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Forum

Preying on Public Fears and Anxieties in a Pandemic: Businesses Selling Unproven and Unlicensed "Stem Cell Treatments" for COVID-19

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In the midst of a global public health emergency, some businesses are taking advantage of widespread fears by marketing purported stem cell treatments for COVID-19. Such businesses target prospective clients with misleading claims, expose patients to potentially risky stem cell-based products, and undermine efforts to develop evidence-based treatments for COVID-19.

Introduction

COVID-19, the disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has in a matter of months become a devastating global pandemic and public health emergency. The relative ease of transmission of the virus; the death, illness, and suffering it has caused; its ability to overwhelm health care systems; and its disruption of social life and economic structures make the disease a source of panic, anxiety, and fear. Tapping into overwhelming public interest in the development of effective vaccines and therapies for COVID-19, some businesses are promoting stem cell-based interventions or exosome products that supposedly treat or prevent COVID-19 or the acute respiratory distress syndrome (ARDS) experienced by some victims of the virus. The purported stem cell treatments these companies sell are unproven, have not been approved by the US Food and Drug Administration (FDA) or other national regulatory bodies, pose risks to patients, and have the potential to undercut efforts to develop evidence-based stem cell treatments and other therapeutic products.

Direct-to-Consumer Marketing of Purported "Stem Cell Treatments" and "Preventive Therapies" for COVID-19

For more than a decade, businesses selling unproven and unlicensed stem cell interventions have claimed to treat individuals with illnesses or injuries for which effective therapies or cures are in fact unavailable. Patients with Alzheimer's disease, chronic obstructive pulmonary disease (COPD), amyotrophic lateral sclerosis, spinal cord injuries, and many other diseases and injuries have all been the focus of clinics that use aggressive marketing tactics to exploit hope, desperation, and vulnerability (Turner and Knoepfler, 2016). Several businesses selling unlicensed stem cell products have been sued by patients alleging they were defrauded, injured, victims of elder abuse, or otherwise harmed (Horner et al., 2018).

Lacking convincing evidence to support their advertising claims, clinics instead solicit clients by using such tokens of legitimacy as scientific-seeming rhetoric and references to published preclinical and clinical studies (Sipp et al., 2017). Clinics selling purported stem cell treatments or "immune-boosting" preventive therapies for COVID-19 and COVID-19-related ARDS exhibit this familiar pattern of using inaccurate advertising claims to make what they are promoting seem credible and worth purchasing.

Perhaps seeking to avoid attracting the scrutiny of regulatory bodies such as the FDA and Federal Trade Commission (FTC), some of these businesses make vague claims on their websites about stem cell treatments for COVID-19. A few businesses have posted to their websites videos of physicians expressing enthusiasm for the supposed promise of stem cell interventions for COVID-19. The sites encourage prospective customers to complete an online form or call and arrange a consultation if they want to learn more about what the clinics are selling. Other companies are less circumspect. Their advertising claims provide insight into how clinics promoting unproven and unlicensed stem cell products are using the pandemic as an opportunity to profit from fearful patients.

For example, a Colorado-based business is advertising "Mesenchymal Stem Cell Exosomes" as a "Viral Inhibitor and Immune System Booster" (see Data S1 for a summary list of online sources for marketing claims). The clinic's website states that the "Stem Cell Center now has a single visit Stem Cell Exosome IV treatment for patients that need to boost their immune system and have a powerful viral inhibitor. This treatment is for those who do not have Covid-19 but for those who want additional defense against the virus." The company claims that individuals with autoimmune disease, COPD, lung disease, or ARDS or who are more than 60 years old and have underlying health conditions "may benefit" from the procedure. "Our goal," the business claims, "is to give our patients peace of mind knowing that they've done everything possible to protect themselves and their family." Individual patients are charged $3,000 for the procedure, two family members are charged "$2,700 per person," and three or more family members are charged "$2,200 per person."

A company with clinics located in Pennsylvania and Delaware issued a press release claiming the business is "Now

Offering Mesenchymal Stem Cell Treatments to Support Lung Health During COVID-19" (https://www.einnews.com/pr_news/512455640/pa-green-wellness-is-now-offering-mesenchymal-stem-cell-treatments-to-support-lung-health-during-covid-19). "In the wake of a global health crisis," the company claims, it "has adapted its signature wellness injection to aid in lung health, restoration of damage and an overall reduction in inflammatory responses." Referencing a small clinical study conducted in China in which mesenchymal stem cells were administered to subjects diagnosed with COVID-19, the CEO of the company is quoted in the press release as stating, "This goes to support the wide range of healing and restoration that can be provided by MSC therapy. While this isn't a cure or a vaccine against this new coronavirus, this technology may have the ability to reverse lung damage in patients and improve their overall health, which puts them in a much better position if they should find themselves with a COVID-19 infection."

