concerns at an early stage could be useful for determining how to best address the needs of the public in a temporarily disrupted health care system. Previous reports illustrated how social media could be used by health care organizations in public health emergencies

(e.g., pandemics, natural disasters, terrorist attacks) for timely information exchange and situational awareness.³ Political events across the world (e.g., Egypt, Turkey) illustrated how social media could be a critical communication channel when Internet service is significantly disrupted across geographic regions.³ The 2013 shutdown represented a different use of social media that occurred when significant contributors (e.g., government health agencies) were unable to fully participate in the conversation. In this context, social media could allow for identification of potential problems and facilitate mobilization of temporary solutions. Social media generated more than 45 million tweets, posts, images, videos, and other related output during the shutdown, and it could serve as a unique tool for identifying problems through real-time surveillance, rapidly disseminating information, and connecting individuals to resources.^{5,10,11} Lessons learned from the use of social media during the shutdown could be applied to other events in which policymakers must decide how to disburse limited resources. The social media accounts of some US federal health departments and agencies were figuratively “furloughed,” but they could have provided key information to the public before going offline. In addition, social media could be used to guide the discussion around the shutdown by identifying public perceptions and concerns

about important health-related topics. ■

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Human Participant Protection

Human participant protection was not required because no human participants were involved in this research.

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Mitigating HIV Health Disparities: The Promise of Mobile Health for a Patient-Initiated Solution

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The HIV epidemic is an ongoing public health problem fueled, in part, by undertesting for HIV. When HIV-infected people learn their status, many of them decrease risky behaviors and begin therapy to decrease viral load, both of which prevent ongoing spread of HIV in the community.

Some physicians face barriers to testing their patients for HIV and would rather their patients ask them for the HIV test. A campaign prompting patients to ask their physicians about HIV testing could increase testing.

A mobile health (mHealth) campaign would be a low-cost, accessible solution to activate patients to take greater control of their health, especially populations at risk for HIV. This campaign could achieve *Healthy People 2020* objectives: improve patient-physician communication, improve HIV testing, and increase use of mHealth. (*Am J Public Health*. 2014;104:2251–2255. doi:10.2105/AJPH.2014.302120)

WORLD AIDS DAY EACH DE-

cember reminds us of the ongoing HIV epidemic in the United States and its disproportionate toll on racial and ethnic minority communities. HIV testing is an essential strategy to curb the ongoing epidemic. When people infected with HIV learn their status, many of them decrease risky behaviors to prevent spread to others¹ and begin antiretroviral therapy to decrease viral load, the main biological predictor of the ongoing spread of HIV in the community.² Despite national recommendations to make HIV testing routine for all adults,^{3–6} HIV testing rates—particularly among the racial and ethnic communities hardest hit—remain low.⁷ Patients want to be tested.⁸ However, physicians face numerous HIV testing barriers, including physician discomfort with initiating HIV testing discussions,⁹ physicians not realizing that patients expect HIV testing to be done,⁸ time,^{10,11} and competing clinical priorities.^{11,12}

A pioneering intervention to improve HIV testing in health care settings may be a patient-initiated approach. The push–pull capacity model offers a framework to guide a solution to improve patient-initiated HIV testing.^{13,14} With a push–pull model, health information can be provided—or pushed—to many patients. This push creates a demand—or pull—for health services that address patient concerns. The ubiquity of cell phones and the pervasive use of text messaging provide an innovative platform for promoting

an effective HIV testing campaign. Operationalizing the push–pull model through mobile health (mHealth) could be a novel approach to improving HIV testing in health care settings. This initiative would reduce demands on physicians, increase patients' engagement in their own health, and address a significant ongoing public health problem.¹⁵ Goals of *Healthy People 2020* include eliminating health disparities and increasing the number of people who have been tested for HIV.¹⁶

THE ONGOING US HIV EPIDEMIC

In the United States, more than one million people are infected with HIV,¹⁷ and approximately 50 000 new HIV infections occur yearly.^{18a} People in the United States of lower socioeconomic status face a greater burden of HIV.^{18b} Individuals who live below the poverty line are twice as likely to be infected with HIV as those who live above the poverty line.¹⁸

