

COMMENTAIRE CRITIQUE / CRITICAL COMMENTARY (ÉVALUÉ PAR LES PAIRS / PEER-REVIEWED)

Health Misinformation and the Power of Narrative Messaging in the Public Sphere

Timothy Caulfield¹, Alessandro R. Marcon², Blake Murdoch², Jasmine M. Brown³, Sarah Tinker Perrault⁴, Jonathan Jarry⁵, Jeremy Snyder⁶, Samantha J. Anthony⁷, Stephanie Brooks⁸, Zubin Master⁹, Christen Rachul¹⁰, Ubaka Ogbogu¹¹, Joshua Greenberg¹², Amy Zarzeczny¹³, Robyn Hyde-Lay²

Résumé

De nombreuses pressions sociales, économiques et académiques peuvent avoir un impact négatif sur les représentations de la recherche biomédicale. Nous passons en revue plusieurs des éléments qui jouent un rôle de plus en plus pernicieux dans l'interprétation, le partage et l'utilisation de l'information sur la santé et les sciences; ce qui nous mène à nous intéresser au rôle du récit. Par conséquent, nous explorons comment les aspects narratifs sont utilisés dans divers contextes sociaux et environnements de communication, puis présentons des réponses novatrices susceptibles de contribuer à contrer les tendances négatives. Comme les méthodes de communication traditionnelles ont échoué à bien des égards auprès du public, des changements d'approche s'imposent, dont l'utilisation novatrice des récits.

Mots-clés

communication en santé, communication scientifique, réseaux sociaux, récit, santé publique

Abstract

Numerous social, economic, and academic pressures can have a negative impact on representations of biomedical research. We review several of the forces playing an increasingly pernicious role in how health and science information is interpreted, shared, and used, drawing discussions towards the role of narrative. In turn, we explore how aspects of narrative are used in different social contexts and communication environments, and present creative responses that may help counter the negative trends. As traditional methods of communication have in many ways failed the public, changes in approach are required, including the creative use of narratives.

Keywords

health communication, science communication, social media, narrative, public health

Introduction

There is growing recognition that numerous social, economic, and academic pressures can have a negative impact on representations of biomedical research. Empirical evidence indicates spin or interpretive bias is injected throughout the knowledge production process, including at the stage of grant writing, in the execution of the research, and in the production of the relevant manuscripts and institutional press releases [1-3]. The popular press, marketing forces, and online media also play significant roles in misrepresenting biomedical research [2,4-6]. Here, the wilful or unintended dissemination of misinformation through increasingly interactive media platforms also stands as a very real and growing concern [7,8] and presents a significant challenge to generating rational, evidence-based conversations about biomedicine generally, and its benefits and risks, in particular.

Exacerbating these forces, numerous trends have emerged which further complicate the science communication landscape, especially in the context of health. In this commentary, we review several of the forces playing an increasingly pernicious role in how information is interpreted, shared, and used. In particular, we focus on the role that narrative plays in communicating science and misinformation to explore how aspects of narrative are used in different social contexts and communication environments. While most people have an inherent understanding of storytelling, narrative has been defined as a type of communication that “describes the cause-and-effect relationships between events that take place over a particular time period that impact particular characters” [9]. Narrative is a powerful tool that can enhance engagement and understanding of both truths and falsehoods [10]. Online, and specifically in the context of misinformation (e.g., conspiracy narratives, pseudoscience), research has shown that the construction and dissemination of narratives requires the efforts of numerous participants with differing levels of engagement [11]. It is dynamic, incorporating numerous discursive elements (multiple sources, hashtags, hyperlinks, memes, etc.) as well as flexible, adopting and discarding both story elements and participants as time passes [11].

This commentary is not meant to be a comprehensive survey of emerging health communication developments or an exhaustive account of the role that narrative plays in that context. While many of the concerns and ideas presented herein are broadly relevant across many jurisdictions with advanced communication infrastructures, our focus is on the United States and Canada. We highlight elements that have increasingly troubled health communication in recent times and present creative responses that may help counter the negative trends. Indeed, as we will see, traditional methods of communication have in many ways failed the public, and changes in approach are required.

Online Communities

Much has been written about the growing influence of social media on public discourse, including in the context of health [12]. While traditional news outlets, such as newspapers, remain the dominant source of science information [13], social media platforms – including Facebook, Twitter, Instagram, YouTube and Reddit – have become important sources of health information and sites for public engagement and community-building [14-18]. Studies show younger generations are increasingly willing to share personal health information online, and people of all generations increasingly go online to seek



others with similar health concerns or conditions for information and support [19]. All age groups in North America use social media heavily [20,21], so the influence of social networking platforms will continue to be significant.

We know, however, that the health and science information on these platforms is often problematic [22,23]. Research has found, for example, that social media are used to spread harmful health messages, including, to cite just a few examples, antivaccine rhetoric [24,25], misinformation about the Zika virus [26] and Lyme disease [27], as well as Ebola-related prevention and treatment strategies [28]. Studies have also shown that falsehoods can diffuse “farther, faster, deeper and more broadly” than the truth [29], and while notions of the “echo chamber” might be overstated [17,30], online environments do exhibit polarization characteristics where misinformation can spread virally [31].

Social media also clearly affects bioscience communication, and this influences not only the general public’s understanding of health and science information but also research funding allocation and policy development [32-34]. Clinicians, scientists and funding institutions can all experience pressure to fund research or change policy in response to social media advocacy. For example, roughly 10 years ago a large online community advocated in Canada for an unproven and scientifically implausible intervention for multiple sclerosis called “liberation therapy”, based on anecdotal evidence that it could generate life-altering improvements for people afflicted by the condition [32]. This pressure led the Canadian Institutes of Health Research in 2010 to convene an expert panel on the topic [32,33], and allocate funds to conduct research, the resulting data of which showed the treatment to be ineffective [35].

