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The Charlie Sheen Effect on Rapid In-home Human Immunodeficiency Virus Test Sales

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Abstract One in eight of the 1.2 million Americans living with human immunodeficiency virus (HIV) are unaware of their positive status, and untested individuals are responsible for most new infections. As a result, testing is the most cost-effective HIV prevention strategy and must be accelerated when opportunities are presented. Web searches for HIV spiked around actor Charlie Sheen's HIV-positive disclosure. However, it is unknown whether Sheen's disclosure impacted offline behaviors like HIV testing. The goal of this study was

to determine if Sheen's HIV disclosure was a record-setting HIV prevention event and determine if Web searches presage increases in testing allowing for rapid detection and reaction in the future. Sales of OraQuick rapid in-home HIV test kits in the USA were monitored weekly from April 12, 2014, to April 16, 2016, alongside Web searches including the terms "test," "tests," or "testing" and "HIV" as accessed from Google Trends. Changes in OraQuick sales around Sheen's disclosure and prediction models using Web searches were assessed. OraQuick sales rose 95% (95% CI, 75–117; $p < 0.001$) of the week of Sheen's disclosure and remained elevated for 4 more weeks ($p < 0.05$). In total, there were 8225 more sales than expected around Sheen's disclosure, surpassing World AIDS Day by a factor of about 7. Moreover, Web searches mirrored OraQuick sales trends ($r = 0.79$), demonstrating their ability to presage increases in testing. The "Charlie Sheen effect" represents an important opportunity for a public health response, and in the future, Web searches can be used to detect and act on more opportunities to foster prevention behaviors.

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Introduction

One in eight of the 1.2 million Americans living with human immunodeficiency virus (HIV) are unaware of their positive status, and untested individuals are responsible for most new infections (Centers for Disease Control and Prevention 2016). As a result, testing is the most cost-effective HIV prevention strategy (Lin et al. 2016) and must be accelerated when opportunities are presented. Yet, many opportunities to promote HIV testing are missed (Frieden et al. 2015), in part, because many opportunities are not captured by traditional HIV

prevention surveillance due to reporting delays and trouble measuring specific timeframes of behavior in sentinel surveillance or health surveys (Ayers et al. 2014a, b).

Recent research discovered one such opportunity, which was coined the “Charlie Sheen effect”—finding Sheen’s public disclosure of his HIV-positive status corresponded with record levels of Web search activity from the public for HIV and HIV prevention (Ayers et al. 2016a, b). While that finding received widespread media attention and motivated Charlie Sheen, himself, to begin advocating for HIV prevention (LELO HEX 2016), it remains unclear whether Sheen’s disclosure had public health implications on HIV testing or, more generally, whether Web searches can be a sensor of traditional sentinel surveillance leading to rapid responses in the future.

Methods

Sales of OraQuick (www.oraquick.com), the only rapid in-home HIV test kit available in the USA, were monitored weekly—the finest temporal resolution available given retailer agreements—from April 12, 2014, to April 16, 2016. Using Google Trends (google.com/trends), searches including the terms “test,” “tests,” or “testing” and “HIV” originating from the USA were monitored and aggregated to match the weekly sales data.

First, we described trends in OraQuick sales around Sheen’s disclosure. Second, we compared observed sales to expected sales around Sheen’s disclosure. Expected sales were computed using Hyndman and Khandakar’s forecasting algorithm and data from all weeks preceding Sheen’s disclosure and then compared to observed sales the week of Sheen’s disclosure until the deviation was no longer significant using 10,000 boot-strapped forecasts, which in this case was 5 weeks later (Hyndman and Khandakar 2007). Third, we computed the World Aids Day 2014 effect, the largest HIV communication campaign, using the same strategy and compared the effect to Sheen’s disclosure. Finally, we assessed how Web search trends for HIV testing predicted OraQuick sales by calculating Pearson’s correlation coefficient (r), and root mean squared error (RMSE), from a simple linear regression using HIV testing Web searches to predict OraQuick sales. Analyses were computed using R Ver. 3.2.3.