In Arizona, a "regenerative medicine clinic" is advertising "stem cell therapy" as a "precautionary measure" for preventing COVID-19. The company's website states, "the anti inflammatory and healing properties of stem cells can help patients form a formidable barrier against the virus. This is especially true for patients who are less equipped to fight off infections due to a weaker immune system, other illnesses or aging." The clinic's website adds, "fortifying the lungs with umbilical cord tissue that contains millions of potent stem cells is a great way for patients to boost their ability to fight off virus and other related illnesses."

A Florida-based business selling purported stem cell treatments for COVID-19 offers conflicting messages, cautioning that it is not claiming its stem cell products can treat or cure COVID-19 or any other infection or disease, while also stating in a section of its website entitled "Stem Cell Therapy And COVID-19," "Lung function and inflammation have been the main concern with the coronavirus. The damage to lung tissues can be fatal, and stem cell therapy has been shown to help repair the damage. According to our protocols, we can inject stem cells directly into the area of concern. Researchers have typically been injecting the stem cells directly into the lungs. Stem cells injected directly into the lungs have been shown to improve the immunity in the lungs and reduce the risk of pulmonary failure caused by inflammation." The company's website notes, "It's possible that your body needs an extra boost to help your immunity. To help our patients stay as healthy as possible, we are offering an array of immune boosting IV infusions. We also offer our existing stem cell therapy packages including IV exosomes." The business encourages potential clients with questions to call "and schedule a free phone conversation with one of our Regenerative Medicine Doctors."

Finally, a California-based "anti-aging clinic" is using YouTube videos to promote "stem cell exosome" products that it ships to the homes of clients. Rather than traveling to the clinic, clients instead receive "mesenchymal stem cell exosomes" delivered on dry ice, a vaporizer, mask, and additional equipment that they are then supposed to use to self-administer the nebulized product at home. The clinic's spokespersons claim the "stem cell exosome vapor treatments" promote lung tissue regeneration, strengthen the lungs and immune system, and reduce inflammation, and it also purportedly "interrupts virus multiplication."

Cross-Border Business Models

Not all US companies advertising purported stem cell-based interventions for COVID-19 or COVID-19-related ARDS administer these products to patients at US-based clinics. A business in Colorado that processes and distributes umbilical-cord-derived stem cells is transporting its allogeneic stem cell product to a facility in the Caribbean. The company states, "We presently supply our Mesenchymal Stem Cells to" a clinic "in the Cayman Islands for treatment of inflammatory conditions. We are pleased to be positioned to offer stem cell therapy for Coronavirus infection. While there are several factors related to the possible extent of this global infection, stem cell therapy represents a therapeutic option to fight the virus and increase survival, while effective vaccines are being developed." At least one other US-based company engaged in processing and distributing umbilical-cord-tissue-derived "mesenchymal stem cell products" is also preparing for marketplace entry by promoting itself as a supplier of allogeneic cell-based therapies that might be helpful in treating individuals diagnosed with COVID-19.

Biobanking Pitched as "Biological Insurance" for the Future Treatment of COVID-19

Other businesses are promoting biobanking of stem cells as a potential therapeutic insurance policy for COVID-19. These companies encourage healthy prospective clients to store their autologous stem cells for possible future therapeutic use in the event of subsequent diagnosis with COVID-19 or COVID-19-related ARDS. Some businesses advertise both stem cell interventions for COVID-19 and banking of stem cells for future use. For example, the Facebook page of a clinic in Alabama states, "We have the option of providing patients with immediate (point of care) production of SVF (stem cells produced from your own fat used the same day) and/or the option of having mini liposuction and then banking your own adipose stem cells for expansion into very high numbers (similar to China). These stored 'personal stem cells' will allow you to have cells available urgently should you contract a potentially lethal virus and become eligible for 'right to try' access to your cells. Having a frozen line of one's own personal mesenchymal stem cells could prove life-saving should someone become a victim of the current viral pandemic."