HIV also has a disproportional impact on racial and ethnic minorities in the United States. Despite making up only 14% and 16% of the US population, African Americans and Hispanics make up 44% and 19%, respectively, of those living with HIV.¹⁸ Despite the high prevalence of HIV in African American and Hispanic communities, African Americans and Hispanics make up a disproportionate share of those unaware of their HIV-positive status.⁷ Although nationally nearly 16% are

unaware they are infected with HIV,¹⁸ 22% of African Americans and 18% of Hispanics with HIV do not know they are infected because they have not been tested.⁷ In a national survey, 26% of African Americans and 44% of Hispanics reported never having been tested for HIV.¹⁹ When African Americans are finally tested, they are tested late: more than 46% of African Americans and more than 48% of Hispanics receive an AIDS diagnosis within three years of their initial HIV diagnosis.²⁰ By contrast, 42% of Whites are diagnosed within three years of an HIV diagnosis.²⁰

MISSED OPPORTUNITIES FOR HIV TESTING IN HEALTH CARE SETTINGS

Although the Centers for Disease Control and Prevention (CDC)⁶ and professional medical societies^{3–5} have advocated routine HIV testing for all adults in high HIV prevalence health care settings since 2006, HIV testing is not widespread. HIV testing reached a peak of 39.8% of adults in 2009 but dropped to 34.7% in 2012.²¹ Many opportunities for HIV testing have been missed. In a 2012 national survey, 72% of participants noted that their health care provider had never suggested HIV testing to them.²² Additionally, studies in primary care settings in areas with high HIV prevalence have found that 74% of patients reported that their health care provider had not offered them HIV testing²³ and

89% reported that their health care provider had never recommended HIV testing.²⁴ Even when HIV indicators are present, many health care providers are not testing. In one study in which patients presented to care with clinical conditions suggestive of HIV, only 18% received a recommendation for HIV testing.²⁵ A CDC report noted that patients who were diagnosed late with HIV had a median of four visits to a health care facility before their eventual HIV testing and diagnosis.²⁶ Studies have found that of HIV-positive patients, more than 80% did not receive their diagnostic HIV test during their recent routine medical examination,²⁷ and 71% had one or more health care encounters in the preceding year during which their health care provider did not test them for HIV.²⁸

PATIENTS WANT TO BE TESTED BY THEIR PHYSICIANS

Numerous studies have shown that a health care provider's recommendation to get tested for HIV can influence a patient's decision to undergo testing.^{22,24,29–31} A recent national survey found that for more than one third of those surveyed, a health care provider's recommendation to test for HIV was the reason they underwent HIV testing.²² Conversely, among participants who had never been tested for HIV, one third reported that not receiving a recommendation from a health care provider was the reason they had not been tested.²² Notably, some studies have found that patients in health care settings actually expect HIV testing to be done by their health care provider. In one study done in health care settings, nearly one in four patients expected that their provider would do HIV testing, and

more than 40% of patients wanted their health care provider to do the testing.⁸ These findings highlight the importance of health care provider HIV testing recommendations for improving HIV testing in health care settings.

PUSH-PULL MODEL FOR IMPROVED HIV TESTING

Because of an ongoing need to improve HIV testing in the United States, in April 2013 the US Preventive Services Task Force recommended routine testing of all adolescents and adults aged 15 to 65 years.⁵ Given the limited success of the 2006 CDC HIV testing recommendations in making HIV testing a routine practice, for this 2013 recommendation to be realized in health care settings, a new paradigm is needed to engage both physicians and patients.⁶ One third of participants in a national survey reported wanting strategies to discuss HIV with their health care provider; only 46% had ever had a discussion about HIV with their health care provider.¹⁹ Furthermore, 42% wanted to know who should get tested for HIV.¹⁹

An innovative and successful strategy to improve HIV testing may be to activate the patient to initiate the discussion and request HIV testing. A recent survey found that 70% of physicians wanted their patients to ask them for an HIV test.³² Campaigns are needed that will push patients to pull their physicians to offer HIV testing. The push–pull capacity model is increasingly being recognized as important for adoption of evidence-based practices and improving public health outcomes.^{13,14} *Push* includes communicating health information to wide populations, and *pull* refers to creating demand for health services.¹³ In fact, when consumers are provided

with the right information, they are then able to demand high-quality health care.¹⁵ A way to push health information to wide populations would be to use the media. Traditional media options include television, radio, and print, and new media options include the Internet, mobile phones, and social media.

