COVINFORM

COronavirus Vulnerabilities and INFOrmation dynamics Research and Modelling

COVID-19 Vaccines: History and Facts

Bi-Monthly Report: 01

adapted & shortened version

Authors

Elena Ambrosetti & Marina Zannella,
Sapienza University of Rome

Diotima Bertel,
SYNYO

Su Anson,
Trilateral Research

Alberto Hernández Tejedor,
Samur Proteccion Civil

To cite this report: Ambrosetti, E., Zanella, M., Bertel, D., Anson, S., & Tejedor, P. (2021). COVID-19 vaccines: history and facts. Bi-monthly report 1, January 2021. COVINFORM H2020 Project No. 101016247.

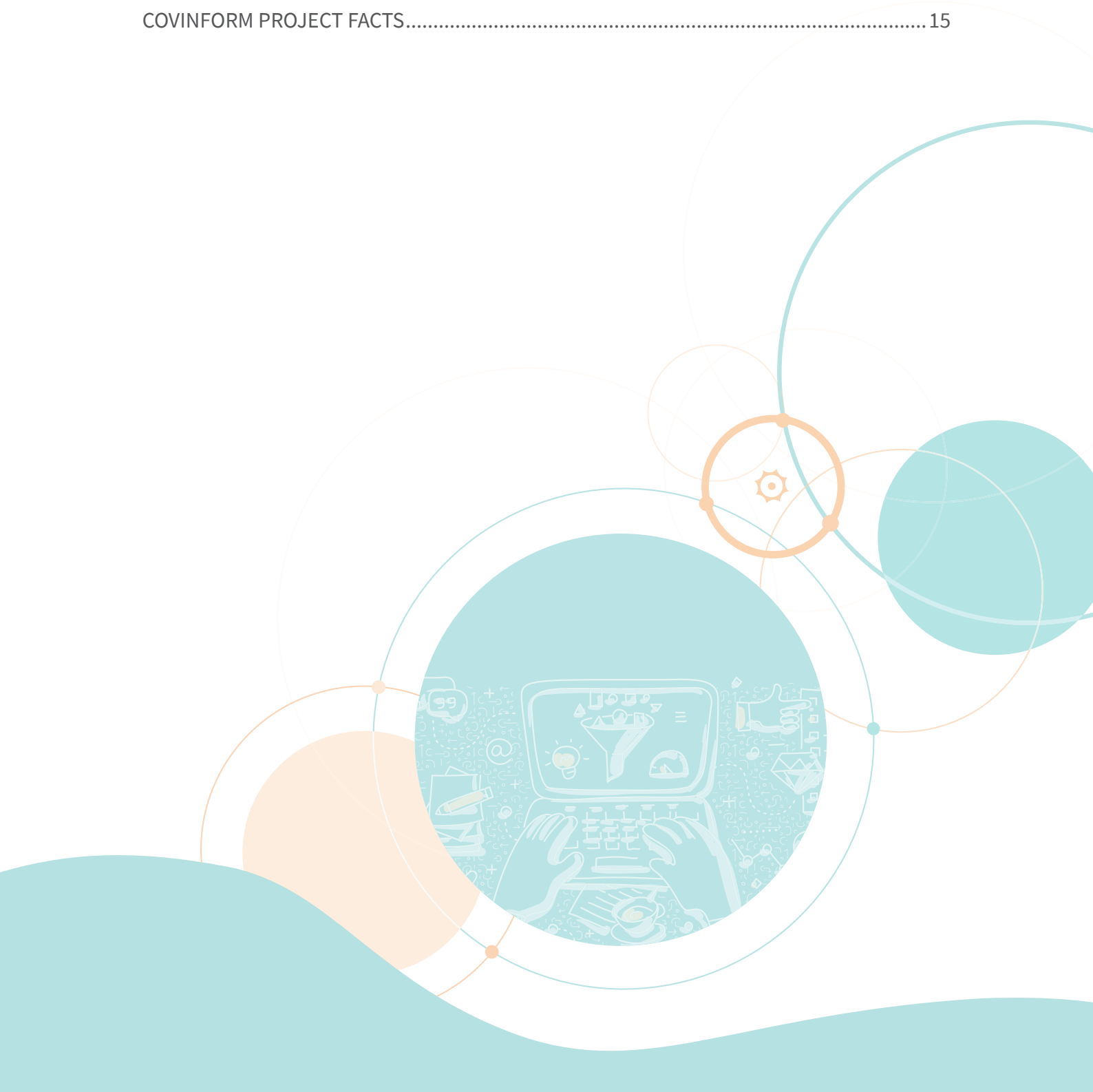
Contributors

Melania Parzonka & Corinna Pannofino,
Trilateral Research

Disclaimer

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 101016247.

