Covid-19, global solidarity, and the case for equitable vaccine distribution through technology transfers

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Original Paper: https://journals.sagepub.com/doi/10.1177/13505084221145666

Key words: Covid-19 pandemic, technology transfers, solidarity, market organization

Abstract

The Covid-19 pandemic has highlighted the importance of health technologies to mitigate against the spread of the disease, but it has also demonstrated that the current biopharmaceutical business model, based on patented medicines and other technologies, leads to vast inequalities in healthcare particularly in low- and middle-income countries. We believe that the pharmaceutical industry has a duty to enable and enact global solidarity through technology sharing, but judging by current technology transfer practices, we question their willingness to assume their role in organizing healthcare markets through solidaristic principles. In the absence of a voluntary adoption of solidaristic practices by pharmaceutical firms, solidarity needs to be institutionalized as a fundamental organizing principle for global healthcare markets, particularly in times of health emergencies.

Introduction

The Covid-19 death toll has been four times higher in low- and middle-income countries (LMICs) than in high-income countries (HICs) (Oxfam, 2022). While 63% of the world's population were fully vaccinated by 2022 and many citizens in higher-income countries had been triple-vaccinated, in many LMICs first-time vaccination rates stayed well below 15% (Zakiyah, 2022). In some countries, such as Burundi, Congo or Haiti, the rate was only 1.5% (Holden, 2022). These numbers serve as a stark reminder of just how problematic the biopharmaceutical business model is: Pfizer and BioNTech earned a pre-tax profit of around US$37 billion from the sale of their Covid-19 vaccine in 2021, and Moderna made pre-tax profits of US$12 billion (Murphy, 2022). Nine new "Covid pharma billionaires" were created because of the pandemic (Ziady, 2021). Yet, these pharmaceutical firms failed to share their life-saving vaccine technologies with LMICs, even when that intellectual property was developed with the help of significant public funding. The Moderna mRNA vaccine, for instance, received as much as US$2.5 billion in funding (Lalani et al., 2022).

It is now clear that vaccine supply shortages and manufacturing concentration cost millions of lives during the pandemic (Watson et al., 2022). Africa, for instance, currently imports 99% of its vaccine consumption (Ekström et al., 2021), and many African countries simply could not compete with the EU or North American countries in the race for vaccine supplies, neither could they manufacture to their own needs. An often-cited argument by pharmaceutical firms against the sharing of Covid-19 vaccine patents to facilitate more widespread volume manufacturing was that pharmaceutical firms had no manufacturing equivalent in LMICs to share their technologies with. Yet, reports from healthcare activists demonstrated that as many as 100 manufacturers in LMICs worldwide could be upskilled quickly to get vaccine production going at short notice (Human Rights Watch, 2021). Clearly, pharmaceutical companies were simply not willing to share their vaccine patents and know-how. A key argument of the paper – a longer version of which can be found here - is that pharmaceutical companies have a fundamental moral duty to share their intellectual property rights (IRPs), know-how and technical expertise (more) fairly and widely and that this needs to go well beyond tokenistic and selective corporate social responsibility (CSR) efforts that are current industry practice. Arguing that such voluntary technology transfer will always be likely to fall short of need, we see a unique window of opportunity to inscribe a global level of solidarity into law through the current Pandemic Treaty or Accord negotiations at the World Health Organization (WHO). The suggestion to anchor so-called technology transfers into global trade agreements have been made for over 30 years. Technology transfers have been recognized as a sustainable way to build manufacturing ecosystems across the globe, and now is the time to enshrine them at a global institutional level of solidarity.

With this paper, we suggest that solidarity should be seen as a key principle of organizing the pharmaceutical industry at a collective, global level. Without such enforcement of solidarity at a global level, pharmaceutical capabilities will never be spread evenly and health injustices, like the high death toll in LMICs during Covid-19, will likely be repeated in the future.

Solidarity as 'standing together' in times of need

Solidarity is an agreement to 'stand together' and a promise to support each other in times of need. It matters because we feel the same when we go through difficult times (Durkheim, 1964), and we all have to face collective adversity at times. This similarity or sharedness binds people, organizations or even nations together (Prainsack and Buyx, 2017). By showing commitment to one another, solidarity brings mutual advantage to all parties (Horne, 2023) and helps them to achieve common goals. In relation to the pandemic, this mutual dependence was apparent to all: nobody was truly safe from Covid-19 infection until the majority of people were vaccinated (Jordà et al., 2020).

