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Marketing of Unproven Stem Cell-Based Interventions: A Call to Action

Douglas Sipp^{1-4*}, Timothy Caulfield^{5,6}, Jane Kaye⁷, Jan Barfoot⁸, Clare Blackburn⁸, Sarah Chan⁹, Michele De Luca¹⁰, Alastair Kent¹¹, Christopher McCabe¹², Megan Munsie¹³, Margaret Sleeboom-Faulkner¹⁴, Jeremy Sugarman¹⁵, Esther van Zimmeren¹⁶, Amy Zarzeczny¹⁷, John E.J. Rasko^{18-20*}

¹Riken Center for Developmental Biology, 2-2-3 Minatojima Minamimachi Kobe, Japan 650-0047

²Keio University School of Medicine, Department of Physiology, 35 Shinanomachi, Shinjuku-ku, Tokyo, Japan 160-8582

³Keio University Global Research Initiative, 35 Shinanomachi, Shinjuku-ku, Tokyo, Japan 160-8582

⁴Riken Center for Advanced Intelligence Project, 1-4-1 Nihonbashi, Chuo-ku, Tokyo, Japan 103-0027

⁵Health Law Institute, University of Alberta, Edmonton, Canada

⁶Faculty of Law and School of Public Health, University of Alberta, Edmonton, Canada

⁷Department of Public Health, University of Oxford, Oxford, United Kingdom

⁸MRC Centre for Regeneration Medicine, University of Edinburgh, United Kingdom

⁹Usher Institute for Population Health Sciences and Informatics, University of Edinburgh, Edinburgh, United Kingdom

¹⁰Center for Regenerative Medicine 'Stefano Ferrari', University of Modena and Reggio Emilia, Modena, Italy

¹¹Genetic Alliance UK, London, United Kingdom

¹²Department of Emergency Medicine, University of Alberta, Edmonton, Canada

¹³Department of Anatomy and Neuroscience, University of Melbourne Parkville,
Australia

¹⁴Department of Anthropology, University of Sussex, Brighton, United Kingdom

¹⁵Berman Institute of Bioethics, Johns Hopkins University, Baltimore, USA

¹⁶Faculty of Law, University of Antwerp, Antwerp, Belgium

¹⁷Johnson Shoyama Graduate School of Public Policy, University of Regina, Regina,
Canada

¹⁸Sydney Medical School, University of Sydney, Sydney, Australia

¹⁹Gene and Stem Cell Therapy Program, Centenary Institute, Sydney, Australia

²⁰Department of Cell and Molecular Therapies, Royal Prince Alfred Hospital, Sydney,
Australia

*Corresponding author Emails: .

DS: sipp@cdb.riken.jp

JEJR: j.rasko@centenary.org.au

Overline: Stem Cells

Abstract Commercial promotion of unsupported therapeutic uses of stem cells is a global problem that has proven extraordinarily resistant to regulatory efforts. We suggest a coordinated global-local approach focused on engagement, harmonization and enforcement is needed reduce the risks and harms associated with direct-to-consumer marketing of unproven stem cell treatments.

The growth of the industry engaged in direct-to-consumer marketing of unproven stem cell interventions online has become impossible to ignore^{1,2}. Effective measures for regulating this sector both nationally and internationally are urgently needed. Despite the lack of compelling evidence from well-designed studies to support their efficacy³, or even in many cases of a plausible biological rationale, many providers aggressively promote the use of stem cells for a wide range of indications. Such practices first emerged in the peripheries of international biomedical research and development⁴, but providers have been making inroads in some leading global markets, including Japan⁵, Australia^{2,6}, and the United States^{1,7}. Public warnings by scientific and medical groups^{8,9}, government organizations¹⁰, and the media¹¹ have not slowed the global expansion of an industry based on marketing of unproven stem cell treatments. The success of this industry has adverse implications for patients' health and the integrity of healthcare markets, as well as potential repercussions for legitimate biomedical endeavors. It also provides an unsettling glimpse of what may lie ahead for other emerging biomedical technologies, such as mitochondrial replacement therapy and gene editing¹².