Table of Contents



A CONCISE HISTORY OF VACCINES

In the 20th century, nearly 1.7 billion people died from infectious diseases. Here are some of the most dramatic numbers: 400 million deaths from smallpox, 96.7 million deaths from measles, 38.1 million deaths from whooping cough, more than 37 million deaths from tetanus, 12.7 million deaths from hepatitis B, and nearly 22 million deaths from meningitis[1].

Today, thanks to the use of vaccines, cases of diphtheria, measles, rubella, mumps, whooping cough, tetanus and diseases caused by *Haemophilus influenzae,* have been reduced by 98 percent, proving that the vaccines are the most effective medicines in the world. In the Western world, mass vaccinations have prevented the deaths of 500 million people (slightly more than the current total population of the 27 EU countries in 2020)[2].

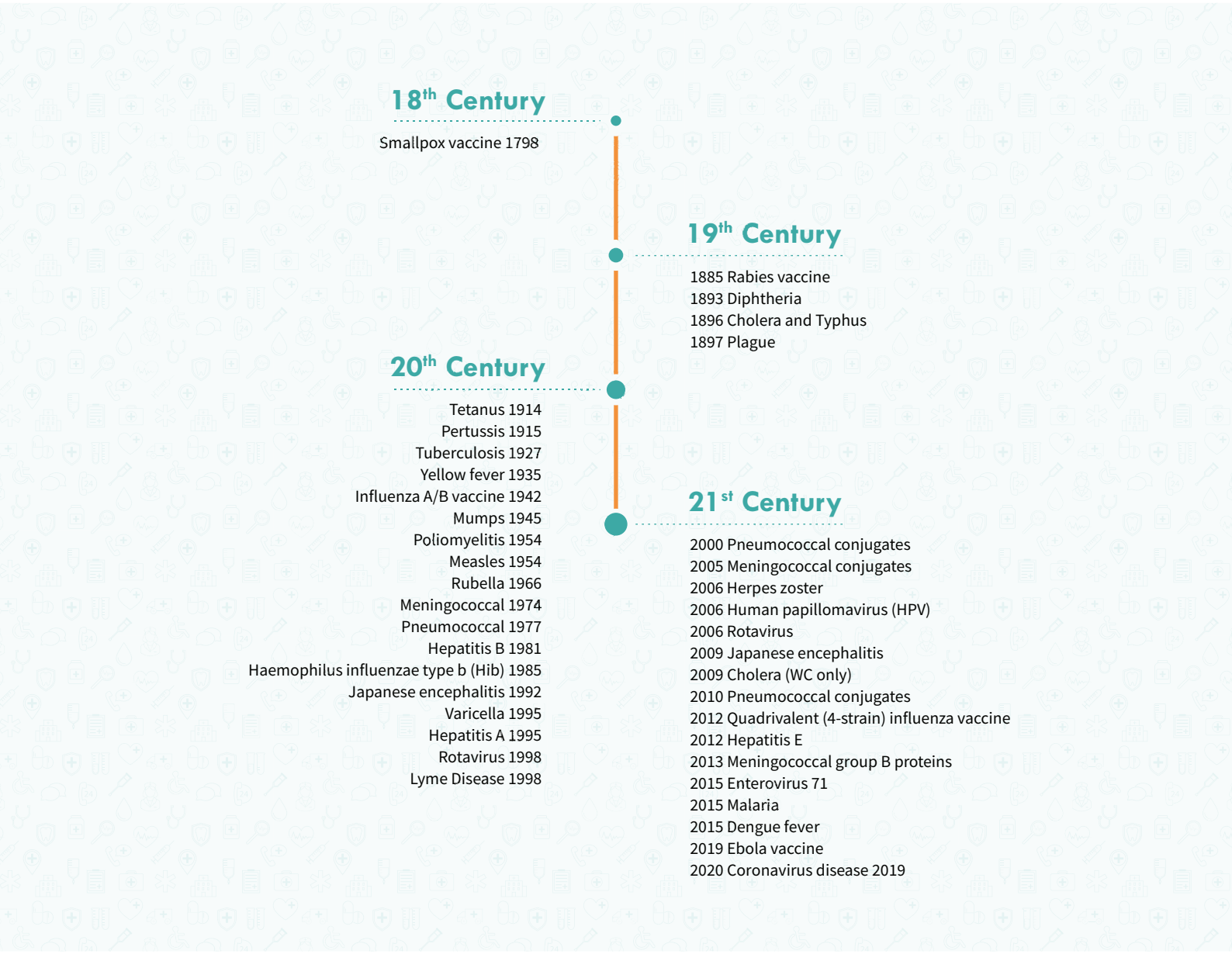
The first vaccine, the one against the smallpox, was introduced at the end of the 18th century by the British doctor Edward Jenner. Jenner had the intuition of the vaccine while observing the powers of cowpox to prevent smallpox. Over the last two centuries, the success of vaccines in saving human lives came from predictions made from the study of animal models, natural infections and sero-epidemiology: thanks to those predictions it has been possible to produce protective antibodies. At the end of the 19th century, the French microbiologist Louis Pasteur, adopting a similar technique to the one used by Jenner, introduced the rabies vaccine (1885). From Pasteur onward, the rush toward vaccine production has been impressively fast, at the rate of nearly one vaccine every year (Figure 1)[3]. In 1886, the vaccines for cholera and typhoid were introduced, in 1897 the vaccine for plague, in 1923 the vaccine for diphtheria, in 1926-1927 the vaccines for whooping cough, tetanus and tuberculosis, in 1935 the vaccine for yellow fever, in 1955 the vaccine for poliomyelitis, between 1963 and 1969 the vaccines for measles, mumps and rubella, and in the following years those against meningitis (various strains in 1975, 1985, 2013), pneumonia (1977), hepatitis B and A (1981, 1995), chickenpox (1995), papilloma virus (2006) and many others for minor diseases.