Solidarity exists at different levels (Prainsack and Buyx, 2012). At an 'interpersonal level', solidarity means individuals working together to stand with and up for each other. Just think back to the UNICEF "buy one give one" campaign. When the world suffered, many people donated money to buy vaccines for others in LMICs (UNICEF, 2022). At a 'group level', shared agreements and commitments were made to get the elderly and healthcare workers vaccinated

first, for example. Finally, the 'contractual/ legal level' refers to the institutionalized forms of solidarity – these exist on a national or state level. For instance, a state's national healthcare system is an institutionalized commitment to care for any sick person in that country. Thus, solidarity is much more than just a voluntary personal notion: it is a value that should be imprinted into the DNA of modern social and political institutions (Prainsack and Buyx, 2017). Reaching beyond these three levels, we argue that global solidarity could be seen as a guiding principle to realize health as a human right for everyone (UN, 2014, 2015), especially when it comes to global know-how and equitable access to medicines.

Organizing technology transfers on principles of solidarity

"Teaching the person how to fish" is always better than "giving someone a fish", and the same principle applies when it comes to the technology that is needed to manufacture and scale essential medicines (Geiger and Conlan, 2022). In a pharmaceutical context, technology transfer typically consists of so-called originator pharmaceutical companies licensing out or otherwise sharing their intellectual property – patents above all, but also manufacturing know-how, scientific studies, formulas, ingredients, equipment, training, information about installation, and equipment functioning or cooperation arrangements (UNCTAD, 1996) - to help other manufacturers to build their own capacities for pharmaceutical production. As early as the 1980s, the United Nations (UN) recognized that intellectual property laws, rules and regimes have a detrimental impact on healthcare in LMICs. The UN has suggested ever since that the pharmaceutical industry should conduct their business ethically, guided by values such as solidarity, equity, fairness, humanity, and cooperation (Roffe, 1985). Yet, no laws or regulations have ever been agreed to enforce pharmaceutical technology transfers (Bünder et al., 2022). That given, pharma firms have been left in a position where they can decide freely what solidarity, ethics and humanity mean to them and how to implement those values in practice. Below is a closer look at pharma's values and actions across the three solidarity levels during the pandemic and a clarification of why urgent action is needed.

At the *individual level of solidarity,* only a handful of pharmaceutical companies have ever engaged in technology transfer efforts. Worth mentioning here is Eli Lilly's multidrug-resistant tuberculosis (TB) program. As part of their CSR efforts, Lilly spent 12 years and US$170 million to share intellectual property licenses, training programs, and research for multidrug-resistant tuberculosis with selected manufacturers in LMICs (Lilly, 2011). While this program was quite successful, it was shelved when Lilly's share price plateaued and shareholders started to get nervous about profit margins (Google Finance, 2022). Despite the success of this technology transfer initiative and a handful of other firm-level tech transfer programmes to increase access to medicines, Covid-19 manufacturers were reluctant to engage with similar voluntary access initiatives. Both Moderna and Pfizer/BioNTech kept repeating the same arguments over and over again: that manufacturers in LMICs were not ready to 'receive' their technologies and that given the pandemic situation, the pharma companies themselves did not have the extra staff or resources needed to set up projects in LMICs. Both arguments have been dispelled since. In the end, instead of sharing their technology and know-how with local

manufacturers, Moderna chose to launch a €437 million effort to build a vaccine plant in Africa. They also exported so-called "BioNTainers" - containers that hold a modular mRNA vaccine manufacturing assembly line aimed at relieving vaccine shortages in the short run (BioNTech, 2022). However, these initiatives focussed on selected LMICs only and they run at the full discretion and control of the pharmaceutical company, including the decision of how much to spend and when to pull back. What is more, as neither of these initiatives involves the transfer of patents or know-how, no meaningful transfer of knowledge to LMICs occurs in the long run (Paiva and Miguel, 2022).