Social media consists of diverse communication ecosystems, shaped by the algorithmic logistics of each particular platform. A core component shared by these ecosystems is “social homophily”: how people more commonly associate and are more influenced by those similar to themselves [14,18,36,37]. The clustering of individuals online into various communities highlights the role that algorithms as well as public intellectuals, celebrities, or influencers can play in knowledge transmission [38-42]. In more contentious social contexts, sharp divisions can emerge between various groups, resulting in the creation of “discourse coalitions” [43,44], where communal terms and arguments are used to promote perspectives [45-48]. Here, heuristics such as confirmation bias [49] and information avoidance [50] work towards enforcing rather than questioning established beliefs. Research has shown there is polarization between antagonistic discourse communities [37,48,51], raising questions about how to transmit accurate information through groups with differing perspectives [37,48,52]. This matter is becoming increasingly complicated with the rise of misinformation, or “fake news” [52,53]. Research has also shown that fake news affects everyone – even those who know the information to be false [54]. Indeed, mere exposure to information can influence belief [55] and repeated exposures can strengthen perceptions of authenticity [56,57]. Online bots (software robots) are also playing a role by taking advantage of platforms’ algorithms to promote particular stories, events or narratives, drown out others, and influence online social ecosystems [52,58,59]. Continued research of online discourse is required, including on platforms such as Instagram, Reddit, YouTube, and blogs. These popular spaces exhibit novel and powerful uses of narrative and pose numerous methodological challenges, requiring collaborative interdisciplinary approaches.

A growing body of literature suggests that narratives can have tremendous sway. Across disciplines, studies have shown how narratives facilitate recall [9,60] and spur emotional responses [61-65], which in turn can increase empathy [9,60,62] and perceptions of a source’s trustworthiness [66,67]. Narratives therefore possess some power of persuasion [66,68,69], whether that be to solidify one’s membership in a particular identity group [60,69] or merely to draw one towards a particular perspective [68]. Recent research has shown how misinformation, and even credible information interpreted and then skewed in a particular manner, can serve as a means of substantiating a particular narrative [11]. As a result, a narrative can gain strength from the supportive “evidence” it creates and draws upon [11]. Social media platforms have become powerful tools for sharing narratives about therapies [70], experiences [71] and emerging science. Social media also allows individuals to form parasocial relationships [72], which may heighten the influence of messaging [73] and strengthen social homophily. Indeed, research has noted that “a person like you” is just as credible a source of information as an academic or technical expert [74].

Not all participation in online communities is necessarily negative. Research has shown how interactive online networks can help to connect individuals seeking similar health information or dealing with similar conditions. Benefits from this connectivity include sharing information and receiving support, which in turn can help individuals consider health strategies or treatment options, build social networks, cope with depression, and overcome social stigma [16,19,75,76]. For example, Mumsnet.com, based in the UK, has approximately 5 million monthly visitors, who use the website to discuss a range of motherhood topics including miscarriage and breastfeeding [75]. On the platform [patientslikeme](https://www.patientslikeme.com)®, with over 600,000 members with nearly 3,000 different conditions, 30% of patients with epilepsy did not know someone with epilepsy prior to using the site [75]. Research has also shown that on a general non-health specific platform like Instagram, women congregate around breastfeeding related hashtags and images, creating supportive networks [77]. Questions remain, however, around the accuracy of information, especially when highly-personal narratives are generated and circulated [63]. Specifically in the case of vaccines, it is now well-known that anti-vaccination perspectives exist and are propagated through social media sites like YouTube and Facebook, the latter of which includes organized groups dedicated to this cause [78-81].

Implicit Hype and “Scienceploitation”

The phenomenon of science hype – the exaggeration or excessive promotion of scientific developments and applications – is getting more attention from the scientific community [82,83] and popular media [84]. The sources of this hype are complex and

interrelated, and they exist throughout the knowledge production pipeline [2]. Science hype can cause a range of social issues, including, *inter alia*, eroding public trust [83], confusing policy debates [35], and facilitating the premature implementation of technologies and the marketing of unproven therapies [85,86]. While the problems with explicit hype are increasingly recognized, we are now seeing the growth of a more subtle form of hype.

The popular press, for example, sometimes presents emerging therapies in a manner that implies efficacy [87]. This “implicit hype” occurs when unproven or even disproven interventions are presented as routine and/or uncontroversial in media reports. For example, recent research about the media portrayal of platelet rich plasma (PRP), an unproven therapy for various ailments including musculoskeletal injuries, found that it was most commonly covered in sports-related stories, and specifically in relation to elite athletes using the therapy as part of injury recovery or performance preparation [87]. The therapy was portrayed as routine, and its use by elite athletes may imply that it is a cutting edge treatment [87]. But given the actual state of research surrounding PRP [88,89], these representations are implicit hype. These stories may have significant sway with the public as they combine high exposure (a story about a professional athlete in popular media), an interesting narrative (an athlete recovering from injury), and a suggestion that an emerging therapy is efficacious. Since narrative communication is persuasive, this implicit hype may be more resonant with most audiences than typical communications about the unproven nature of a therapy.

Another issue is that of pseudoscience, that is to say theories, assertions or interventions that claim or appear to be scientific but are not. Pseudoscientific phraseology is too often accepted in popular media without any critical reflection. A recent study of Spanish science journalists found that only 44.9% agreed that pseudoscientific information in the media is dangerous, with many respondents dismissing concern or expressing apathy as to the effects of false messaging in the media [90]. Journalistic apathy concerning the distinction between science and pseudoscience can only further hinder public understanding of novel health or biomedical developments, especially in cases where the public only has basic knowledge about the topic at hand.

There are also explicit marketing strategies that leverage hype. Recent research has shown, for example, that some complementary and alternative medicine (CAM) providers combine hype and stem cell language in their marketing for both unproven stem cell therapies and other pseudoscientific products and therapies [91]. For instance, the language of quantum physics [92], genetics [93], and microbiome research [94] have been used to market therapies that have not been scientifically tested. By capturing the interest around the scientific domain of stem cells, marketers can increase the attractiveness of, and exposure to, their products – even if they have no actual relation to stem cells. This phenomenon, which we call “scienceploitation”, occurs in many contexts but is understudied [91]. Because this type of misrepresentation uses language that can confer scientific legitimacy, it can be particularly difficult to address, especially if it is accompanied by other tokens of legitimacy (e.g., reference to publications in predatory journals or registered clinical trials) [95] and is part of a broader, memorable narrative.