[1] Information is beautiful. 20th Century Death | see here & here
[2] Grignolio, A. (2016). Chi ha paura dei vaccini? Codice.
[3] Plotkin, S. (2014). History of vaccination. Proceedings of the National Academy of Sciences, 111(34), 12283-12287.

The protagonist of post-World War II vaccinology was the American microbiologist Maurice Hilleman (1919-2005), who worked on the measles vaccine. He created nine of the most widely used vaccines today (including those against mumps, rubella, hepatitis A, hepatitis B and pneumonia) and in 1971 developed the second most important combination vaccine after the diphtheria, pertussis (whooping cough), and tetanus vaccine (DPT), namely the trivalent measles-mumps-rubella. Hilleman is perhaps the man who has saved the most lives in history: about eight million a year, according to an estimate published in *Nature*[4].

Early techniques used for the development of vaccines were based on the production of protective antibodies and on cellular functions able to control pathogen replication in the occurrence of an infection despite the presence of antibodies. These techniques are still crucial even though new strategies for vaccine development already exist[5].

Figure 1. Timeline of vaccines from 18th to 21st century



[4] Dove, A. (2005). Maurice Hilleman. Nature medicine, 11(4), S2-S2.
[5] Plotkin, S. A., & Plotkin, S. L. (2011). The development of vaccines: how the past led to the future. Nature Reviews Microbiology, 9(12), 889-893. & Rappuoli, R., Pizza, M., Del Giudice, G., & De Gregorio, E. (2014). Vaccines, new opportunities for a new society. Proceedings of the National Academy of Sciences, 111(34), 12288-12293.

WHAT IS THE CURRENT STATE OF PROGRESS OF COVID VACCINES?

The end of 2020 brought new hope to tackle the pandemic: the approval in several countries of safe and effective vaccines to protect against COVID-19. Since the dawn of the pandemic, scientists around the world have been engaged in a race against time to stop the virus, which to date has claimed 1.926.625 lives globally[6]. Their efforts bore fruits: researchers are testing 289 candidate vaccines today, while 10 are already in use (Figure 2)[7]. Still, there are many challenges to face: countries must organize vaccination strategies and vaccination deployment plans and it will be necessary to keep the guard up for months to come until the immunization of the population is achieved.