A health campaign push–pull model using mobile phones—a near-universal media—could be used to create consumer demand for HIV testing in health care settings. In one study, nearly one in three patients felt that text messages about HIV prevention would be helpful.³³ Periodic prompts delivered via media have been shown to be effective in reminding and motivating people to change health behaviors.³⁴ Figure 1 illustrates how an mHealth campaign could remind and push the patient to engage and pull the physician into a discussion about HIV testing, thereby leading the physician to order the HIV test. Ideally, this mHealth campaign message using cell phones would be delivered when it is most relevant: just before a patient's appointment with his or her physician. Notably, the health campaign push–pull model could also involve strategies that push the physician to offer HIV testing.

PROMISE OF MOBILE PHONES FOR AN mHEALTH CAMPAIGN

According to a National Institutes of Health Consensus Group, mHealth is the use of mobile devices to improve health research, services, and outcomes.³⁵ Mobile phones are the most widely available and used new media technology for mHealth. Recent surveys have found that 91% of US adults own a mobile phone³⁶ and 61% of mobile

phone owners have smartphones, which have many of the functions of a computer.³⁷ Mobile phone ownership is high even among racial and ethnic minority groups and across all education and income levels (Table 1).³⁶ Because only 19% of smartphone users have health-related mobile applications,³⁹ a text message–based mHealth campaign could have greater reach and impact. According to a 2013 national survey, text messaging is the most frequent activity done on a mobile phone, with 81% of US adults using their mobile phones to send and receive text messages.³⁸ Text messaging is ubiquitous across race/ethnicity, education level, and household income (Table 1).³⁸ Text messaging is also more frequently used than other forms of Internet messaging. Only 20% of e-mails are opened and 12% of Facebook feeds are viewed, whereas 99% of text messages are opened.⁴⁰

Because so many people own mobile phones and use text messaging, health campaign messages could be delivered to a large number of people at a time when the message is most relevant, for example near the time of a physician's appointment. According to a recent survey, every 10 minutes one in five people check their phone and every 30 minutes one in four people check their phones.⁴¹ Unlike health campaigns using static media such as billboards and television, the portability of mobile phones and asynchronous nature of text messaging facilitate access of messages at a time convenient to the message receivers. Health text messages can be personalized or interactive, if desired, and these are salient features for health campaign promotion and effectiveness.⁴² As summarized by Cole-Lewis and Kershaw,⁴³ text

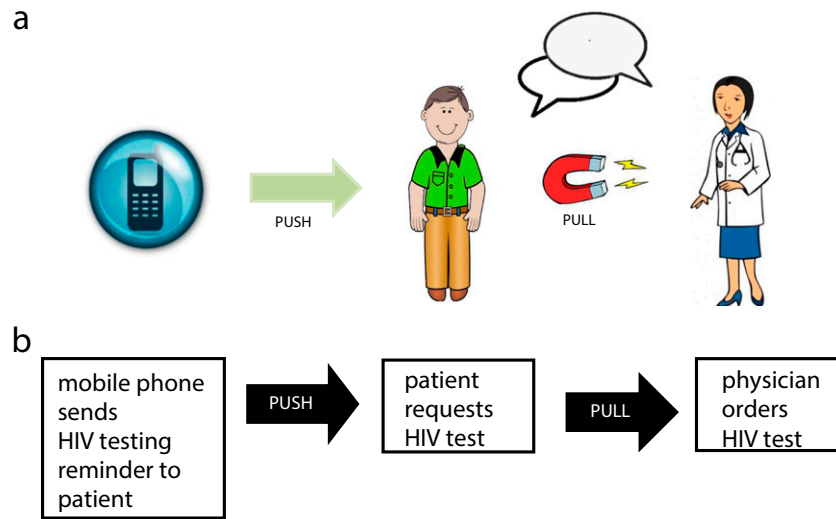


FIGURE 1—Representation of an HIV testing push–pull model between patients and physicians using mobile health, both (a) graphically and (b) descriptively.