Efforts to ensure that stem cell-based interventions rest on a foundation of scientific evidence have not all been in vain. Authorities in Germany were successful in closing a private clinic that marketed stem cell treatments primarily to overseas patients, but only after several reports of serious adverse events, including the death of an infant¹³. The Chinese Ministry of Health has made significant strides in curtailing an industry in which hundreds of clinics promoted purported stem cell therapeutics over the internet¹⁴. More recently, the resolution of the Stamina Foundation controversy in Italy provides an excellent example of academic researchers and regulatory officials

successfully pushing back against a highly publicized provider of unproven stem cell treatments¹⁵. In this case, a private foundation aggressively promoted supposed therapeutic uses of mesenchymal stem cells, and gained national attention by rallying support from some media and advocacy groups around a narratives of patients' rights and demands for accelerated testing and approval. Following a several year public debate and scientific review, the "Stamina method" was unanimously rejected as unworthy of further study by a Ministry of Health expert panel. This was an important victory in the fight to ensure that unsupported therapeutic claims about stem cell therapies do not go unchallenged. The Stamina Foundation case in particular provides important insights into how promoters of unproven stem cell treatments harness and manipulate popular sentiments and misconceptions, and how scientists and physicians can help to inform both media representations and public policy¹⁶. By mobilizing support from international scientific organizations and engaging with the public through traditional media and social media, scientists were able to exert a positive influence on national policies that initially appeared to be veering toward state support for pseudomedicine¹⁷.

In this Perspective, we draw on the mounting body of literature describing the growth and characteristics of direct-to-consumer marketing of stem cell-based therapies^{1, 2, 18, 19} to highlight a number of key features and challenges for broad-based efforts to regulate this industry. We also examine how past successes in countering the premature commercialization of stem cell-based therapies in medicine can inform coordinated responses to this phenomenon nationally and internationally.

Defining the problem

The marketing of stem cells online takes place within a context of heightened direct-to-consumer marketing activity in the health sector. DTC advertising of medical products and services reflects the increasingly commercialized and consumer-oriented nature of the health sector. The growth of the internet and social media have provided new outlets for the marketing of both licensed and unlicensed therapeutics and offer sellers the ability to reach worldwide audiences, highlighting the difficulties of enforcing national laws in a global marketplace²⁰. Critics have cautioned that such unmediated forms of drug advertising may evade regulatory oversight and provide unreliable or incomplete information regarding risks, efficacy, and treatment alternatives²¹.

Many professional organizations, including the largest international academic societies in cell therapy³ and stem cell research²², have adopted a staged approach to determining what constitutes sufficient evidence of efficacy to justify routine clinical uses of stem cells. These approaches hold that such decisions should typically be based on results from independent randomized, controlled clinical trials, a view broadly consistent with the norms of evidence-based medicine. Nevertheless, it is important to recognize that study designs and evidentiary standards continue to evolve, and there is a diversity of viewpoints on the nature and quality of evidence needed to support widespread clinical adoption. For this reason, there is inevitably a grey zone between the extremes of strong scientific support and quackery²³.

Nonetheless, requiring new stem cell-based interventions to be carefully evaluated for safety and efficacy prior to entering widespread clinical use is consistent with best practices in biomedical research and development, for which there is substantial agreement across many jurisdictions. The steps involved in conventional clinical

translation of new therapies include: a compelling scientific rationale; well-defined and validated standards for *ex vivo* processing to achieve cellular product quality and potency; substantial evidence from rigorously designed independent clinical studies demonstrating safety and efficacy in the context of a specific medical indication; and the provision of information from such studies to inform clinical decision-making²⁴.

Stem cell-based interventions are classified under diverse and potentially incompatible national regulatory frameworks. Many countries, including the United States, have defined a wide spectrum of treatments using human cell and tissue as medical products with the oversight of the U.S. Food and Drug Administration (FDA) in the United States, or equivalent national authority, such as the European Medicines Agency in the EU. Other countries, including Australia and Japan, allow physicians broad discretion in using autologous cells in the course of medical procedures²⁵. In the majority of nations, however, clear rules governing the clinical use of stem cell-based interventions are absent. Cell-based interventions may be categorized as ‘products’, which are subject to oversight by national regulatory authorities, or as ‘procedures’ conducted within the scope of medical practice. These distinct regulatory philosophies have direct implications for how stem cells can be advertised in different jurisdictions. Evidence standards in the context of commercial advertising, market authorization and standard of care often vary considerably, as do the enforcement options available to national regulators.