Patients in the Public Sphere

Patients are also harnessing the power of the narrative to promote public awareness, build community and raise money and a profile for certain therapies. For example, the use of online crowdfunding has recently grown at an explosive rate [96,97]. Health related crowdfunding has proven to be a highly competitive affair, and campaign leaders often attempt to construct “worthy bodies” that justify or morally compel donation [98]. In this way, the creation of powerful and compelling narratives is a key aspect of successful crowdfunding [99-101]. A similar effect can occur with public solicitation for organ donation, where patients can be judged not only on their personal appearance but also the biographical narratives they create to engender sympathy [102,103].

Narratives often include information about the interventions sought and their efficacy, creating problems when these interventions are unproven or pseudoscientific. Indeed, recent research has shown that the narratives of crowdfunding campaigns for unproven stem cell therapies “underemphasize risks”, “exaggerate the efficacy” and “convey potentially misleading messages about stem-cell based interventions” [104].

These examples show another way in which persuasive narratives can mislead. Marketing can extend into the personal narratives of individuals seeking aid, as campaigns often propagate the marketing language of the clinics where treatment is sought [104]. This can act as a legitimizing force for unproven interventions, and legitimacy is subsequently reinforced when popular media outlets publish uncritical human-interest stories about such campaigns [105].

Policy Options

As noted, science communication is happening in the context of a research translation process prone to hype [2], a media environment rife with ambiguity and false balance [106-108], and an online environment marred by inaccurate news [52,53]. Meanwhile, the potential sway of the misinformation is often heightened by the use of engaging narratives. These forces add to the complexity of crafting effective, evidence-based policy responses. Complicating things further is the reality that not all audiences are affected by narratives in the same manner or to the same degree. Some research has shown, for example, that audiences engaging a topic peripherally are more likely to find testimonials more convincing and persuasive than those highly motivated to engage the topic and analyze the information [109]. With a wide range of audiences encountering numerous and

diverse topics in popular media at any given time, the role of narrative is likely having some impact on how the public makes sense of biomedical issues – particularly in the contexts of nascent, developing science and health topics about which little is known.

Addressing the spread of misinformation through persuasive narratives seems essential, though it will not be easy. Many of the entities that twist information operate over the Internet. When online sources and communities come under fire, they can quickly and easily spring up in a new form elsewhere. The law can be an unwieldy, slow and overly blunt tool in the face of amorphous messaging and shifting actors. Still, existing legal and regulatory tools can have important roles to play in the right contexts. We must better enforce existing truth in advertising law, which can act to curb misrepresentations in marketing and the proliferation of unproven and disproven treatments [85,91,110]. Given this is a complaint driven regulatory framework, non-profit organizations and individuals can play an important role, as we have seen, for example, with recent claims of false advertising made against Goop by the non-profit group Truth in Advertising [111]. The law of negligent and fraudulent misrepresentation is also useful for all manner of claims that are false and relied upon [112]. And when health care professionals are involved, as is often the case [113], governing regulatory bodies should take steps against members who breach practice norms through the provision of misleading information [114,115].

Despite these useful avenues, law and policy have limits. They can be slow, expensive, and, when government action is needed, constrained by political considerations. As such, more informal policy responses should also be considered. Individual public advocacy, at both the grassroots level and among prominent experts, can have a significant effect [116-118]. For example, David Stephan, whose son died of meningitis in 2016 after his parents treated him solely with “natural remedies”, was removed as a keynote speaker from a wellness exposition in Western Canada after backlash on Twitter caused many corporate event sponsors to threaten to pull out if he was left on the program [119]. One important aspect of this success story was the timeliness of the critical response online. Real time social media interventions that rapidly counter misinformation are needed to ensure that belief systems founded on misinformation do not take hold [25]. Codified standards, norms, and guidelines in the scientific community defining appropriate media engagement – as some scientific societies have begun to develop [120] – are imperative to encourage a sense of responsibility to engage with and correct misinformation in the public sphere. Further, influential and reputable voices from various communities need to persistently encourage responses from powerful social media platforms regarding their influential role in information dissemination [121]. Some positive responses from platforms are already evident [81,122,123], but these need continual monitoring. It also necessary for public health initiatives to move beyond the monitoring of online communities and begin developing ways to engage effectively with them, especially those existing on established and popular platforms outside of traditional public health institutions and practices.

Importantly, it should also be possible to use a narrative communication style to improve public understanding of evidence-based medicine, both through social media and more traditional avenues. To do so effectively will require health and science communicators to recognize the important research around “virality” [124-126] in terms of both information dissemination and interaction with platform algorithms, and to design communication strategies that use these findings to their benefit. Examples of this type of messaging are already evident [127] and can be drawn upon to experiment with new approaches. Further, scientists and science communicators new to social media should learn tactics and strategies from successful colleagues. The power of social media and the impact of narrative are prevalent and strong, so there is an imperative to strategically draw upon their advantages to counter some of their more problematic applications. For example, research has shown that narratives presenting the ramifications of not vaccinating – specifically children’s suffering from preventable illness – can have a real impact on intention to vaccinate [128,129]. Additionally, clear and definitive statements with a narrative component, made by respected and trusted voices will prove highly useful, and also provide dependable resources upon which journalists can rely.

Opinion editorials offer another useful pathway for narrative communication; indeed, recent research has found them to have an influence on public perception [130]. That said, science writing could also benefit from narrative style, if applied in a manner that does not compromise the truthfulness and comprehensiveness of the content [131]. We should not use narratives to fight anecdote with anecdote. Rather, narratives can serve as a vehicle not only to communicate science and relevant science-informed policy in a more engaging and digestible manner but to foster an understanding around “the process and credibility of scientific reasoning” [132]. The spread of misinformation causes real harm. Unfortunately, countering this noise is growing increasingly more complex and challenging. It will require the use of a host of science communication tools and strategies, including the creative use of narratives.