messaging offers great promise as a tool for improving health because it is commonly available, relatively low cost, in widespread use, and technologically easy to use and can be applicable to many health conditions. Studies have found that text message campaigns are successful at encouraging preventive health behaviors.⁴² In particular, text message interventions have been successful and engaging in promoting sexual health⁴⁴ and HIV prevention.⁴⁵

Although all of these qualities are attributes that make the mobile phone a highly effective option for a health campaign, only 9% of mobile phone owners say they receive text message updates or alerts about any health issue.³⁹ Among those that do, African Americans are the most likely to receive health information via text.³⁹ An mHealth solution may be ideal given that in a survey of more than 1 000 patients, nearly one in three people felt that

mHealth would offer them greater control of their health.⁴⁶ Owing to the widespread ownership and use of mobile phones and their portability, people could conveniently and frequently access health text messages. On the basis of constructs from the health belief model of behavior change, which has been used to guide successful health communications campaigns,⁴⁷ an mHealth campaign could provide self-efficacy and a cue to action for patients to talk to their doctors and be more engaged in their health. Further research is needed to understand what messages will stimulate behavior change.

IMPLEMENTING AN mHEALTH CAMPAIGN

A successful text message mHealth campaign should be locally driven. Locally driven campaigns can address the needs of the target audience and their specific health concerns, be tailored to the information technology (IT)

infrastructure of the local health system, and therefore more directly engage the local community. Such a campaign would be managed by the health system's IT department. This type of campaign could be implemented with minimal cost because the IT department could contract with companies such as SMS Marketing 360,⁴⁸ Frontline SMS,⁴⁹ or Magpi,⁵⁰ which offer free text-messaging platforms. Because the IT department maintains records of patients' appointments, they could therefore easily send a health text message concomitant with preexisting appointment reminders. This timing would facilitate a cue to action for patients to discuss the text message health content with their physician at the time of their appointment.

Additionally, physicians would encourage their own patients to sign up for this local mHealth campaign. Working with the IT department would facilitate personalized messages signed by the patient's physician. A recent study found that patients would prefer campaigns promoted by their own health care provider.³² When physicians recommend health behaviors, patients are more likely to adopt these behaviors, thus improving their health. Such a campaign could be modeled after the Kaiser Permanente Mobile Storm campaign, which has successfully sent appointment reminders, treatment reminders, and notification of completed lab results.⁵¹ Another campaign prototype is the Oregon Reminders mHealth campaign.⁵² This campaign sends personalized messages regarding HIV and other sexually transmitted infection testing, appointment reminders, and prescription refills.⁵² Patient engagement campaigns could be further strengthened by also implementing parallel

TABLE 1—Mobile Phone Ownership and Text Message Usage by Sociodemographic Characteristics: United States, 2013

Sociodemographic Characteristic	Mobile Phone Ownership, %	Text Message Use, %
Race/ethnicity		
African American	93	85
Hispanic	88	87
White	90	79
Education		
Some college education	> 90	> 80
Without a college education	> 80	> 70
Income < \$30 000 annually	86	78

Source: Rainie³⁶ and Duggan.³⁸

physician-targeted campaigns. These campaigns would remind busy physicians to offer patient-specific preventive health screenings recommended by national guidelines. Such physician-targeted campaigns could also be mHealth based or could be done through traditional avenues, such as academic conferences, electronic medical record reminders, or continuing medical education courses.

CONCLUSIONS

More than 30 years into the HIV epidemic, the infection is still spreading because many are unaware of their positive status as a result of testing rates remaining low. The current HIV epidemic is having a disproportionate impact on African American and Hispanic communities in the United States, in part because people have not been tested for HIV. "Communication inequalities based on education, income, race, and ethnicity are likely to influence what people know about health,"^{53(p833)} and may be contributing to HIV testing and health disparities.⁵³⁻⁵⁵ Because of the widespread ownership and use of mobile phones—particularly among the populations most affected by HIV—mHealth is a promising avenue for reducing these inequalities and breaching the digital divide. Because only 0.3% of health-related mobile applications were dedicated to HIV and sexually transmitted infections in 2012,^{39,56} a mobile phone text message-based campaign may be an ideal solution to help mitigate the ongoing HIV epidemic by improving HIV testing. It is possible that an innovative patient-initiated health campaign promoting testing—in conjunction with physicians routinely offering HIV testing—may offer the synergy needed to improve HIV testing

rates in health care settings and decrease the ongoing spread of HIV in the community. This type of intervention could facilitate improved patient–physician communication and increase the use of mHealth, both key objectives of the *Healthy People 2020* goals.¹⁶