Inflated messages

Much of the coverage of stem cells in the popular press to date has been unjustifiably optimistic, both in terms of the potential clinical benefit and the time frame in which such treatments would reach routine clinical application²⁶. This positive messaging is

leveraged by some providers to market unproven stem cell-based interventions. Indeed, the term ‘stem cell’ has been used broadly in promises of youth, rejuvenation and good health, as well as in the branding of cosmetics, dietary supplements, and sports products²⁷. Such hyperbole carries with it not only an increased risk of exploitation of vulnerable families desperate for a cure, but also of significant damage to the health of those subjected to these unproven interventions. In the longer term, unfulfilled promises may bring regenerative medicine R&D into disrepute.

In parallel to the hyping of the clinical utility of stem cells, providers of unproven stem cell interventions often display tokens of scientific legitimacy in their marketing messages (Table 1). Such tokens of scientific legitimacy include publications in journals with weak or non-existent peer review, the registration of pay-to-participate clinical trials on public databases. It can be difficult even for professionals, let alone patients, to determine whether these tokens demonstrate true compliance with the evidentiary standards for developing and testing stem cell therapies.

Misrepresentations of the safety and efficacy of stem cell interventions by commercial providers may build on exaggerated accounts of the state of the science in the popular media and research publications. Media accounts may uncritically report statements about the efficacy of stem cell-based treatments. Such articles are then re-posted on clinic websites, cited in social media, and used in crowd-funding efforts, which may further consolidate public expectations and arouse the curiosity of patients. However, the presumption of the efficacy of stem cell-based interventions is not simply a media issue. The pressure to publish, patent, promote, and commercialize research results, as well as to secure funding for future research, are all contributors to the ‘hyping’ of

stem cell science²⁸.

Regulatory turmoil

National regulatory authorities have been challenged in recent decades by calls for faster access to medical products, even in advance of the completion of rigorous clinical trials. This may reduce the willingness or ability of policy makers, patient groups, and regulators to take a stand against the commercial promotion of unproven stem cell interventions. In the United States, for example, in the face of a strong push for deregulation by providers and patient activists, the FDA is reviewing its regulations on human cell and tissue products. This comes at a time when so-called “right to try” laws designed to weaken federal oversight of the sale of products to terminally ill patients have been passed in the majority of the United States²⁹, and the newly enacted federal 21st Century Cures Act has included provisions for accelerating approvals of cell biologics³⁰. New laws passed in Japan to stimulate the regenerative medicine industry through the introduction of conditional approvals (effectively shifting efficacy testing to a post-market context)³¹ have also had a major impact on discussions of how new stem cell-based products should be regulated.

Current trends toward ever greater acceleration of medical approvals are a cause for concern given the limits they inevitably impose on premarket testing and the new ethical and legal questions they raise. Whereas medical product deregulation may promote access to interventions via a market model, there are accompanying risks to the health and economic well-being of patients. In under-regulated markets or those in which direct-to-consumer marketing goes unchecked, patients are obliged to make healthcare decisions without access to reliable information. Furthermore, providers may not be held accountable for the validity of their therapeutic claims,

thereby increasing physical, emotional and financial risks to patients and their families. When individuals spend their limited dollars on ineffective therapies, that expenditure comes at the cost of alternative effective therapies and other activities that could improve their quality of life; thus, patients purchasing inefficacious treatments might forego effective care. Further, under-regulated markets make it difficult for experts and non-experts to seek and evaluate information about competing claims. Even within regulated markets, health care is characterized by a high degree of information asymmetry, in which consumers must rely on providers' expert knowledge. Under-regulated health markets in contrast permit a lack of reliable information on both sides of the equation that can be profitable to sellers without conferring utility to buyers. Such deficits severely limit both the opportunity for patients to make informed decisions and the incentives for investment in the development of definitive clinical evidence. Deregulation exacerbates these problems and thus increases the likelihood of the wasteful allocation of limited health care resources.

Time to act

What then is to be done? Clearly, mutual engagement across a broad range of stakeholders is needed to foster regulatory frameworks that facilitate progress in medical research and ultimately affordable clinical benefit. Uncontrolled advertising and delivery of stem cell interventions for which no evidence or proven rationale exists risks stem cell medicine becoming identified as just another instance of commercialization outpacing evidence. The situation is further complicated by jurisdictional limits on the ability to control cross-border trade in health services³². If the enormous public investment into stem cell research and development, and indeed

its real therapeutic potential, is not to be squandered, it is important that healthcare systems are structured in ways that incentivize scientifically grounded, clinically meaningful and valuable innovation while curtailing exploitative practices.