At a *group level of solidarity*, vaccine-producing pharmaceutical companies could have chosen to put their technology into 'technology access pools' or 'technology transfer hubs'. Technology pools are public-private partnerships that work by encouraging commercial companies to act with solidarity and license their technologies - either for free or for a modest royalty. Often technology pools combine relevant patents before they get generic manufacturers in LMICs involved in producing these (old and new) formulations at scale. This blueprint has proven to be quite successful: The United Nations-backed Medicines Patent Pool has worked since 2010 toward scaling the manufacturing of essential medicines in LMICs for illnesses including HIV/AIDS, Hepatitis or TB medicines (MPP, 2022). During the pandemic, the WHO launched the Covid-19 Technology Access Pool (C-TAP), modelled on and with support of the Medicines Patent Pool. However, none of the pharmaceutical companies showed any willingness to share and the pool essentially remained empty of patents (Geiger and McMahon, 2023). Technology transfer hubs, another way of voluntary licensing and bundling different patents, fared no better. A mRNA hub was proposed and launched by the WHO in South Africa with the aim of reverse-engineering Moderna's Covid-19 vaccine and spreading the resulting technology out to different 'spoke' manufacturers in various LMICs (Davies, 2022). While Moderna could not take any legal action against the hub as reverse-engineering is legally permitted in South Africa, they offered no help to the hub either (Nolan, 2021). Reports even indicated that they used their powerful PR-machine to create political opposition to the hub. As we can see: in theory, voluntary group-level (that is industry-wide) approaches to technology transfer of pharmaceutical technologies into LMICs could work well as they manage many aspects of complexity, resources, and time better than individual firm efforts. However, by and large, the pharmaceutical industry has shown itself to be largely apathetic in participating in these efforts, including during the recent pandemic.

When it comes to technology transfers organised at a national *institutional level*, voluntary efforts tend to be replaced by mandatory commitments or laws. Until the mid-1990s, most countries had their own intellectual property laws and arrangements. India, known for a long time as the 'pharmacy of the Global South', for instance, was a proficient copier of technologies from originators in high-income countries and had a vibrant generics industry. However, this changed in 1995 when the World Trade Organization (WTO) implemented the Agreement on Trade-Related Aspects of Intellectual Property Rights, or TRIPS in short. Any country that wished to be part of the WTO had to agree to the laws and enforcement procedures outlined by TRIPS related to trademarks, copyrights, patents, information, and designs (WTO, 2022a, b).

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In fact, TRIPS was the mechanism that made technology transfers necessary for LMICs (t'Hoen et al., 2011). An amendment to TRIPS known as the Doha Declaration 2002 provided a legal route to enforcing technology transfers in cases of public health emergencies: compulsory licencing mechanisms. Compulsory licensing is a legal procedure whereby a company is forced to license their intellectual property (e.g. a patent for medications). Cumbersome and time–consuming, this procedure can only be implemented on a case-by-case and country-by-country basis and often not without retaliation from countries that are host to big pharmaceutical firms. During the HIV/AIDS pandemic, the South-African government under Nelson Mandela actually took big pharma to court in 1998 to enforce compulsory licencing of life-saving but highly expensive AIDS medication (Medecins Sans Frontiers, 2009) – a move that was strongly opposed by the U.S. To avoid the unavoidable delays that compulsory licensing causes, many legal commentators and civil society organizations called for a full TRIPS waiver for Covid-19 related technologies, including vaccines. However, after a full 18 months of negotiations only a 'compromise text' was agreed (Thambisetty et al., 2021) - and not until mid-2022 (WTO, 2022c). This so-called 'targeted TRIPS waiver' covers patents (but not diagnostics or therapeutics) for a 5-year time span or until the pandemic is formally over. It ensures that the basic provisions of TRIPS are 'not violated' (ibid). Many commentators consider the compromise waiver as a failure and a betrayal of LMICs (Corporate Europe Observatory, 2022).

Another idea to institute solidarity at national institutional level would be to introduce "conditionalities" into the public R&D subsidies that pharmaceutical firms receive from governments, e.g., university supports, tax breaks and investment incentives, just to name a few (Krikorian and Torreele, 2022). Conditionalities provide a legal basis that ensures that pharmaceutical companies have no choice but to act with solidarity - charging less and/or sharing more fairly in return for public money. While conditionalities are certainly a remedial option at a national level, their enforcement across global markets would be a significant challenge.

A global level of solidarity

To truly reorient the system towards the 'global public interest' (Swaminathan et al., 2022), we propose to add a fourth one to Prainsack and Buyx's (2017) three solidarity tiers: the global level. We believe that only global solidarity that is organized and harmonized at a global level, with equal voices by all concerned, would be able to overcome the power positions of Big Pharma manufacturers and their protectionist governments. Tier-4 global solidarity would be globally organized and governed by strong supranational institutions, for instance a much-strengthened WHO, replacing what Kickbusch and Holzscheiter (2021, n.p.) have diagnosed as a "highly fragmented and often poorly synchronized [global] institutional patchwork".