Given that many people with HIV remain unaware of their HIV infection and that the US Preventive Services Task Force recently recommended routine HIV testing of all people aged 15 to 65 years, novel strategies are needed to encourage more widespread HIV testing in health care settings.⁵ Cross-disciplinary partnerships between health and technology fields could catalyze innovative strategies. As noted by former US Secretary of Health and Human Services Kathleen Sebelius, mHealth is "the biggest technology breakthrough of our time," which could empower traditionally hard-to-reach patient populations to take control of their own health.⁵⁷ This underused technology offers great promise to improve the health of communities facing the greatest disease burdens. ■

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M. Arya planned the thematic content, conducted literature reviews, contributed to the writing of all sections and the development of the model, and synthesized revision. D. Kumar contributed to literature reviews on HIV testing and mHealth and the writing of the sections about the HIV epidemic and HIV testing disparities. S. Patel contributed to literature reviews on health campaigns and mHealth and the writing of the section on the use of mHealth in a health campaign. D. Kumar and S. Patel contributed to the revision of the commentary in its entirety. R. L. Street Jr contributed to the literature research on mHealth in health communication, the organization of the article, and the inclusion of theory-based evidence in the push–pull mHealth model. T. P. Giordano contributed to the revision of the HIV epidemic, HIV testing disparities, and push–pull model sections; the organization of the commentary; and the design of the mHealth push–pull figure. K. Viswanath contributed to the revision of the push–pull model section and the implications of mHealth in breaching the digital divide. All authors approved the final version of the article.

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Science and Public Health Principles Used to Reduce Road Deaths

Leon S. Robertson, PhD

An editorial in a previous issue of this journal falsely claims that the US government's efforts to reduce road fatalities are not based on science. It says that, as a result, the United States has fallen behind other countries in road death prevention.

A large body of research and evaluation informed federal and state safety programs from the outset.

Evans's comparisons of death trends among countries without adjustment for changes in relevant risk factors or specification of the injury reduction policies among the countries tell us nothing about the causes of the declines or the effects of specific ameliorative efforts. (*Am J Public Health*. 2014; 104:2256–2258. doi:10.2105/AJPH.2014.302352)

IN AN ARTICLE¹ AND EDITORIAL²

on motor vehicle fatalities, Evans asserts that science was ignored in efforts to reduce motor vehicle injuries in the United States. He writes that difference in reductions in motor vehicle deaths among countries is a result of a differential emphasis on driver behavior and vehicle factors in the causation of road fatalities. In fact, he ignores the sound science that informed motor vehicle safety standards, state law enforcement and behavior change programs in countermeasure choice. His data tell us nothing about the factors that influence trends in deaths among different countries.

HISTORY

An extensive review of the scientific study of injury risk factors and effectiveness of attempts at prevention was published in a 1964 book.³ The first author, William Haddon Jr, MD, MPH, was a scientist based in the New York State Health Department where he conducted groundbreaking research on the role of alcohol in fatal crashes.⁴ A review of the book in *The New York Times* came to the attention of Senator Abraham Ribicoff who subsequently convened hearings on the federal government's activities to prevent motor vehicle related injuries. The legislative process eventually led to two acts of Congress—one authorizing the regulation of motor vehicle performance characteristics that could be improved to reduce the incidence and severity of injury and another authorizing aid to the states to enhance law enforcement and

other behavioral change approaches to injury reduction, as well as to improve emergency medical response. Haddon became the first administrator of the federal agency created to implement the laws.⁵

Evans relies on studies of pre-crash fault finding to argue that driver behavior causes most accidents. James J. Gibson, a psychologist who authored the 1938 article cited by Evans, later identified degree of energy exchange with the human anatomy during crashes as the necessary condition for incidence and severity of injury and noted that the word “accident” has no meaningful operational definition for scientists.⁶