Stem Cell Hype in a Pandemic

Many of the businesses advertising supposed stem cell therapies or exosome treatments for COVID-19 are using press releases and their websites to connect their products to news media reports and press alerts that enthusiastically describe "cures" and breakthroughs" in China following the administration of stem cells to individuals who were diagnosed with COVID-19. The title of one such article states, "Chinese Doctor Claims He Has Found 100% Cure For Coronavirus" (https://www.albawaba.com/editors-choice/chinese-doctor-claims-he-has-found-100-cure-coronavirus-1345690). Another article is entitled, "Chinese doctor claims he made a breakthrough in coronavirus pandemic with stem cell injections – having 100% success rate after treating nine mostly elderly patients" (https://www.dailymail.co.uk/news/article-8116881/

Doctor-claims-breakthrough-stem-cell-injections-treat-coronavirus.html). A third article is titled, "Coronavirus: critically ill Chinese patient saved by stem cell therapy, study says" (https://www.scmp.com/news/china/society/article/3053080/coronavirus-critically-ill-chinese-patient-saved-stem-cell). These uncritical news media reports are used as "evidence" that the "mesenchymal stem cell treatments" or "exosome therapies" these clinics are selling will benefit their clients.

Hyping of pre-clinical and clinical findings is a longstanding problem in the field of stem cell research (Caulfield et al., 2016). News media accounts of stem cell "cures" for COVID-19 reveal that individual case reports and preliminary clinical studies with few research subjects are being depicted in a misleading and hyperbolic manner. Inaccurate public representations concerning the supposed benefits of stem cell products are contributing to the broader surge of misinformation about supposed treatments, tests, and preventive measures for COVID-19. They risk misleading the public in a manner that helps businesses selling unproven and unapproved stem cell interventions persuade prospective clients by making it appear as though such products have already been confirmed by credible clinical studies to be safe and effective therapies or even outright cures.

Numerous clinical studies testing various stem cell and exosome products for COVID-19 are underway in China, the US, and elsewhere (Khoury et al., 2020a). More such studies will doubtless be registered in clinical trials databases as researchers around the world attempt to develop safe and efficacious treatments for COVID-19. However, at present there are no publicly available results for most of these trials. Instead, stem cell hyperbole related to COVID-19 appears to be driven by a pre-print reporting a single case in which stem cells were administered to a person with COVID-19 (Liang et al., 2020), a small preliminary study with seven research subjects who were administered mesenchymal stem cells and three participants who were given placebos (Leng et al., 2020), and claims concerning unpublished and unverifiable study results for which there does not seem to be a pre-registered clinical trial protocol or any publicly accessible data (https://www.dailymail.co.uk/news/article-8116881/Doctor-claims-breakthrough-stem-cell-injections-treat-coronavirus.html).

Translational Clinical Research

Pre-clinical research and peer-reviewed findings from clinical trials investigating the use of stem cell interventions in individuals diagnosed with various lung diseases lend support to claims that there are credible scientific reasons to evaluate the safety and efficacy of various stem cell products and determine whether they might serve as effective treatments for COVID-19 and COVID-19-related ARDS (Khoury et al., 2020a). Acknowledging the many challenges the pandemic poses to the clinical research enterprise, and recognizing the urgency of finding treatments, such products need to be tested in well-designed and rigorously conducted clinical trials capable of generating meaningful safety and efficacy data (Kalil, 2020). Only by conducting such trials will it be possible to determine whether there is substantial evidence that supports approving one or more stem cell products as treatments for COVID-19. In contrast, the preliminary clinical studies that have already involved administering stem cell products to individuals diagnosed with COVID-19 do not support commercializing such interventions or justify claiming they are effective treatments for COVID-19. Data from clinical studies testing administration of mesenchymal stromal cells in individuals suffering from various kinds of lung diseases also highlight the importance of avoiding making premature claims about efficacy in the care of individuals with COVID-19. Despite the numerous clinical trials that have involved evaluating different kinds of stem cell interventions in individuals suffering from COPD, ARDS, and other respiratory diseases, no such stem cell-based products have been approved by the FDA or become evidence-based standard of care. Further research is needed to better understand how lungs regenerate and to determine whether particular cell-based products can be used as safe and efficacious therapies in treating particular respiratory diseases.