Policy and communication responses

Legal and Policy tools

- Better enforcement of existing truth in advertising law, and/or improvements thereto
- Regulatory policy change and enforcement for health professionals spreading misinformation
- Policy outlining rules for and encouraging expert media engagement and the use of narrative
- Litigation

Social Tools

- Advocacy by non-profit organizations (e.g., litigation against Goop)
- Advocacy by individuals (official complaints, social media activism)
- Expert engagement in the popular press and on social media to counter misinformation
- Encouragement of social media companies to combat misinformation by modifying platforms
- Opinion editorials
- Use of creative communication strategies that utilize narratives, art, video, etc.
- Support and adoption of further research on effective communication strategies

Remerciements

Les auteurs aimeraient remercier *Alberta Innovates – Health Solutions*, *Génome Canada*, *Genome Alberta*, les Instituts de recherche en santé du Canada, la Fondation canadienne du rein et le Réseau de cellules souches pour leur généreux soutien envers les projets suivants : *PACE-Omics: Personalized, Accessible, Cost Effective Applications of Omics Technologies*; *The Canadian National Transplant Research Program: Increasing Donation and Improving Transplantation Outcomes*; *Stem Cells and Misleading Marketing Claims*; *The Next Step: Specific Steps for Addressing the Marketing of Unproven Stem Cell Therapies*, qui ont tous appuyé le contenu de cette publication. De plus, les auteurs tiennent à remercier tous les participants qui ont assisté et pris part à l'atelier suivant : *Mapping the Emerging Issues in the Public Representation of Bioscience and Health Issues*: David Hartell, Lori West, Mike Spear, Morgan Barber et Evan Horbay.

Conflicts d'intérêts

Zubin Master est un éditeur de la *Revue canadienne de bioéthique*. Il n'a pas participé à l'évaluation ni à la révision de ce manuscrit.

Responsabilités des évaluateurs externes

Les recommandations des évaluateurs externes sont prises en considération de façon sérieuse par les éditeurs et les auteurs dans la préparation des manuscrits pour publication. Toutefois, être nommé comme évaluateur n'indique pas nécessairement l'approbation de ce manuscrit. Les éditeurs de la *Revue canadienne de bioéthique* assument la responsabilité entière de l'acceptation finale et de la publication d'un article.

Édition/Editors: Ezio Di Nucci & Aliya Afddal

Évaluation/Peer-Review: Joseph Ali

Affiliations

¹ Health Law Institute, Faculty of Law; School of Public Health, University of Alberta, Edmonton, Canada

² Health Law Institute, Faculty of Law, University of Alberta, Edmonton, Canada

³ Institute of Health Economics; Department of Psychiatry, University of Alberta, Edmonton, Canada

⁴ University Writing Program, University of California, Davis, United States of America

⁵ Office for Science and Society, McGill University, Montreal, Canada

⁶ Faculty of Health Sciences, Simon Fraser University, Burnaby, Canada

⁷ The Hospital for Sick Children; Canadian National Transplant Research Program, Toronto, Canada

⁸ Department of Pediatrics, Faculty of Medicine, University of Alberta, Edmonton, Canada

⁹ Biomedical Ethics Research Program, Mayo Clinic, Rochester, United States of America

¹⁰ Rady Faculty of Health Sciences, University of Manitoba, Winnipeg, Canada

¹¹ Faculty of Law; Faculty of Pharmacy and Pharmaceutical Sciences, University of Alberta, Edmonton, Canada

¹² School of Journalism and Communication, Faculty of Communication and Media Studies, Carleton University, Ottawa, Canada

¹³ Johnson Shoyama Graduate School of Public Policy, University of Regina, Regina, Canada

Correspondance / Correspondence: Timothy Caulfield, caulfield@ualberta.ca

Reçu/Received: 30 Nov 2018 **Publié/Published:** 24 May 2019

Les éditeurs suivent les recommandations et les procédures décrites dans le [Code of Conduct and Best Practice Guidelines for Journal Editors](#) de COPE. Plus précisément, ils travaillent pour s'assurer des plus hautes normes éthiques de la publication, y compris l'identification et la gestion des conflits d'intérêts (pour les éditeurs et pour les auteurs), la juste évaluation des manuscrits et la publication de manuscrits qui répondent aux normes d'excellence de la revue.

Acknowledgements

The authors would like to thank *Alberta Innovates – Health Solutions*, *Genome Canada*, *Genome Alberta*, the Canadian Institutes of Health Research, the Kidney Foundation of Canada, and the Stem Cell Network for their generous support of the following projects: *PACE-Omics: Personalized, Accessible, Cost Effective Applications of Omics Technologies*, *The Canadian National Transplant Research Program: Increasing Donation and Improving Transplantation Outcomes*, *Stem Cells and Misleading Marketing Claims*, *The Next Step: Specific Steps for Addressing the Marketing of Unproven Stem Cell Therapies*, all of which supported the event and contents of this publication. Additionally the authors would like to thank all the participants that attended and participated in *Mapping the Emerging Issues in the Public Representation of Bioscience and Health Issues*: David Hartell, Lori West, Mike Spear, Morgan Barber, and Evan Horbay.

Conflicts of Interest

Zubin Master is an Editor at the *Canadian Journal of Bioethics*. He was not involved in the evaluation nor the review of this manuscript.

Peer-reviewer responsibilities

Reviewer evaluations are given serious consideration by the editors and authors in the preparation of manuscripts for publication. Nonetheless, being named as a reviewer does not necessarily denote approval of a manuscript; the editors of [Canadian Journal of Bioethics](#) take full responsibility for final acceptance and publication of an article.

The editors follow the recommendations and procedures outlined in the COPE [Code of Conduct and Best Practice Guidelines for Journal Editors](#). Specifically, the editors will work to ensure the highest ethical standards of publication, including: the identification and management of conflicts of interest (for editors and for authors), the fair evaluation of manuscripts, and the publication of manuscripts that meet the journal's standards of excellence.