During Haddon's tenure at the new agency, he and his deputy Robert Brenner developed a matrix of the combination of factors and phases of crashes that could be studied and the results possibly applied to reduce injuries. The factors were the behaviors of individuals (car and truck drivers, pedestrians, bicyclists, and motorcyclists), vehicle attributes that increase risk of a crash or the severity of injury given a crash, and environment factors that exacerbate incidence and severity of injury or postcrash ameliorative efforts. The phases were before, during, and after the crash.⁷ For example, road deaths can be reduced by reduction in drunk driving before the crash, modifying vehicles to absorb energy before it injures or kills occupants during the crash, and prompt medical treatment after the crash. This matrix guided the agency's work and has become a standard reference for injury

epidemiologists and injury prevention practitioners (a recent search for Haddon Matrix on Google Scholar [scholar.google.com] produced 17 900 results).

Now known as the National Highway Traffic Safety Administration (NHTSA), the agency from the outset had scientists on staff who conducted research on the factors and phases of the matrix and contracted with outside researchers as well. Several US states also supported research efforts that inform their legislators and injury prevention efforts. As in all government, academic, and independent research institutes, some of the research is excellent and some mediocre or inept, but to say that science was ignored is simply wrong. The implementation of vehicle safety regulations and support for state programs has waxed and waned depending on the ideologies of those in political power and budget constraints that affect such efforts by any government.

For more than 20 years, NHTSA's work at the federal level has been supplemented by research and promotion of preventive efforts by the National Center for Injury Prevention and Control at the Centers for Disease Control and Prevention.⁸ The Injury Center supports academic injury prevention research centers that have produced numerous studies in injury epidemiology and evaluation of injury prevention programs, many directed at road deaths.

SCIENCE

Those who carefully conduct scientific studies of disease and

injury know that the attribution of causation requires meticulous accounting of known risk factors that might impact a conclusion regarding the contribution of any one. In his article, Evans displays reductions in motor vehicle fatalities in various countries from their highest points without correlating them to any risk factors. He makes no adjustment among countries for changes over time in economic conditions, vehicle safety standards, laws and programs to change driver behavior, the mix of vehicles types such as bicycles, motorcycles, trucks and cars, or differences in rollover propensity and other vehicle factors that vary within these vehicle categories.⁹ For example, motorcycle occupant death rates per vehicle or per mile are far higher than those of other road vehicles and are concentrated among more recently sold vehicles.¹⁰ Motorcycle sales in the United States more than doubled from 1999 to 2006 and motorcyclist deaths almost doubled from 2483 in 1999 to 4837 in 2006 and they remained above 4500 per year through the last published data for 2012.¹¹ By 2006, there were more motorcyclist deaths than pedestrian deaths. Any trend analysis, singly or among countries, that doesn't account for such changes is fatally flawed.

The graphs that Evans displays show acceleration in the decline in deaths in all of the countries beginning in 2007 to 2008 when the world economy went into deep economic recession following near collapse of banks in many countries and government bailouts to keep them afloat. Ups and downs in road fatality rates are well known to be correlated to economic prosperity and recession respectively.¹² I wouldn't recommend policies that reduce

economic growth to reduce road fatalities because of the myriad other negative consequence of recession, including an increase in suicides.¹³ I would recommend that anyone comparing trends in road deaths among countries account for the effects of differential economic ups and downs among the countries.

Once risk factors that account for substantial variance of incidence and severity of a reasonably homogeneous set of diseases or injuries are identified, choice of interventions should be based on the extent to which risk factors can be changed, the demonstrated effectiveness of attempts to change them and potential barriers to implementation. Evans says that US road deaths would have been reduced on the order of 20 000 more per year if the US reduction from its peak had matched that of the Netherlands. He emphasizes issuance of speeding tickets based on automated photographic equipment and speed measurement as a major means of accomplishing the change. The Netherlands has 117 430 kilometers of roads compared with 6 341 421 kilometers in the United States. The population density in the Netherlands is 493 per square kilometer, more than 14 times that of the United States (34 per km²). It is much easier to enforce speed and other laws where the population is concentrated in a small area such as urban areas of the United States where the population density is more like the Netherlands. In the United States, deaths occur disproportionately on rural roads at night. I leave to the imagination of the reader what would happen to automated ticketing machines on rural US roads where people roam in vehicles with assault weapons in their gun racks.