Scientific Communities Condemning the Sale of Unproven Stem Cell Interventions for COVID-19

Numerous respected scientific organizations known for supporting evidence-based clinical translation of stem cell therapies have issued forceful statements condemning businesses marketing unproven and unlicensed stem cell therapies for COVID-19. The International Society for Stem Cell Research (ISSCR) (https://www.isscr.org/news-publicationsss/isscr-news-articles/article-listing/2020/03/06/isscr-statement-regarding-the-marketing-of-unproven-stem-cell-treatments-for-covid-19), the International Society for Cell and Gene Therapy (ISCT) (https://isctglobal.org/news/494824/ISCT-Releases-Statement-on-Unproven-Stem-Cell-Treatments-for-COVID-19.htm), the Alliance for Regenerative Medicine (https://alliancerm.org/bioethics/stem-cell-clinical-trials/), EuroStemCell (https://www.eurostemcell.org/stem-cells-and-covid-19), the Stem Cell Network in Canada (https://stemcellnetwork.ca/warning-claims-of-stem-cell-treatments-for-covid-19-unfounded-and-misleading/), Stem Cells Australia (http://www.stemcellsaustralia.edu.au/news—events/news/warning-about-unproven-stem-cell-treatments-for-covid-19.aspx), and the Stem Cell Network North Rhine-Westphalia (https://www.stammzellen.nrw.de/en/newsroom/article/statements-on-covid-19-and-stem-cells) have all expressed concern about clinics selling unproven stem cell interventions for COVID-19. These bodies rightly note that there are no approved and evidence-based stem cell therapies for COVID-19 and businesses should not sell unproven and unapproved products as treatments. Statements from these organizations matter. However, in terms of their ability to directly regulate conduct, these scientific communities typically are confined to expelling members that do not meet their standards for responsible conduct. They have no broader regulatory authority to investigate businesses selling unapproved stem cell interventions. Their warnings are important but ultimately law enforcement agencies and regulatory bodies are responsible for taking action against noncompliant businesses and clinicians.

Organizations Promoting the Use of Stem Cell Products for COVID-19

Despite commendable efforts by various scientific societies to criticize deceptive advertising of stem cell products for treatment or prevention of COVID-19, at least

two organizations are engaging in activities that risk propagating the misrepresentation that there are evidence-based stem cell therapies now available for COVID-19.

For example, the American Academy of Stem Cell Physicians, an organization with many members drawn from participants in the direct-to-consumer stem cell "industry," recently submitted to World Health Organization Director Dr. Tedros Adhanom Ghebreyesus a letter containing a recommended treatment protocol for individuals diagnosed with COVID-19 (https://www.prnewswire.com/news-releases/the-american-academy-of-stem-cell-physicians-recommends-a-treatment-protocol-for-covid-19-to-the-who-301026685.html). The Academy's list of recommendations includes administering to hospitalized patients diagnosed with COVID-19 umbilical cord blood and "nebulizer with Amniotic fluid derived Exosomes." The letter provides no scientific evidence supporting the use of these products in the care of individuals with COVID-19.

Another organization, the American Society for Interventional Pain Physicians, issued a statement in which the Society claims it is "asking authorities to approve expanded umbilical cord stem cell infusions for treatment" (https://files.constantcontact.com/a496a007601/1e9e53f1-c9af-4f53-913d-871dd86edc4c.pdf). In an accompanying article, members of the Society call for compassionate access to such products in the care of patients with COVID-19 (Atluri et al., 2020).

The two associations claiming that birth-tissue-derived stem cell products are safe and effective treatments for COVID-19 lack the public standing and reach of societies such as ISSCR and ISCT. Nonetheless, their public messaging risks spreading the misrepresentation that a substantial body of evidence already supports the safe and efficacious use of stem cell products in the care of individuals with COVID-19.

Testing Safety and Efficacy of Stem Cell Products in Well-Designed Clinical Trials

There are legitimate scientific reasons to pursue clinical research testing the safety and efficacy of various stem cell products in the care of individuals with COVID-19 (Khoury et al., 2020a). While such products should not be promoted as cures and treatments, they merit careful study in well-designed and properly conducted clinical trials that comply with applicable ethical, scientific, and regulatory standards for human subjects research (Khoury et al., 2020b). In particular, there are compelling reasons to facilitate efforts to evaluate whether some stem cell products might be safe and efficacious in treating COVID-19-related acute respiratory distress.