References

1. Boutron I, Ravaud P. [Misrepresentation and distortion of research in biomedical literature](#). Proceedings of the National Academy of Sciences. 2018;115(11):2613-9.
2. Caulfield T, Condit C. [Science and the sources of hype](#). Public Health Genomics. 2012;15(3-4):209-17.
3. Yavchitz A, Boutron I, Bafeta A, Marroun I, Charles P, Mantz J, Ravaud P. [Misrepresentation of randomized controlled trials in press releases and news coverage: a cohort study](#). PLoS medicine. 2012;9(9):e1001308.
4. Kamenova K, Reshef A, Caulfield T. [Angelina Jolie's faulty gene: newspaper coverage of a celebrity's preventive bilateral mastectomy in Canada, the United States, and the United Kingdom](#). Genetics in Medicine. 2014;16(7):522-28.
5. Turner L, Knoepfler P. [Selling stem cells in the USA: assessing the direct-to-consumer industry](#). Cell Stem Cell. 2016;19(2):154-7.
6. van Atteveldt NM, van Aalderen-Smeets SI, Jacobi C, Ruigrok N. [Media reporting of neuroscience depends on timing, topic and newspaper type](#). PLOS One. 2014;9(8):e104780.
7. Anderson J, Rainie, L. [The future of truth and misinformation online](#). Pew Research Center. 2017 Oct 19.
8. Edelman. [2018 Edelman Trust Barometer Global Report](#). 2018.
9. Dahlstrom MF. [Using narratives and storytelling to communicate science with nonexpert audiences](#). Proceedings of the National Academy of Sciences. 2014;111(Suppl 4):13614-20.
10. Glaser M, Garsoffky B, Schwan S. [Narrative-based learning: Possible benefits and problems](#). Communications. 2009;34(4):429-47.
11. Introne J, Gokce Yildirim I, Iandoli L, DeCook J, Elzeini S. [How people weave online information into pseudoknowledge](#). Social Media + Society. 2018; DOI:2056305118785639.
12. Smailhodzic E, Hooijsma W, Boonstra A, Langley DJ. [Social media use in healthcare: a systematic review of effects on patients and on their relationship with healthcare professionals](#). BMC Health Services Research. 2016;16(1):442.
13. Funk C, Gottfried J, Mitchell A. [Science News and Information Today](#). Pew Research Center. 2017 Sept 20.
14. Centola D. [The spread of behavior in an online social network experiment](#). Science. 2010;329(5996):1194-7.
15. De Choudhury M, De S. [Mental health discourse on Reddit: self-disclosure, social support, and anonymity](#). Proceedings of the Eighth International AAAI Conference on Weblogs and Social Media. 2014 Jun 1.
16. De Choudhury M, Morris MR, White RW. [Seeking and sharing health information online: comparing search engines and social media](#). Proceedings of the SIGCHI conference on human factors in computing systems. 2014 Apr 26;1365-1376.
17. Flaxman S, Goel S, Rao JM. [Ideological segregation and the effects of social media on news consumption](#). SSRN. 2013.
18. Guilbeault D, Becker J, Centola D. Complex contagions: A decade in review. In: Lehmann S, Ahn YY, eds. Complex Spreading Phenomena in Social Systems. Cham: Springer, 2018. p. 3-25.
19. Graham AL, Cobb CO, Cobb NK. The internet, social media, and health decision-making. In: Diefenbach MA, Miller-Halegoua S, Bowen DJ, eds. Handbook of Health Decision Science. New York: Springer, 2016. p. 335-55.
20. Gruzd A, Jacobson J, Mai P, Dubois E. [The state of social media in Canada 2017](#). Version: 1.0. Ryerson University Social Media Lab. SSRN. 2018 Apr 30.
21. Smith A, Anderson M. [Social media use in 2018](#). Pew Research Center. 2018 Mar 1.
22. Antheunis ML, Tates K, Nieboer TE. [Patients' and health professionals' use of social media in health care: motives, barriers and expectations](#). Patient Education and Counseling. 2013;92(3):426-31.
23. Madathil KC, Rivera-Rodriguez AJ, Greenstein JS, Gramopadhye AK. [Healthcare information on YouTube: a systematic review](#). Health Informatics Journal. 2015;21(3):173-94.
24. Dunn AG, Leask J, Zhou X, Mandl KD, Coiera E. [Associations between exposure to and expression of negative opinions about human papillomavirus vaccines on social media: an observational study](#). Journal of Medical Internet Research. 2015;17(6):e144.
25. Tomeny TS, Vargo CJ, El-Toukhy S. [Geographic and demographic correlates of autism-related anti-vaccine beliefs on Twitter, 2009-15](#). Social Science & Medicine. 2017;191:168-75.
26. Sharma M, Yadav K, Yadav N, Ferdinand KC. [Zika virus pandemic—analysis of Facebook as a social media health information platform](#). American Journal of Infection Control. 2017;45(3):301-2.
27. Basch CH, Mullican LA, Boone KD, Yin J, Berdnik A, Eremeeva ME, Fung IC. [Lyme disease and YouTubeTM: A cross-sectional study of video contents](#). Osong Public Health and Research Perspectives. 2017;8(4):289-92.
28. Oyeyemi SO, Gabarron E, Wynn R. [Ebola, Twitter, and misinformation: a dangerous combination?](#) BMJ. 2014;349:g6178.
29. Vosoughi S, Roy D, Aral S. [The spread of true and false news online](#). Science. 2018;359(6380):1146-51.
30. Dubois E, Blank G. [The echo chamber is overstated: the moderating effect of political interest and diverse media](#). Information, Communication & Society. 2018;21(5):729-45.
31. Del Vicario M, Bessi A, Zollo F, Petroni F, Scala A, Caldarelli G, Stanley HE, Quattrociocchi W. [The spreading of misinformation online](#). Proceedings of the National Academy of Sciences. 2016;113(3):554-9.
32. Chafe R, Born KB, Slutsky AS, Laupacis A. [The rise of people power](#). Nature. 2011;472(7344):410-11.
33. Pullman D, Zarzeczny A, Picard A. [Media, politics and science policy: MS and evidence from the CCSVI trenches](#). BMC Medical Ethics. 2013;14(1):6.
34. Diresta R, Lotan G. [Anti-vaxxers are using Twitter to manipulate a vaccine bill](#). Wired. 2015 June 8.