Figure 2. Number of existing COVID-19 vaccines by status

[6] WHO data updated to January 10, 2021. https://covid19.who.int/
[7] COVID-19 vaccine tracker developed by the Vaccine Centre at the London School of Hygiene & Tropical Medicine (data updated to 1 Jan. 2021). https://vac-lshtm.shinyapps.io/ncov_vaccine_landscape/_w_a1ac4096/#

Despite the enthusiasm for these achievements bringing new hope for the future, many people are skeptical regarding the rapidity with which the vaccine was developed. **So how was the rapid development of the vaccine possible?**

COVID-19 vaccines follow the same development procedures as other vaccines but in a compressed time (Figure 3). Different approaches have been used by companies to speed up the development timelines, including combining clinical trial phases and mobilizing more human resources. The compression of time has been facilitated by early and continuous dialogue between developers and regulatory experts, as in the case of the European Medicines Agency (EMA) that offers informal consultation with its COVID-19 Task Force (ETF) and rapid scientific advice (see here). These different strategies (or their combination) made the fast-track development of COVID-19 vaccines possible without compromising quality and safety standards. Once all the development stages are successfully completed, national and supranational regulators perform quality, safety and efficacy checks for which developers must provide data from all testing / investigations done. Regulators are actively engaged in reducing the timeframe for evaluation as far as safety standards are guaranteed, for example by accessing data as they become available during the development process. After approval, the safety of vaccines is monitored while they are in use to evaluate their efficacy and possible rare side effects.

Figure 3. Vaccines development process

PHARMACEUTICAL QUALITY

Scientists perform small-scale studies to determine the vaccine's final formulation

PRECLINICAL TESTING

Scientists perform in vitro and animal studies to evaluate the immune response generated by the vaccine

CLINICAL TRIALS, PHASE I

The vaccine is given to a small number (generally **20-100**) of **volunteers** to assess its safety and ability to generate an immune response, as well to determine the right dosage

CLINICAL TRIALS, PHASE II

The vaccine is tested on a larger group (**several hundreds**) of **volunteers** to confirm its efficacy and to study the best dosing and the most common side effects

CLINICAL TRIALS, PHASE III

This phase involves **thousands of volunteers** and shows how effective the vaccine is at protecting against the infection and what are the less common side effects

The Vaccine Centre of the London School of Hygiene & Tropical Medicine reports that there are currently 220 COVID-19 vaccines in preclinical testing and 70 in clinical evaluation. The detailed status of the progress of vaccine candidates is shown in Figure 4.

Figure 4. Number of COVID-19 vaccines in development by clinical phase

Table 1 COVID-19 Vaccines currently in use (Appendix)[8]

	BioNTech/ Pfizer BNT162b2	Beijing/ Sinopharm BBIBP-CorV	Moderna mRNA-1273
Where?	Approved in Canada, EU and other countries. Emergency use in U.K., U.S. and other countries. Approved for emergency use by WHO	Approved in China, U.A.E., Bahrain. Emergency use in Egypt	Approved in Canada. Emergency use in U.S., EU, Israel
Type	Messenger RNA Vaccines[9]	Inactivated Coronavirus Vaccines[10]	Messenger RNA Vaccines
How is it given?	2 doses, 3 weeks apart, intramuscular injection	2 doses, 3 weeks apart, intramuscular injection	2 doses, 4 weeks apart, intramuscular injection
What are its storage requirements?	Ultra-cold (-60°C to -80°C)	Pending - refrigeration (2°C to 8°C) is typical for inactivated vaccines	Refrigeration (2°C to 8°C) for up to 30 days or frozen (-15°C to -25°C) for long-term storage
Total number participating in registered trials	45,838	56,128	33,720
Efficacy data	Vaccine efficacy against COVID-19 reported to be 95% based on primary analysis of 170 confirmed cases	Vaccine efficacy against COVID-19 reported to be 79% but data are pending	Vaccine efficacy against COVID-19 reported to be 94.5% based on based on data on 95 cases

[8] Information is taken from: COVID-19 vaccine tracker developed by the Vaccine Centre at the London School of Hygiene & Tropical Medicine (data updated to 1 January 2021) and WHO (data updated to January 10, 2021).

[9] RNA and DNA vaccines represent a cutting-edge approach that uses genetically engineered RNA or DNA to generate a protein that itself safely prompts an immune response.