In the US, several companies with stem cell products in development have submitted Investigational New Drug (IND) applications to the FDA or intend to submit INDs. The FDA has already begun reviewing such studies and clearing them to commence recruiting study participants. To provide proper oversight of submitted clinical studies and the investigational products they are designed to test, the FDA will need to be able to exercise its regulatory authority free from political pressure and other attempts to influence its review and approval processes.

Some studies testing stem cell products for COVID-19 lack blinding, randomization, and a control arm; have small sample sizes; are conducted at a single clinical site; suffer from additional limitations; and are unlikely to generate high-quality safety and efficacy data. An additional concern with such poorly designed or very preliminary studies is that despite not having the capacity to generate robust evidence, they could lead to patients with COVID-19 seeking access to unproven stem cell products on a Right-to-Try basis. In contrast, other studies are well-designed, multi-center randomized controlled trials that should generate valuable data concerning whether particular stem cell-based products can be used to treat individuals with COVID-19. Funding agencies are also providing support for stem cell research related to COVID-19. For example, the California Institute for Regenerative Medicine approved $5 million in emergency funding that will be used to support research intended to develop therapies for COVID-19 (https://www.cirm.ca.gov/about-cirm/newsroom/press-releases/03272020/stem-cell-agency-board-approves-5-million-emergency).

Conclusion: Further Regulatory Action Is Needed

The FDA and FTC have taken enforcement action against numerous businesses selling unproven therapies or preventive measures for COVID-19. The US Department of Justice has also announced its intention to prosecute parties making fraudulent claims related to COVID-19 (https://www.justice.gov/coronavirus). Agencies responsible for overseeing markets for health products in other countries have likewise stated that they intend to target individuals and companies making false claims and selling unapproved treatments and tests.

To date the FDA has issued three untitled letters to businesses advertising unproven stem cell interventions or exome products for treatment or prevention of COVID-19. One such letter was sent to Dynamic Stem Cell Therapy, a company selling unlicensed stem cell products to prevent or treat COVID-19 (https://www.fda.gov/media/136668/download). A second letter was issued to Regenerative Solutions of New Jersey for advertising an unapproved exosome product for treatment or prevention of COVID-19 (https://www.fda.gov/media/137396/download). A third letter was issued to Kimera Labs, the business that supplied Regenerative Solutions of New Jersey with its exosome product (https://www.fda.gov/media/137129/download). Whether such untitled letters will have a wider impact on the market for unlicensed stem cell products remains to be determined. The FDA has not issued formal warning letters to any businesses selling unproven and unlicensed stem cell products or exosomes for COVID-19 or filed in federal court for permanent injunctions enjoining such businesses from marketing and administering unlicensed products for treatment or prevention of COVID-19.

The FTC has also taken action against businesses unlawfully advertising stem cell "treatments" and other purported therapies for COVID-19, issuing warning letters to Absolute Health Clinic, American Medical Aesthetics, the Center for Regenerative Cell Medicine, Stemedix, and Vidaful Medicine (https://www.ftc.gov/system/files/warning-letters/covid-19-letter_to_absolute-health-clinic.pdf, https://www.ftc.gov/system/files/warning-letters/covid-19-letter_to_american-medical-aesthetics.pdf, https://www.ftc.gov/system/files/warning-letters/covid-19-letter_to_center-regenerative-cell-medicine.pdf, https://www.ftc.gov/system/files/warning-letters/covid-19-letter_to_stemedix-inc.pdf, https://www.ftc.gov/system/files/warning-letters/covid-19-letter_to_dap-vidaful-medicine.pdf).

Acknowledging the serious challenges currently facing the FDA and FTC, state oversight bodies, and their counterparts in other countries, regulatory bodies and law enforcement authorities tasked with addressing pandemic-related fraud and other forms of noncompliant activity should be alert to additional businesses peddling purported stem cell therapies and exosome treatments for COVID-19 and COVID-19-related ARDS. Such companies make misleading claims, expose patients to potentially risky products, promote false hope, might lead some individuals to place less emphasis on physical distancing and sheltering in place measures, and administer unproven stem cell interventions that likely will result in the subsequent exclusion of recipients from well-designed and competently conducted clinical studies.

Regulatory bodies such as the FDA and FTC must make challenging resource allocation decisions when deciding whether to investigate particular businesses. The commercial and clinical activities of businesses selling purported stem cell treatments and preventive measures for COVID-19 constitute sufficient risks to patient safety, public health, and truthfulness in advertising and commerce to warrant further investigations and enforcement actions. Patients need evidence-based therapies, preventive measures, and supportive care for COVID-19 rather than unproven and unapproved products marketed as effective treatments.