35. Traboulee AL, Machan L, Girard JM, Raymond J, Vosoughi R, Hardy BW, Emond F, Garipey JL, Bone JN, Siskin G, Klass D. [Safety and efficacy of venoplasty in MS: A randomized, double-blind, sham-controlled phase II trial](#). *Neurology*. 2018;91(18):e1660-8.
36. McPherson M, Smith-Lovin L, Cook JM. [Birds of a feather: Homophily in social networks](#). *Annual Review of Sociology*. 2001;27(1):415-44.
37. Sunstein CR. *#Republic: Divided democracy in the age of social media*. Princeton: Princeton University Press; 2018.
38. Caulfield T. *Is Gwyneth Paltrow Wrong About Everything?: When Celebrity Culture and Science Clash*. Toronto: Penguin Canada; 2015.
39. Freberg K, Graham K, McGaughey K, Freberg LA. [Who are the social media influencers? A study of public perceptions of personality](#). *Public Relations Review*. 2011;37(1):90-2.
40. Khamis S, Ang L, Welling R. [Self-branding, 'micro-celebrity' and the rise of social media influencers](#). *Celebrity Studies*. 2017;8(2):191-208.
41. Muchnik L, Aral S, Taylor SJ. [Social influence bias: A randomized experiment](#). *Science*. 2013;341(6146):647-51.
42. Striphas T. [Algorithmic culture](#). *European Journal of Cultural Studies*. 2015;18(4-5):395-412.
43. Hajer MA. Discourse coalitions and the institutionalization of practice: the case of acid rain in Great Britain. In Fischer F, Forester J., eds. *The Argument Turn in Policy Analysis and Planning*. Routledge; 1994/2002, p. 51-84.
44. Metzger T, Dodge J. [Dynamic discourse coalitions on hydro-fracking in Europe and the United States](#). *Environmental Communication*. 2016;10(3):365-79.
45. Attwell K, Smith DT, Ward PR. ['The Unhealthy Other': How vaccine rejecting parents construct the vaccinating mainstream](#). *Vaccine*. 2018;36(12):1621-6.
46. Marcon AR, Caulfield T. [Commenting on chiropractic: A YouTube analysis](#). *Cogent Medicine*. 2017;4(1) DOI: 10.1080/2331205X.2016.1277450.
47. Smart G. Argumentation across Web-based organizational discourses: The case of climate change. In Candlin CN, Sarangi S, eds. *Handbook of Communication in Organisations and Professions*. Berlin/Boston: De Gruyter Mouton; 2011. p. 363-86.
48. Yardi S, Boyd D. [Dynamic debates: An analysis of group polarization over time on twitter](#). *Bulletin of Science, Technology & Society*. 2010;30(5):316-27.
49. Stanovich KE, West RF. [Individual differences in reasoning: Implications for the rationality debate?](#). *Behavioral and brain sciences* 2000; 23(5):645-65.
50. Golman R, Hagmann D, Loewenstein G. [Information avoidance](#). *Journal of Economic Literature*. 2017;55(1):96-135.
51. Schmidt AL, Zollo F, Scala A, Betsch C, Quattrocioni W. [Polarization of the vaccination debate on Facebook](#). *Vaccine*. 2018;36(25):3606-12.
52. Lazer DM, Baum MA, Benkler Y, Berinsky AJ, Greenhill KM, Menczer F, Metzger MJ, Nyhan B, Pennycook G, Rothschild D, Schudson M. [The science of fake news](#). *Science*. 2018;359(6380):1094-6.
53. Silverman C. [This analysis shows how viral fake election news stories outperformed real news on Facebook](#). *Buzzfeed*. 2016 Nov 16.
54. Fazio LK, Brashier NM, Payne BK, Marsh EJ. [Knowledge does not protect against illusory truth](#). *Journal of Experimental Psychology: General*. 2015;144(5):993-1002.
55. Jolley D, Douglas KM. [The effects of anti-vaccine conspiracy theories on vaccination intentions](#). *PloS One*. 2014;9(2):e89177.
56. Henkel LA, Mattson ME. [Reading is believing: The truth effect and source credibility](#). *Consciousness and Cognition*. 2011;20(4):1705-21.
57. Pennycook G, Cannon T, Rand DG. [Prior exposure increases perceived accuracy of fake news](#). *Journal of Experimental Psychology: General*. 2018;147(12):1865-1880.
58. Ferrara E, Varol O, Davis C, Menczer F, Flammini A. [The rise of social bots](#). *Communications of the ACM*. 2016;59(7):96-104.
59. McKelvey F, Dubois E. [Computational propaganda in Canada: The use of political bots](#). *The Computational Propaganda Project Working Paper Series. Working Paper No.2017.6*; 2017.
60. Neimand A. [How to tell stories about complex issues](#). *Stanford Social Innovation Review*. 2018 May 7.
61. Aldama FL. [The science of storytelling: Perspectives from cognitive science, neuroscience, and the humanities](#). *Projections*. 2015;1:80-95.
62. Barraza JA, Zak PJ. [Empathy toward strangers triggers oxytocin release and subsequent generosity](#). *Annals of the New York Academy of Sciences*. 2009;1167(1):182-9.
63. Morgan SE, Movius L, Cody MJ. [The power of narratives: The effect of entertainment television organ donation storylines on the attitudes, knowledge, and behaviors of donors and nondonors](#). *Journal of Communication*. 2009;59(1):135-51.
64. Yoo JH, Kreuter MW, Lai C, Fu Q. [Understanding narrative effects: The role of discrete negative emotions on message processing and attitudes among low-income African American women](#). *Health communication* 2014; 29(5):494-504.
65. Zak PJ. [Why inspiring stories make us react: The neuroscience of narrative](#). *Cerebrum*. 2015 Jan-Feb; 2015:2.
66. Cialdini RB. *Influence: The psychology of persuasion*. New York: William Morrow and Company; 1993.
67. Farmer H, McKay R, Tsakiris M. [Trust in me: Trustworthy others are seen as more physically similar to the self](#). *Psychological Science*. 2014;25(1):290-2.