[10] This type of vaccine consists of the disease-causing virus that has been inactivated or weakened (with heat or chemicals) so it does not cause disease but still it is able to generate an immune response. It can be used in people that may not be able to use a live attenuated virus vaccine (e.g., those who are immunocompromised).

INFORMATION & MISINFORMATION ABOUT COVID-19 VACCINATIONS

How do I make sense of all the COVID-19 vaccine information?

Since the emergence of the coronavirus pandemic in 2019, there has been a vast amount of information shared about the risk, protective actions and restrictions, and more recently about the COVID-19 vaccines. However, the amount of information and presence of contradictory information can make it difficult to decide what information to trust and whether to take the vaccine.

As countries across the globe roll out their vaccination programme, priority is typically being given to healthcare workers, people in a higher age group (e.g., over 70), and the clinically vulnerable. Information on priority groups and how and when you may have access to the vaccine may be available from your national government and public health authorities. Not everyone will share the same views of the vaccine and there are some people who may choose not to have the vaccine. However, it is important that any information covering the COVID-19 vaccine is clear and can be understood to enable people to make an informed decision.

Information on the COVID-19 vaccine will be available from a variety of different sources. This will include both different organisations (e.g., government, public health authorities, the media, community leaders, etc) and different channels (e.g., websites, social media such as Twitter or Facebook, television, printed materials, etc). Information may cover:

- The development and testing of the vaccine
- The roll-out of the vaccine to different groups
- The benefits and risks of having the vaccine
- Advice for particular groups such as pregnant women
- How you will receive the vaccine (e.g., number of doses)
- The effectiveness of the vaccine
- Side effects of the vaccine
- COVID-19 myths and correcting inaccurate information

There may be groups of the public that are unable to access the information available for different reasons such as not having access to online information and the information being available in limited languages and formats (e.g., not being available in audio or large print). If there are members of your family and friends who are unable to access information on the COVID-19 vaccine, please do share any facts with them. As the next section highlights, the COVID-19 pandemic has also witnessed an overwhelming amount of false information.

How do I know what information to trust?

According to the World Health Organisation (WHO), the COVID-19 pandemic has been accompanied by an *infodemic*[11]. An infodemic describes the fast spread of a both misinformation and factual information, resulting in an overabundance of information.

Especially the rapid development and distribution of vaccines have been accompanied by a large amount of misinformation, myths and conspiracy theories. Misinformation is harmful in several ways: it endangers democracy, public health, and even the lives of individuals. However, there are simple ways to 'flatten the curve of the infodemic'. The EU-funded H2020 project EUNOMIA[12] has defined guidelines for *Information Hygiene* that are simple and easy to apply by everyone:

Be cautious of information forwarded to you through your network. Because we tend to trust our friends, our cognitive filters weaken, making a social media feed fertile ground for misinformation, disinformation and 'fake news' to sneak into our consciousness.

Be wary of popular posts. Misinformation travels significantly faster, deeper and more broadly than the truth. Posts from individuals or organisations that are experts in a topic are not necessarily popular in social media.

Be wary of language that is making you feel emotional. It is designed to become viral, not to inform. Online content that evokes high-arousal emotions such as anger and anxiety has been shown to spread faster and more broadly than neutral content. Misinformation often uses inflammatory and sensational language, which may alter people's emotions.

Be mindful of your emotions when reading a post. Anger makes you susceptible to biases. Anger encourages biased evaluation information, while anxiety promotes initial beliefs based on the information environment. Heightened emotionality is predictive of increased belief in misinformation.

Refrain from sharing based only on headline. Already reading a false statement once is enough to increase later perceptions of its accuracy ('illusory truth effect'). The effect holds true even if participants forget having seen the information previously. Even if people disagree with information, repetition made it more plausible.

[11] WHO (2020). *Managing the COVID-19 infodemic: Promoting healthy behaviours and mitigating the harm from misinformation and disinformation.* Retrieved from https://www.who.int/news/item/23-09-2020-managing-the-covid-19-infodemic-promoting-healthy-behaviours-and-mitigating-the-harm-from-misinformation-and-disinformation (14.01.2021)

[12] EUNOMIA User-oriented, secure, trustful & decentralised social media, project funded under Grant Agreement No. 825171. https://eunomia.social/

Take a moment to think when provided with a nudge, such as some form of flag. Most people do not want to spread misinformation, but the social media context focuses their attention on factors other than truth and accuracy. Flagging misinformation is most effective if a warning is shown even before reading misinformation, e.g. in the form of a tag that marks the information as suspect.