Recent history provides several examples of successful responses against direct-to-consumer stem cell marketers. Journalistic pressure has in some cases been effective in exposing predatory stem cell clinics, leading to the closure of clinics in the United States³³ and Germany¹³. Medical specialties, such as plastic surgery³⁴ and respiratory medicine³⁵, have issued position statements highlighting the lack of sufficient evidence to justify routine use of stem cells in these fields, and state licensing boards have taken action in a small number of instances³⁶. The Stamina Foundation incident, which involved dedicated efforts by biologists, physicians, social science scholars, lawmakers, regulators and the media over several years of often-heated public engagement is a case in point. Scientific experts worked with, and sometimes confronted, the media to get the facts straight on the actual state of the science with respect to the cells purportedly used by the clinic in question. This exposure was critical to successfully guiding the Italian government on how to handle what appeared to be a surge in patient demand for unproven stem cell interventions. The commitment of experts to public engagement also helped to foster greater public skepticism about therapeutic claims made by the Stamina Foundation. Several leading Italian scientists also made the critical decision to appeal to international colleagues to help them in taking a stand. After nearly five years, their advocacy efforts resulted in the closure of the clinic.

National efforts, while critically important, cannot alone succeed in countering the activities of a transnational industry. The effectively borderless nature of the internet, the ease of international travel, and jurisdictional limits on extraterritorial enforcement all create windows of opportunity for clinics targeting patients across national borders. International research and medical organizations can play vital roles in supporting the work of local colleagues, but also in setting consensus regulatory and practice standards, driving evidence development, and facilitating the exchange of information among stakeholder groups. To date, organizations dedicated to stem cell and cell therapy research have taken the lead in global coordination, but recent surveys of the global stem cell marketing industry suggests that much work remains to be done. Proactive efforts should now be implemented by organizations with broad constituencies, such as the World Health Organization.

We propose a cooperative model in which stakeholder groups at the national and international levels work together in complementary ways. Research organizations should advocate for appropriate regulations and accurate media representations in their local contexts, and may support regulatory agencies through monitoring and outreach efforts. The development of national guidelines that protect patients and human research subjects is another important role for national organizations, particularly in countries which have yet to formalize rules governing clinical research and use of human stem cell-based products. At the global level, stem cell research and medical organizations can support national initiatives by advising on development of regulations appropriate to individual nations' specific circumstances and needs, and facilitating efforts to harmonize the current patchwork of national regulatory systems.

Setting standards is as important in science regulation as it is in scientific research, but regulations over the use of stem cells in medicine appear to be diversifying at the global level. Approaches to international regulation not only need to develop consistent rules over the commercialization of medical practices and products, but also need to give them teeth by developing cross-border partnerships for compliance (Figure 1). Consensus building and the inclusive consolidation of regulatory norms may best be facilitated by global agencies with the breadth of perspective and authority to coordinate and reconcile divergent interests. We note that international harmonization by professional, industry and other stakeholder groups has been broadly effective in the regulation of small-molecule drugs and biotechnologies, but this remains underdeveloped with respect to cellular therapeutics, which could similarly benefit from consensus medical practice standards, harmonization of market approval pathways, and resource-building for the development and enforcement of local regulations. In the pharmaceuticals arena, the International Council for Harmonization has been successful in developing and promulgating global drug quality standards. A similar international effort could help reduce the enormous heterogeneity and incompatibility of the various national systems governing stem cell products. For medical practice as well, the World Health Organization could contribute through developing guidelines on the responsible clinical use of human cells and tissues, and advising countries seeking to develop local practice standards. Importantly, the national and international elements of this model need to remain in communication in order to coordinate their public engagement, harmonization and enforcement activities.

However, the need for global conformity should not preclude the option of local action where the opportunity arises. Given the time it takes to achieve consensus on regulatory issues, this would allow local jurisdictions to act to protect the interests of their citizens, while bringing them into line with a more globally harmonized framework subsequently. The globalization of health markets and the specific tensions surrounding stem cell research and its applications have made this a difficult challenge. But the stakes are too high not to take a united stance.