SUPPLEMENTAL INFORMATION

Supplemental Information can be found online at https://doi.org/10.1016/j.stem.2020.05.003.

DECLARATION OF INTERESTS

L.T. has reported to the FDA numerous businesses selling unlicensed and unproven stem cell interventions. On a pro bono basis, L.T. filed an expert opinion report and rebuttal report supporting plaintiffs in a lawsuit filed against a business marketing purported stem cell interventions. L.T. was also deposed in this case and was examined and cross-examined in a court hearing. This work was also conducted on a pro bono basis. L.T. is a member of the International Society for Cell and Gene Therapy and a member of the International Society for Stem Cell Research.

WEB RESOURCES

Centers for Disease Control and Prevention, https://www.cdc.gov/coronavirus/2019-ncov/index.html

The Niche, https://ipscell.com/2020/03/as-clinics-buzz-about-coronavirus-patient-given-non-fda-approved-exosomes/

The Washington Post, https://www.washingtonpost.com/health/2020/03/09/fda-ftc-crack-down-coronavirus-fraudulent-prevention-treatment-claims/

The New York Times, https://www.nytimes.com/2020/04/02/health/stem-cell-treatment-coronavirus.html

World Health Organization, https://www.who.int/emergencies/diseases/novel-coronavirus-2019

REFERENCES

Atluri, S., Manchikanti, L., and Hirsch, J.A. (2020). Expanded Umbilical Cord Mesenchymal Stem Cells (UC-MSCs) as a Therapeutic Strategy in Managing Critically Ill COVID-19 Patients: The Case for Compassionate Use. Pain Physician *23*, E71–E83.

Caulfield, T., Sipp, D., Murry, C.E., Daley, G.Q., and Kimmelman, J. (2016). SCIENTIFIC COMMUNITY. Confronting stem cell hype. Science *352*, 776–777.

Horner, C., Tenenbaum, E., Sipp, D., and Master, Z. (2018). Can civil lawsuits stem the tide of direct-to-consumer marketing of unproven stem cell interventions. NPJ Regen. Med. *3*, 5. https://www.nature.com/articles/s41536-018-0043-6.

Kalil, A. (2020). Treating COVID-19-Off-Label Drug Use, Compassionate Use, and Randomized Clinical Trials During Pandemics. JAMA. Published online March 24, 2020 https://jamanetwork.com/journals/jama/fullarticle/2763802.

Khoury, M., Cuenca, J., Cruz, F.F., Figueroa, F.E., Rocco, P.R.M., and Weiss, D.J. (2020a). Current Status of Cell-Based Therapies for Respiratory Virus Infections: Applicability to COVID-19. Eur. Respir. J., 2000858. https://erj.ersjournals.com/content/early/2020/04/01/13993003.00858-2020.

Khoury, M., Rocco, P., Phinney, D., Krampera, M., Martin, I., Viswanathan, S., Nolta, J., LeBlanc, K., Galipeau, J., and Weiss, D. (2020b). Cell-Based Therapies for COVID-19: Proper Clinical Investigations are Essential. Cytotherapy. Preproof published online April 17 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7163352/pdf/main.pdf.

Leng, Z., Zhu, R., Hou, W., Feng, Y., Yang, Y., Han, Q., Shan, G., Meng, F., Du, D., Wang, S., et al. (2020). Transplantation of ACE2$^-$ Mesenchymal Stem Cells Improves the Outcome of Patients with COVID-19 Pneumonia. Aging Dis. *11*, 216–228.

Liang, B., Chen, J., Li, T., Wu, H., Yang, W., Li, Y., Li, J., Yu, C., Nie, F., Ma, Z., et al. (2020). Clinical remission of a critically ill COVID-19 patient treated by human umbilical cord mesenchymal stem cells. ChinaXiv, 202002.00084v1 http://chinaxiv.org/abs/202002.00084.

Sipp, D., Caulfield, T., Kaye, J., Barfoot, J., Blackburn, C., Chan, S., De Luca, M., Kent, A., McCabe, C., Munsie, M., et al. (2017). Marketing of unproven stem cell-based interventions: A call to action. Sci. Transl. Med. *5*, eaag0426.

Turner, L., and Knoepfler, P. (2016). Selling Stem Cells in the USA: Assessing the Direct-to-Consumer Industry. Cell Stem Cell *19*, 154–157.