68. Braddock K, Dillard JP. [Meta-analytic evidence for the persuasive effect of narratives on beliefs, attitudes, intentions, and behaviors](#). *Communication Monographs*. 2016;83(4):446-67.
69. Jones M, Crow D. [How can we use the 'science of stories' to produce persuasive scientific stories?](#). *Palgrave Communications*. 2017;3(1):53.
70. Du L, Rachul C, Guo Z, Caulfield T. [Gordie Howe's "miraculous treatment": Case study of Twitter users' reactions to a sport celebrity's stem cell treatment](#). *JMIR Public Health and Surveillance*. 2016;2(1):e8.
71. Han J, Wiley J. [Digital illness narratives: a new form of health communication](#). *Transactions of the International Conference on Health Information Technology Advancement*. 2013;18.
72. Yuksel M, Labrecque LI. ["Digital buddies": Parasocial interactions in social media](#). *Journal of Research in Interactive Marketing*. 2016;10(4):305-20.
73. Chung S, Cho H. [Fostering parasocial relationships with celebrities on social media: Implications for celebrity endorsement](#). *Psychology & Marketing*. 2017;34(4):481-95.
74. Edelman. [2017 Edelman Trust Barometer](#). 2017.
75. Griffiths F, Dobermann T, Cave JA, Thorogood M, Johnson S, Salamatian K, Gomez Olive FX, Goudge J. [The impact of online social networks on health and health systems: a scoping review and case studies](#). *Policy & Internet*. 2015;7(4):473-96.
76. Setoyama Y, Yamazaki Y, Namayama K. [Benefits of peer support in online Japanese breast cancer communities: differences between lurkers and posters](#). *Journal of Medical Internet Research*. 2011;13(4):e122.
77. Marcon AR, Bieber M, Azad MB. [Protecting, promoting, and supporting breastfeeding on Instagram](#). *Maternal & Child Nutrition*. 2019;15(1):e12658.
78. Bessi A, Zollo F, Del Vicario M, Puliga M, Scala A, Caldarelli G, Uzzi B, Quattrociocchi W. [Users polarization on Facebook and Youtube](#). *PloS One*. 2016;11(8):e0159641.
79. Evrony A, Caplan A. [The overlooked dangers of anti-vaccination groups' social media presence](#). *Human Vaccines & Immunotherapy*. 2017;13(6):1475.
80. Pilkington E, Glenza J. [Facebook under pressure to halt rise of anti-vaccination groups](#). *The Guardian*. 2019 Feb 12.
81. Matsakis L. [Facebook will crack down on anti-vaccine content](#). *Wired*. 2019 Mar 7.
82. Marcon AR, Bieber M, Caulfield T. [Representing a "revolution": how the popular press has portrayed personalized medicine](#). *Genetics in Medicine*. 2018;20:950-956.
83. Master Z, Resnik DB. [Hype and public trust in science](#). *Science and Engineering Ethics*. 2013;19(2):321-35.
84. Wetsman N. [When splashy headlines become the goal of science, the process suffers](#). *Popular Science*. 2018 Mar 5.
85. Caulfield T, Sipp D, Murry CE, Daley GQ, Kimmelman J. [Confronting stem cell hype](#). *Science*. 2016;352(6287):776-7.
86. Petersen A, Krisjansen I. [Assembling 'the bioeconomy': Exploiting the power of the promissory life sciences](#). *Journal of Sociology*. 2015;51(1):28-46.
87. Rachul C, Rasko JE, Caulfield T. [Implicit hype? Representations of platelet rich plasma in the news media](#). *PLOS One*. 2017;12(8):e0182496.
88. Engebretsen L, Steffen K, Alsousou J, Anitua E, Bachl N, Devilee R, Everts P, et al. [IOC consensus paper on the use of platelet-rich plasma in sports medicine](#). *British Journal of Sports Medicine*. 2010;44(15):1072-81.
89. Moraes VY, Lenza M, Tamaaki MJ, Faloppa F, Belloti JC. [Platelet-rich therapies for musculoskeletal soft tissue injuries](#). *The Cochrane Library*. 2014 Jan 1.
90. Cortiñas-Rovira S, Alonso-Marcos F, Pont-Sorribes C, Escribà-Sales E. [Science journalists' perceptions and attitudes to pseudoscience in Spain](#). *Public Understanding of Science*. 2015;24(4):450-65.
91. Murdoch B, Zarzechny A, Caulfield T. [Exploiting science? A systematic analysis of complementary and alternative medicine clinic websites' marketing of stem cell therapies](#). *BMJ Open*. 2018;8(2):e019414.
92. Szeto E, Tomlinson A, Smart V. ['This is snake oil': Scientists don't buy balance-boosting clips featured on Dragons' Den](#). *CBC*. 2018 Feb 2.
93. Caulfield T, Borry P, Toews M, Elger BS, Greely HT, McGuire A. [Marginally scientific? Genetic testing of children and adolescents for lifestyle and health promotion](#). *Journal of Law and the Biosciences*. 2015;2(3):627-644.
94. Bowles B. [Unfiltered fervor: The rush to get off the water grid](#). *The New York Times*. 2017 Dec 29.
95. Sipp D, Caulfield T, Kaye J, Barfoot J, Blackburn C, Chan S, De Luca M, Kent A, McCabe C, Munsie M, Sleeboom-Faulkner M. [Marketing of unproven stem cell-based interventions: a call to action](#). *Science Translational Medicine*. 2017;9(397):eaag0426.
96. Massolution. [2015CF Crowdfunding Industry Report](#). 2015.
97. Young MJ, Scheinberg E. [The rise of crowdfunding for medical care: promises and perils](#). *JAMA*. 2017;317(16):1623-4.
98. Paulus TM, Roberts KR. [Crowdfunding a "Real-life Superhero": the construction of worthy bodies in medical campaign narratives](#). *Discourse, Context & Media*. 2018;21:64-72.
99. Berliner LS, Kenworthy NJ. [Producing a worthy illness: Personal crowdfunding amidst financial crisis](#). *Social Science & Medicine*. 2017;187:233-42.
100. Kim JG, Hong H, Karahalios K. [Understanding identity presentation in medical crowdfunding](#). *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 2018 Apr 21.