Results

OraQuick sales reached record highs the week of Sheen’s disclosure (Fig. 1), increasing 95% (95% CI, 75–117; $p < 0.001$) that week and remained elevated for 4 weeks ($p = 0.018$). Excess OraQuick sales following Sheen’s disclosure were equivalent to about 7 World Aids Days. Sales of the week of World Aids Day increased 31% (95% CI, 12–46;

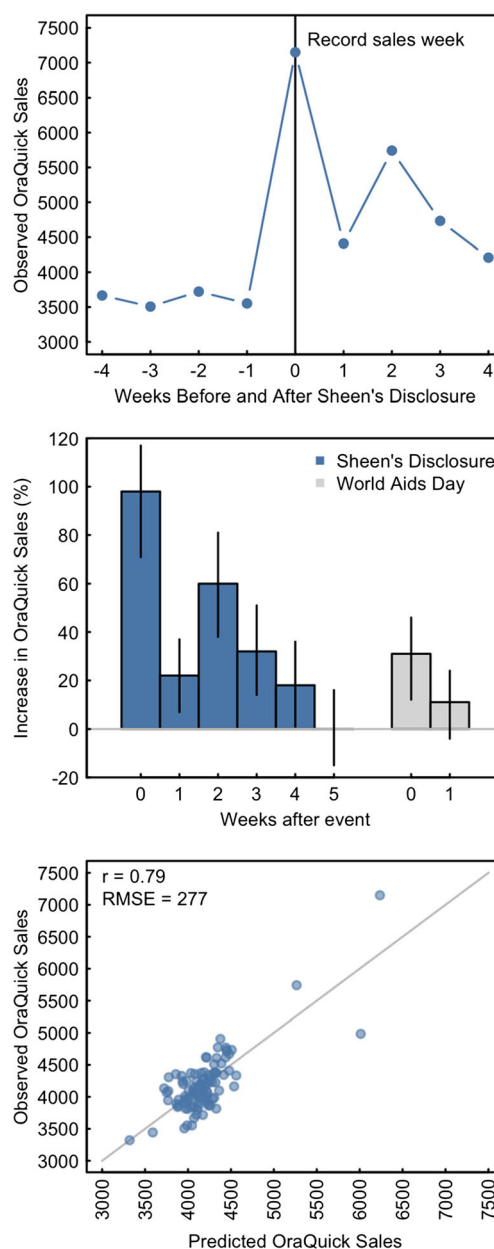


Fig. 1 Top panel shows weekly OraQuick sales focused around the Sheen disclosure. Middle panel shows the effect estimates for sales by week following Sheen’s disclosure and World Aids Day until the increase was no longer significant. Bottom panel shows observed weekly sales plotted alongside predicted weekly sales using HIV testing search volume

$p < 0.001$) but returned to expected levels the next week, representing 1122 more sales than expected versus 8225 excess sales around Sheen’s disclosure.

Over the entire time series (April 12, 2014, to April 16, 2016), the correlation between observed OraQuick sales and those predicted by Web search trends was $r = 0.79$. The RMSE suggests that knowing the search volume alone produces sales predictions with an average relative error rate within 7% (e.g., RMSE/mean sales). For instance, a prediction

of 5000 weekly sales based solely on search volume is within ± 350 of actual OraQuick sales.

Conclusions

Sheen's disclosure invigorated public engagement with HIV prevention, motivated record sales of rapid in-home HIV test kits, surpassed World Aids Day by a factor of about 7, and were validly predicted by Web search trends. Our new findings reinforce how celebrity can impact health decision-making (Ayers et al. 2014a, b; Noar et al. 2013) and make an even stronger case that Sheen's disclosure promoted HIV prevention, thanks to the availability of rapid in-home HIV testing. In particular, the public's health decisions are heavily influenced by public figures and reveal an opportunity for the prevention community to target health behaviors when related issues are widely publicized in the media (Hoffman and Tan 2013). The findings herein are relevant to earlier studies that suggest the use of concrete examples (i.e., an individual) compared to abstract examples (i.e., groups of people) can lead to deeper processing of information that persists over time (Anderson 1983), which is a condition indicative of guiding behavior (Krosnick and Petty 1995). Similarly, empathy is easier to motivate others when the empathy is targeted toward an individual versus a group (Cameron and Payne 2011). It is easy to imagine that a single individual, Sheen, disclosing his HIV status may be more compelling and motivating for people than an unnamed mass of individuals.

It is noteworthy that the Charlie Sheen effect was absent of any coordinated public health response, unlike some past celebrity events that were heavily coordinated. Instead, the public appeared to act on a consistent public health message that has become engrained in public consciousness: get tested (Sunguya et al. 2016). Had public health agencies echoed this message piggybacking on Sheen, how much larger could the effect had become, and is it still possible to promote the Charlie Sheen effect even now?

Prevention Implications

Looking beyond the case of Sheen's disclosure, our results suggest that concrete prevention outcomes such as HIV-testing sales can be presaged by Web searches building on earlier work in HIV research relying on big social media data (Young et al. 2017). Because Web search trends are publicly available in near real-time, these data provide substantial lead-time for experts to detect and amplify organic advocacy while

it is occurring in the field (Ayers et al. 2016a; Leas et al. 2016). Future events, such as celebrity health disclosures, might be translated into "teachable moments" that have public health benefit by mining and responding to changes in Web searches.