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Competing Interests: DS is a member of the Ethics and Public Policy Committees of the International Society for Stem Cell Research. JR is Director of Pathology at Genea, an IVF company, is on the Board of Cure the Future Foundation and Global Research Foundation, is a committee member of New Directions in Leukemia and is President-Elect of the International Society for Cellular Therapy. JR is chair of the Royal Prince Alfred Hospital Institutional Biosafety Committee and federal Gene Technology Advisory Committee of the Office of the Gene Technology Regulator, Australian Government. MdL is a Board Member and Scientific Director of Holostem Therapie Avanzate, Modena, Italy. MM is a member of the advisory committee of the Australasian Society for Stem Cell Research, International Society for Stem Cell Research and International Society for Cellular Therapy. JS serves on Merck KGaA's Bioethics Advisory Panel and Stem Cell Research Oversight

Committee and on Quintile's Ethics Advisory Panel, and is a member of the Ethics and Public Policy Committees of the International Society for Stem Cell Research

References

1. Turner, L. & Knoepfler, P. Selling Stem Cells in the USA: Assessing the Direct-to-Consumer Industry. *Cell stem cell* **19**, 154-157 (2016).
2. Berger, I. et al. Global Distribution of Businesses Marketing Stem Cell-Based Interventions. *Cell stem cell* **19**, 158-162 (2016).
3. Srivastava, A. et al. Part 1: Defining unproven cellular therapies. *Cytotherapy* **18**, 117-119 (2016).
4. Lau, D. et al. Stem cell clinics online: the direct-to-consumer portrayal of stem cell medicine. *Cell stem cell* **3**, 591-594 (2008).
5. Fujita, M., Hatta, T., Ozeki, R. & Akabayashi, A. The current status of clinics providing private practice cell therapy in Japan. *Regenerative medicine* **11**, 23-32 (2016).
6. McLean, A.K., Stewart, C. & Kerridge, I. Untested, unproven, and unethical: the promotion and provision of autologous stem cell therapies in Australia. *Stem Cell Res Ther* **6**, 33 (2015).
7. Taylor-Weiner, H. & Graff Zivin, J. Medicine's Wild West--Unlicensed Stem-Cell Clinics in the United States. *N Engl J Med* **373**, 985-987 (2015).
8. Dominici, M. et al. Positioning a Scientific Community on Unproven Cellular Therapies: The 2015 International Society for Cellular Therapy Perspective. *Cytotherapy* **17**, 1663-1666 (2015).
9. Daley, G.Q. et al. Setting Global Standards for Stem Cell Research and Clinical Translation: The 2016 ISSCR Guidelines. *Stem cell reports* **6**, 787-797 (2016).
10. Food and Drug Administration. FDA warns about stem cell claims (2012).
11. Kolata, G. in New York Times (NY, NY USA; 2016).
12. Charo, R.A. On the Road (to a Cure?)--Stem-Cell Tourism and Lessons for Gene Editing. *N Engl J Med* **374**, 901-903 (2016).
13. Mendick, R. & Hall, A. in The Telegraph (London; 2011).
14. Rosemann, A. & Sleeboom-Faulkner, M. New regulation for clinical stem cell research in China: expected impact and challenges for implementation. *Regenerative medicine* **11**, 5-9 (2016).
15. Margottini, L. Final chapter in Italian stem cell controversy? *Science* (2014).
16. Cattaneo, E. & Corbellini, G. Stem cells: taking a stand against pseudoscience. *Nature* **510**, 333-335 (2014).
17. Bianco, P. et al. Regulation of stem cell therapies under attack in Europe: for whom the bell tolls. *The EMBO journal* **32**, 1489-1495 (2013).
18. Liang, B.A. & Mackey, T.K. Stem cells, dot-com. *Sci Transl Med* **4**, 151cm159 (2012).
19. Connolly, R., O'Brien, T. & Flaherty, G. Stem cell tourism--a web-based analysis of clinical services available to international travellers. *Travel Med Infect Dis* **12**, 695-701 (2014).
20. Mackey, T.K., Cuomo, R.E. & Liang, B.A. The rise of digital direct-to-consumer advertising?: Comparison of direct-to-consumer advertising expenditure trends from publicly available data sources and global policy implications. *BMC Health Serv Res* **15**, 236 (2015).
21. Stange, K.C. Time to ban direct-to-consumer prescription drug marketing. *Ann Fam Med* **5**, 101-104 (2007).