101. Kim JG, Kong HK, Karahalios K, Fu WT, Hong H. [The power of collective endorsements: credibility factors in medical crowdfunding campaigns](#). Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems 2016 May 7.
102. McGee EM. [Using personal narratives to encourage organ donation](#). The American Journal of Bioethics. 2005;5(4):19-20.
103. Neidich EM, Neidich AB, Cooper JT, Bramstedt KA. [The ethical complexities of online organ solicitation via donor-patient websites: avoiding the “beauty contest”](#). American Journal of Transplantation. 2012;12(1):43-7.
104. Snyder J, Turner L, Crooks VA. [Crowdfunding for unproven stem cell-based interventions](#). JAMA. 2018;319(18):1935-6.
105. Murdoch B, Marcon AR, Downie D, Caulfield T. [Media portrayal of illness-related medical crowdfunding: A content analysis of newspaper articles in the United States and Canada](#). PLOS One. 2019;14(4):e0215805.
106. Clarke CE. [A question of balance: The autism-vaccine controversy in the British and American elite press](#). Science Communication. 2008;30(1):77-107.
107. Dixon GN, Clarke CE. [Heightening uncertainty around certain science: Media coverage, false balance, and the autism-vaccine controversy](#). Science Communication. 2013;35(3):358-82.
108. Friedman SM, Dunwoody S, Rogers CL. Communicating Uncertainty: Media Coverage of New and Controversial Science. New York: Routledge; 2012.
109. Braverman J. [Testimonials versus informational persuasive messages: The moderating effect of delivery mode and personal involvement](#). Communication Research. 2008;35(5):666-94.
110. Ogbogu U. [Combating unlicensed stem cell interventions through truthful advertising law: a survey of regulatory trends](#). McGill Journal of Law & Health. 2015;9(2): 311-335.
111. Helmore, E. [Gwyneth Paltrow’s Goop faces new false advertising claims](#). The Guardian. 2017 Aug 24.
112. Caulfield T, Ogbogu U, Robertson G. [Commentary: the law, unproven CAM and the referral challenge](#). Focus on Alternative and Complementary Therapies 2013; 18(1):1-7.
113. Murdoch B, Carr S, Caulfield T. [Selling falsehoods? A cross-sectional study of Canadian naturopathy, homeopathy, chiropractic and acupuncture clinic website claims relating to allergy and asthma](#). BMJ Open. 2016;6(12):e014028.
114. Zarzeczny A, Caulfield T, Ogbogu U, Bell P, Crooks VA, Kamenova K, Master Z, Rachul C, Snyder J, Toews M, Zoeller S. [Professional regulation: a potentially valuable tool in responding to “stem cell tourism”](#). Stem Cell Reports. 2014;3(3):379-84.
115. Munsie M, Hyun I. [A question of ethics: selling autologous stem cell therapies flaunts professional standards](#). Stem Cell Research. 2014;13(3):647-53.
116. Abbott A. [Italian scientists slam selection of stem-cell trial](#). Nature. 2015;523:15-16.
117. Phillips K. No, [Gwyneth Paltrow, women should not put jade eggs in their vaginas, gynecologist says](#). The Washington Post. 2017 Jan 22.
118. Scientific American Editors. [Universities should encourage scientists to speak out about public issues](#). Scientific American. 2018 Feb 1.
119. Mattern A. [Father convicted in son’s meningitis death will not speak at wellness expos after backlash](#). CBC News. 2018 Feb 11.
120. International Society for Stem Cell Research. [Guidelines for stem cell research and clinical translation](#). 2016.
121. Boutilier A, Oved Chown M, Silverman C, L J. [Canadian government says it’s considering regulating Facebook and other social media giants](#). The Hamilton Spectator. 2019 Apr 9.
122. Harvey D. [Helping you find reliable public health information on Twitter](#). Blog.Twitter.com. 2019 May 10.
123. Lewis S. [YouTube adds feature to fact-check viral conspiracy videos and fake news](#). CBS News. 2019 Mar 7.
124. Weng L, Menczer F, Ahn YY. [Virality prediction and community structure in social networks](#). Scientific Reports. 2013;3:2522.
125. Goel S, Anderson A, Hofman J, Watts DJ. [The structural virality of online diffusion](#). Management Science. 2015;62(1):180-96.
126. Brossard D. [New media landscapes and the science information consumer](#). Proceedings of the National Academy of Sciences. 2013;110(Suppl 3):14096-101.
127. D’Souza S. [Canadian video debunking fake online health claims becomes viral hit](#). CBC News. 2018 Jul 15.
128. Shelby A, Ernst K. [Story and science: how providers and parents can utilize storytelling to combat anti-vaccine misinformation](#). Human Vaccines & Immunotherapy. 2013;9(8):1795-801.
129. Capurro G, Greenberg J, Dubé E, Driedger M. [Measles, moral regulation and the social construction of risk: media narratives of “anti-vaxxers” and the 2015 Disneyland outbreak](#). Canadian Journal of Sociology. 2018;43(1):25-48.
130. Coppock A, Ekins E, Kirby D. [The long-lasting effects of newspaper op-eds on public opinion](#). Quarterly Journal of Political Science. 2018;13(1):59-87.
131. Perrault S. Communicating Popular Science: From Deficit to Democracy. London: Palgrave Macmillan; 2013.
132. Dahlstrom MF, Scheufele DA. [\(Escaping\) the paradox of scientific storytelling](#). PLOS Biology. 2018;16(10):e2006720.