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Compliance with Ethical Standards

Funding None

Conflict of Interest Dr. Ayers and Dr. Althouse share an equity stake in Directing Medicine LLC that advises clinician-scientists how to implement some of the methods embodied in this work. Dr. Dredze has received consulting fees from Directing Medicine LLC and Sickweather LLC, who use social media for public health surveillance. Bloomberg LP provided salary support for authors [MD], but did not have any additional role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript. The company who provided testing data (OraSure) did not have any role in the study design, data analysis, decision to publish, or preparation of the manuscript. Neither the data nor the methods described in this article are proprietary. There are no other conflicts to be reported.

Ethical Approval This study did not involve human subjects but relied upon secondary data analysis of publicly available data.

Informed Consent Did not apply

References

- Anderson, C. A. (1983). Abstract and concrete data in the perseverance of social theories: When weak data lead to unshakeable beliefs. *Journal of Experimental Social Psychology*, *19*, 93–108.
- Ayers, J. W., Althouse, B. M., Noar, S. M., & Cohen, J. E. (2014a). Do celebrity cancer diagnoses promote primary cancer prevention? *Preventive Medicine*, *58*, 81–84.
- Ayers, J. W., Althouse, B. M., & Dredze, M. (2014b). Could behavioral medicine lead the web data revolution? *JAMA*, *311*, 1399–1400.
- Ayers, J. W., Althouse, B. M., Dredze, M., Leas, E. C., & Noar, S. M. (2016a). News and internet searches about human immunodeficiency virus after Charlie Sheen's disclosure. *JAMA Internal Medicine*, *176*, 552–554.
- Ayers, J. W., Westmaas, J. L., Leas, E. C., Benton, A., Chen, Y., Dredze, M., & Althouse, B. M. (2016b). Leveraging big data to improve health awareness campaigns: A novel evaluation of the Great American Smokeout. *JMIR public health and surveillance*, *2*.
- Cameron, C. D., & Payne, B. K. (2011). Escaping affect: How motivated emotion regulation creates insensitivity to mass suffering. *Journal of Personality and Social Psychology*, *100*, 1–15.
- Centers for Disease Control and Prevention. (2016). Trends in US HIV Diagnoses, 2005–2014. *Fact Sheet*: <http://www.cdc.gov/nchhstp/newsroom/docs/factsheets/hiv-data-trends-fact-sheet-508.pdf>.
- Frieden, T. R., Foti, K. E., & Mermin, J. (2015). Applying public health principles to the HIV epidemic—How are we doing? *New England Journal of Medicine*, *373*, 2281–2287.
- Hoffman, S. J., & Tan, C. (2013). Following celebrities' medical advice: Meta-narrative analysis. *BMJ*, *73*, 3.

- Hyndman, R.J., & Khandakar, Y. (2007). Automatic time series forecasting: The forecast package for R 7. 2008. URL: <https://www.jstatsoft.org/article/view/v027i03>.
- Krosnick, J. A., & Petty, R. E. (1995). Attitude strength: An overview. In R. E. Petty & J. A. Krosnick (Eds.), *Attitude strength: Antecedents and consequences* (pp. 1–24). Mahwah: Erlbaum.
- Leas, E. C., Althouse, B. M., Dredze, M., Obradovich, N., Fowler, J. H., Noar, S. M., & Ayers, J. W. (2016). Big data sensors of organic advocacy: The case of Leonardo DiCaprio and climate change. *PloS One*, *11*, e0159885.
- LELO HEX. (2016). Charlie Sheen talks condoms for LELo HEX | Youth is wasted on the young. URL <https://youtu.be/0iOOPY0pQf4>.
- Lin, F., Farnham, P. G., Shrestha, R. K., Mermin, J., & Sansom, S. L. (2016). Cost effectiveness of HIV prevention interventions in the US. *American Journal of Preventive Medicine*, *50*, 699–708.
- Noar, S. M., Ribisl, K. M., Althouse, B. M., Willoughby, J. F., & Ayers, J. W. (2013). Using digital surveillance to examine the impact of public figure pancreatic cancer announcements on media and search query outcomes. *Journal of the National Cancer Institute Monographs*, *2013*, 188–194.
- Sunguya, B. F., Munisamy, M., Pongpanich, S., Yasuoka, J., & Jimba, M. (2016). Ability of HIV advocacy to modify behavioral norms and treatment impact: A systematic review. *American Journal of Public Health*, *106*, e1–e8.
- Young, S. D., Yu, W., & Wang, W. (2017). Toward automating HIV identification: Machine learning for rapid identification of HIV-related social media data. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, *74*, S128–S131.