Solidarity-driven global change has been achieved before, for instance in the banning of certain pesticide (Maguire and Hardy, 2009) or ozone depleting substances (Maxwell and Briscoe, 1998). These are important blueprints for future pandemic preparedness. A perfect platform to initiate such change is the pandemic treaty negotiations, which commenced at the UN in March

2022 (EU, 2022). The pandemic treaty, or so-called 'pandemic accord', brings together WHO countries to develop an international agreement, rules and norms on how countries can better prevent pandemics from happening and respond better to future health emergencies (D'Auterive, 2023). This accord builds on principles of equity and solidarity, and it explicitly links "faster development and deployment of new vaccines and medicines worldwide" to "respect and protect[ion of] human rights" (ibid, n.p). Treaty negotiations are currently underway and will likely last at least until the World Health Assembly of May 2024. Gostin, the director of the WHO's Collaborating Center on National and Global Health Law, had to acknowledge recently: the originally norms-driven language of the pandemic treaty 'zero draft' has been substantially watered down already, also in relation to technology transfers (Balakrishnan, 2023), yet it is still an important step in the right direction to constitute a legally-binding level of global solidarity in access to medicines.

To both achieve a meaningful treaty promoting global solidarity and ensure its enforcement in a health crisis, the WHO would have to be empowered significantly, and a rebalancing of power between the WHO and WTO, at least in times of global health emergencies, will be required too.

Conclusion

This paper is a call for 'tech sharing instead of tech hoarding', in the words of UNAIDS Executive Director Winnie Byanyima (Gitahi and Byanyima, 2022): embedding global solidarity as a core organizing principle into international pharmaceutical legislation and institutions. Reviewing the near-complete lack of solidaristic concern of vaccine manufacturers and their unwillingness to 'carry costs' to enable vaccine equity during Covid-19, we argued that existing calls for vaccines to be a global public good on the basis of global solidarity have proven woefully inadequate. We thus call for societal agreement to institutionalize global solidarity as an organizing principle for global health and to compel pharmaceutical firms to share medical technologies and knowledge with regional partners in LMICs in order to build up local manufacturing ecosystems.

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References

Balakrishnan, V. S. (2023) 'WHO Pandemic Treaty: The Good, The Bad, & The Ugly – An Interview With Larry Gostin'. 14 September. Available from: https://healthpolicy-watch.news/who-pandemic-treaty-the-good-the-bad-the-ugly-an-interview-with-larry-gostin/

BioNTech (2022) 'BioNTech Introduces First Modular mRNA Manufacturing Facility to Promote Scalable Vaccine Production in Africa'. 16 February. Available from: https://investors.biontech.de/news-releases/news-release-details/biontech-introduces-first-modular-mrna-manufacturing-facility#:~:text=The%20establishment%20of%20the%20first,the%20second%20half%20of%202022.

Bünder, T., Rathert, N. and Mair, J. (2022) 'Understanding Firm-and Field-Level Change Toward Sustainable Development: Insights From the Pharmaceutical Industry and Access to Medicines, 1960-2020', in G. Eorge, G. Haas, M. R. Joshi, et al. (eds) *Handbook on the Business of Sustainability*, pp. 300–19. Cheltenham: Edward Elgar Publishing.

Corporate Europe Observatory (2022).'TRIPS 'Waiver failure': EU betrayal of global south on vaccine access obscured by lack of transparency'. 8 July. Available from: https://unfoundation.org/blog/post/the-pandemic-accord-explained-what-countries-are-doing-to-protect-against-future-global-health-emergencies/?gclid=Cj0KCQjwoK2mBhDzARIsADGbjep2Q5SMFQgIV74pmOyUCbqOnvOefi1Ehx9Ys243WpVbPor8e36JT8MaApmfEALw_wcB

D'Auterive, N. (2023). 'The pandemic accord explained: what countries are doing to protect against future global health emergencies'. 19 May. Available from: https://unfoundation.org/blog/post/the-pandemic-accord-explained-what-countries-are-doing-to-protect-against-future-global-health-emergencies/?gclid=Cj0KCQjwoK2mBhDzARIsADGbjep2Q5SMFQgIV74pmOyUCbqOnvOefi1Ehx9Ys243WpVbPor8e36JT8MaApmfEALw_wcB

Davies, M. (2022) 'Covid-19: WHO Efforts to Bring Vaccine Manufacturing to Africa Are Undermined by the Drug Industry, Documents Show', *British Medical Journal* 376: o304.