Some of the decline in deaths in recent decades in all countries is the result of manufacturer adoption of vehicle crashworthiness and crash avoidance in their designs, sometimes voluntarily and sometimes by government regulation. The countries in Evan's article also have consumer protection agencies that issue recalls of defective vehicles and other products.¹ Governments have employed voluntary behavior-change programs and laws with some success as well. Seat belt and child restraint use laws have reduced deaths as has some alcohol control legislation in many countries including the United States. In the United States, motorcycle helmet use laws and the 55-mile-per-hour speed limit reduced deaths for a time but eventually were abandoned in most US states because of political pressure on legislatures, not for lack of scientific knowledge of their effectiveness. Any valid analysis of differences in fatality rate trends among countries must account for the effects of changes in relevant laws.

In 1980, a US General Accounting Office report claimed that the NHTSA administered program of grants to states for highway safety had little effect on fatality risk among the states.¹⁴ Since studies of high school driver education found that they increased fatalities because they increased teenaged driving without reducing the risk per driver,¹⁵ a study separated the federal funds that were used by the states to support that program and those supporting motorcyclist education and other countermeasures. Adjusted for age distribution and unemployment in the 48 contiguous states, the fatalities among the states from 1975 to 1980 increased in relation to more

funding of high school driver education, were unrelated to motorcyclist fatalities and were lowered in relation to increases in funds per capita that the states used for other programs.¹⁶ NHTSA subsequently did a controlled experiment of high school driver education and found no effect on subsequent crashes between those who took the course and a control group. It stopped funding the courses in its state grant programs. It responded appropriately to the science.

NHTSA has spent billions of dollars on highway safety grants to the states, \$527.9 million in fiscal year 2013.¹⁷ In 2013, the agency spent less than \$20 million on vehicle defect investigation and recall enforcement, against which Evans rants in his editorial. Of course, that is not the total cost of recalls because the manufacturers, not NHTSA, bear the brunt of the cost of recalls. Evans notes that some recalls are done before there are any associated injuries or deaths reported. Many deaths resulting from vehicle defects are never reported as such. Most crash investigations are done by police who are oriented toward driver violations, not vehicle defects, particularly defects that increase severity of injury given a crash. If a manufacturer discovers a problem, such as a defective fuel line that increases the probability of fire in a crash, it is obligated to recall the vehicles and remedy the problem. Would Evans prefer them to wait until some people are fried to initiate the recall?

Evans says that science shows that "crash test results, new vehicle safety technology, and biomechanics research . . . have relatively little to do with traffic safety."^{2(p1349)} That is not what the science finds. The original US vehicle safety standards for

passenger cars based on extant research and engineering at the time accounted for a 40% reduction in deaths per vehicles in use, controlling for other risk factors.¹⁸ Rates in subsequent model years of passenger vehicles also showed declines as crashworthiness improved.¹⁹ Electronic stability control that corrects for driver errors that lead to skids and somewhat for vehicle stability was found to reduce single vehicle fatal crashes more than 40%.²⁰ An important issue is whether various vehicle attributes prevent the same deaths or have independent effects. A study of 1995 to 2005 model cars, vans, pickup trucks and SUVs in the United States found 42% fewer deaths in vehicles that had electronic stability control systems. Improved crashworthiness as measured by offset frontal and side crash tests, if applied to all vehicles, would have produced an additional 28% reduction, and static stability improvement would have reduced the deaths 11%. Because the study controlled for the relative effects of each attribute given the presence or absence of the other, the effects are additive. The total is 81% of the deaths. There was no correlation of the presence or absence of behavioral or environmental risk factors among vehicles with and without the modifications that could account for the difference in deaths among vehicles associated with the vehicle modifications.²¹

Long lists of scientifically studied countermeasures that reduce particular subsets of fatalities are available.²² Efficient deployment requires data on when, where and how severe injuries occur. Environmental health officers in the US Indian Health Service have demonstrated how to identify clusters of subsets of injuries, choose appropriate countermeasures and

persuade tribal governments and state officials to implement effective countermeasures.²³ Application of these methods nationwide by public health agencies would be a boon to further reductions in fatal and severe injuries. ■

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