22. Daley, G.Q. et al. Setting global standards for stem cell research and clinical translation: the 2016 ISSCR guidelines. *Stem cell reports* (2016).
23. Sleeboom-Faulkner, M.E. The large grey area between 'bona fide' and 'rogue' stem cell interventions — Ethical acceptability and the need to include local variability. *Technological Forecasting and Social Change* **109**, 76-86 (2016).
24. Sugarman, J. & Sipp, D. in *Translational Stem Cell Research* 125-135 (Humana Press, 2011).
25. Rosemann, A., Bortz, G., Vasen, F. & Sleeboom-Faulkner, M. Global regulatory developments for clinical stem cell research: diversification and challenges to collaborations. *Regenerative medicine* **11**, 647-657 (2016).
26. Zarzeczny, A., Rachul, C., Nisbet, M. & Caulfield, T. Stem cell clinics in the news. *Nat Biotechnol* **28**, 1243-1246 (2010).
27. Sipp, D. Stem cell stratagems in alternative medicine. *Regenerative medicine* **6**, 407-414 (2011).
28. Caulfield, T., Sipp, D., Murry, C.E., Daley, G.Q. & Kimmelman, J. Confronting stem cell hype. *Science* **352**, 776-777 (2016).
29. Rubin, M.J. & Matthews, K.R.W. The Impact of Right to Try Laws on Medical Access in the United States. *Baker Institute Policy Report* (2016).
30. Servick, K. Under 21st Century Cures legislation, stem cell advocates expect regulatory shortcuts. *Science* (2016).
31. Sipp, D. Conditional approval: Japan lowers the bar for regenerative medicine products. *Cell stem cell* **16**, 353-356 (2015).
32. Cohen, I.G. *Patients with passports : medical tourism, law and ethics.* (Oxford University Press, New York, NY; 2015).
33. Forsyth, J. in Reuters (2012).
34. ASAPS/ASPS position statement on stem cells and fat grafting. *Aesthet Surg J* **31**, 716-717 (2011).
35. Ikonomidou, L., Freishtat, R.J., Wagner, D.E., Panoskaltsis-Mortari, A. & Weiss, D.J. The Global Emergence of Unregulated Stem Cell Treatments for Respiratory Diseases. Professional Societies Need to Act. *Ann Am Thorac Soc* **13**, 1205-1207 (2016).
36. Miller, R. Flouting warning, Florida stem-cell cardiologist has license suspended. *Medscape* (2012).

Figure 1. This scheme indicates approaches for countering the premature commercialization and deregulation of unproven stem cell therapies. This will require both local and global action by the scientific, medical and regulatory communities. Advocacy, monitoring, public outreach, rule-making and enforcement at the national level are necessary activities. These can be complemented by international standards-setting, coordination, engagement

and harmonization, which may benefit from support by authoritative international bodies such as the World Health Organization.

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Table 1: Coopted tokens of scientific legitimacy

Accreditations and awards	Asserting certification of products or practices by international standards organizations, or claiming training certification.
Boards and advisors	Convening scientific or medical advisory boards featuring prominent business leaders and academic faculty members.
Clinical study registration	Registering trials whose apparent purpose is solely to attract patients willing to pay to participate in them.
Ethics review	Marketers may use the imprimatur of 'ethics review' to convey a sense of legitimacy to their products or procedures.
Location	Renting of laboratory or business space within a legitimate scientific or government institution.
Membership	Joining established academic or professional societies to suggest legitimacy by association.
Outcome registries	Publication of open-ended voluntary monitoring datasets rather than undertaking controlled clinical trials.
Patenting	Suggesting that patent applications or grants indicate clinical utility, rather than simply novelty and inventiveness.
Publication	Publishing research and commentary in journals with limited anonymous peer review.
Rationales	Citing preclinical and other research findings to justify clinical application without sufficient efficacy testing in humans.
Self-regulation	Forming organizations to 'self-regulate' in ways that support premature commercialization.
Technical language	Using scientific-sounding words that imply academic rigor.
Testimonials and endorsements	Providing glowing 'expert' opinions or celebrity comments on unsupported clinical uses or standing of the provider