Durkheim, E. (1964) '*The Division of Labour in Society'*. New York, NY: Free Press.

EU (2022) 'An International Treaty on Pandemic Prevention and Preparedness'. Available from: https://www.consilium.europa.eu/en/policies/coronavirus/pandemic-treaty/

Geiger, S. and Conlan, C. (2022) 'Global Access to Medicines and the Legacies of Coloniality in COVID-19 Vaccine Inequity', *Policy & Practice* 34: 46–61.

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Website: https://www.ucd.ie/geary Email: geary@ucd.ie.

Geiger, S. and McMahon, A. (2021) 'Analysis of the Institutional Landscape and Proliferation of Proposals for Global Vaccine Equity for COVID-19: Too Many Cooks or Too Many Recipes?'. *Medical Ethics Journal*. 48(9) Available from: http://dx.doi.org/10.1136/medethics-2021-107684

Gitahi, G. and Byanyima, W. (2022) 'African Leadership is Essential to Overcoming Global Pandemics'. 24 August, Available from: https://www.dailymaverick.co.za/article/2022-08-24-african-leadership-is-essential-to-overcoming-global-pandemics/

Google Finance (2022) 'Eli Lilly and Co'. Available from: https://www.google.com/finance/quote/LLY:NYSE?sa=X&ved=2ahUKEwjlr_7WyvP5AhXJTcAKHTsTCCYQ3ecFegQIIhAi&window=MAX

Holden, J. (2022) 'Tracking Coronavirus Vaccinations Around the World'. Available from: https://www.scientificamerican.com/article/a-covid-vaccine-for-all/

Horne, L. C. (2023) 'Two Conceptions of Solidarity in Health Care'. *Social Theory and Practice*. Available from: https://philpapers.org/rec/HORTCO-32

Human Rights Watch (2021) 'Experts Identify 100 plus Firms to make Covid-19 Vaccine', 15 December. 15 December, Available from: https://www.hrw.org/news/2021/12/15/experts-identify-100-plus-firms-make-covid-19-mrna-vaccines#:~:text=%E2%80%9CThere%20are%20over%20100%20companies,vaccine%20supply%20in%20poor%20countries.

Jordà, O., Singh, S. R. and Taylor, A. M. (2020) 'The Long Economic Hangover of Pandemics', *IMF Finance & Development* 57(2): 12–5.

Kickbusch, I. and Holzscheiter, A. (2021) 'Can Geopolitics Derail the Pandemic Treaty?', *British Medical Journal* 375: e069129.

Krikorian, G. and Torreele, E. (2022) 'We Cannot Win the Access to Medicines Struggle Using the Same Thinking That Causes the Chronic Access Crisis', *Health and Human Rights* 23(1): 119–27.

Lalani, H. S., Avorn, J. and Kesselheim, A. S. (2022) 'US Taxpayers Heavily Funded the Discovery of COVID-19 Vaccines', *Clinical Pharmacology and Therapeutics* 111(3): 542–4.

Lilly (2011) 'Lilly Foundation Commits US $30 Million to The Lilly MDR-TB Partnership'. 27 October, Available from: https://investor.lilly.com/static-files/a831523d-2007-460e-ae73-29e16dbfedc3

Maguire, S. and Hardy, C. (2009) 'Discourse and Deinstitutionalization: The Decline of DDT', *Academy of Management Journal* 52(1): 148–78.

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Website: https://www.ucd.ie/geary Email: geary@ucd.ie.

Maxwell, J. and Briscoe, F. (1998) 'There's Money in the Air: The CFC Ban and DuPont's Regulatory Strategy', *Business Strategy and the Environment* 6(5): 276–86.

Medecins Sans Frontiers (2009) '1998: Big Pharma Versus Nelson Mandela'. 20 February. Available from: https://msfaccess.org/1998-big-pharma-versus-nelson-mandela

Medicines Patent Pool (2022) 'About Us'. Available from https://medicinespatentpool.org/

Murphy, T. (2022) 'COVID-19 Vaccine Sales Push Moderna to $12B profit in 2021', *ABS News*, 24 February. Available from: https://apnews.com/article/coronavirus-pandemic-business-health-united-states-36c2759d0dd5d2bbb3a48d99f3b6d759

Nolan, S. (2021) 'Here's Why Developing Countries Can Make mRNA Covid Vaccines', *New York Times*, 22 October. Available from: https://www.nytimes.com/interactive/2021/10/22/science/developing-country-covid-vaccines.html

Oxfam (2022). 'COVID-19 death toll four times higher in lower-income countries than rich ones', 3 March. Available from: https://www.oxfam.org/en/press-releases/covid-19-death-toll-four-times-higher-lower-income-countries-rich-ones

Paiva, E. L. and Miguel, P. L. (2022) 'Overcoming Enduring Inequalities in Global Value Chains? Interpreting the Case of Brazil's Covid-19 Vaccine Supply Through a Chess Metaphor', *Organization* 29: 414–25.

Prainsack, B. and Buyx, A. (2012) 'Solidarity in Contemporary Bioethics–Towards a New Approach', *Bioethics* 26(7): 343–50.

Roffe, P. (1985) 'Transfer of Technology: UNCTAD's Draft International Code of Conduct', *The International Lawyer* 19(2): 689–707.

Swaminathan, S., Pécoul, B., Abdullah, H., et al. (2022) 'Reboot Biomedical R&D in the Global Public Interest', *Nature* 602: 207–10.

t'Hoen, E., Berger, J., Calmy, A., et al. (2011) 'Driving a Decade of Change: HIV/AIDS, Patents and Access to Medicines for All', *Journal of the International Aids Society* 14(1): 15.

Thambisetty, S., McMahon, A., McDonagh, L., et al. (2021) 'The COVID-19 TRIPS Waiver Process in Critical Review: An Appraisal of the WTO DG Text (IP/C/W/688) and Recommendations for Minimum Modifications'. Available from: http://dx.doi.org/10.2139/ssrn.4124497

UN (2014) 'The Road to Dignity by 2030: Ending Poverty, Transforming all Lives and Protecting the Planet'. Available from:

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Website: https://www.ucd.ie/geary Email: geary@ucd.ie.

https://www.un.org/disabilities/documents/reports/SG_Synthesis_Report_Road_to_Dignity_by_2030.pdf

UN (2015) 'Transforming Our World: The 2030 Agenda for Sustainable Development'. Available from: https://sdgs.un.org/2030agenda

UNCTAD (1996) 'Facilitating Transfer of Technology to Developing Countries: A Survey of Home-Country Measures'. Available from: https://unctad.org/system/files/official-document/iteipc20045_en.pdf

UNICEF (2022) 'Covid-19 Vaccine Appeal'. Available from: https://www.unicef.ie/donate/get-a-vaccine-give-a-vaccine/#1

Watson OJ, Barnsley G, Toor J, Hogan AB, Winskill P and Ghani AC (2022) 'Global impact of the first year of COVID-19 vaccination: a mathematical modelling study'. *The Lancet Infectious Diseases*, 22(9): 1293-1302.

World Trade Organization (2022a) 'Part III — Enforcement of Intellectual Property Rights'. Available from: https://www.wto.org/english/docs_e/legal_e/27-trips_05_e.htm

World Trade Organization (2022b) 'TRIPS — Trade-Related Aspects of Intellectual Property Rights'. Available from: https://www.wto.org/english/tratop_e/trips_e/trips_e.htm

WTO (2022c).'TRIPS Council welcomes MC12 TRIPS waiver decision, discusses possible extension'. 7 July. Available from: https://www.wto.org/english/news_e/news22_e/trip_08jul22_e.htm#:~:text=At%20MC12%2C%20trade%20ministers%20adopted,over%20the%20next%20five%20years

Zakiyah, E. (2022) 'Africa's First mRNA Hub in Cape Town a Potential 'Game Changer', Says WHO Boss'. 16 February, Available from: https://www.news24.com/life/wellness/body/condition-centres/infectious-diseases/coronavirus/pics-africas-first-mrna-hub-in-cape-town-a-potential-game-changer-says-who-boss-20220216-2

Ziady, H. (2021) 'Covid Vaccine Profits Mint 9 New Pharma Billionaires', *CNN Business*, 21 May. Available from: https://edition.cnn.com/2021/05/21/business/covid-vaccine-billionaires/index.html

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