Be wary of resharing information for its high novelty. Misinformation not only travels faster than true information, it is also more novel. Novel information is more likely to be retweeted, because novelty attracts human attention, contributes to productive decision-making, and encourages information sharing.

Repost to refute with evidence. When resharing a post with a comment aiming to discredit it, we may still be contributing to its amplification. To be effective, corrections must explain why the misinformation was disseminated in the first place or provide an alternative explanation of the relevant information.

Use a dedicated tool or button to flag misinformation. Users are generally more likely to believe articles that agree with their point of view. Asking users to rate articles pushes them to think more critically about the truthfulness of the articles.

All in all, our recommendation is:
If in doubt, don't share.

RELEVANT SOURCES OF INFORMATION

European Centre for Disease Prevention and Control.
https://www.ecdc.europa.eu/en/covid-19-pandemic

European Commission. Coronavirus response.
https://ec.europa.eu/info/live-work-travel-eu/coronavirus-response_en#safecovid19vaccinesforEuropeans

European Vaccination Information Portal. *https://vaccination-info.eu/en*

Lewandowsky, S., Cook, J., Schmid, P., Holford, D. L., Finn, A., Leask, J., Thomson, A., Lombardi, D., Al-Rawi, A. K., Amazeen, M. A., Anderson, E. C., Armaos, K. D., Betsch, C., Bruns, H. H. B., Ecker, U. K. H., Gavaruzzi, T., Hahn, U., Herzog, S., Juanchich, M., Kendeou, P., Newman, E. J., Pennycook, G., Rapp, D. N., Sah, S., Sinatra, G. M., Tapper, K., Vraga, E. K (2021). The COVID-19 Vaccine Communication Handbook. A practical guide for improving vaccine communication and fighting misinformation. *https://sks.to/c19vax*

World Health Organisation. Coronavirus disease (COVID-19) pandemic.
https://www.who.int/emergencies/diseases/novel-coronavirus-2019

First lessons learned from COVID-19 vaccination in Spain

To illustrate the challenges public authorities may encounter, we showcase first lessons learned in the vaccination process in Spain.

In Spain, as in other countries, a vaccination plan has been developed in different phases, prioritizing vaccination for certain population groups based on risk. Until now, state bodies and security forces have collaborated in managing logistics.

However, specific incidents have occurred in the distribution and administration of vaccines that we have to learn from so that they are not repeated:

1. Administration to relatives of the people of the group to which they were directed, affecting the criteria of distributive justice.
2. Lack of training of the health worker administering the vaccine, which has led some people to receive the entire vial instead of the fraction corresponding to an individual dose.
3. Inability to administer all the vaccines due to excess doses arriving or because the number of people estimated or committed did not turn up to be vaccinated. In the case of the Pfizer/BioNtech vaccine, this implies the loss of the vaccines.

Most likely the first two have been isolated incidents that, with adequate control, training and information have a low risk of reoccurring. Regarding the third, it is necessary to dedicate sufficient personnel to the coordination tasks between the centre where the vaccines are administered and the logistics warehouse where they are stored. There will be a much higher risk of vaccine loss when vaccinating other risk groups such as the elderly, or people with chronic diseases that are self-employed and live at home, and who, for various reasons, might not attend their appointment in the vaccination centre.

To optimize the delivery of vaccines, there is a need for better coordination in distribution and storage. A fast and efficient vaccination plan is crucial for coming out of the COVID-19 pandemic, making vaccine delivery logistics a top priority and a shared concern amongst EU members.

To learn more about the vaccination campaign in Spain, read our blog post, where one of the consortium partners, SAMUR-Protección Civil – a pre-hospital emergency – service, outlines the issues that public authorities encountered with the launch of the vaccination program in Spain.

The COVINFORM project

Acronym	COVINFORM
Title	COronavirus Vulnerabilities and INFOrmation dynamics Research and Modelling
Coordinator	SYNYO GmbH
Reference	101016247
Type	Research and Innovation Action (RIA)
Programme	HORIZON 2020
Topic	SC1-PHE-CORONAVIRUS-2020-2C Behavioural, social and economic impacts of the outbreak response
Start	01 November 2020
Duration	36 months

Contact

Consortium

SYNYO GmbH (SYNYO), Austria
Magen David Adom in Israel (MDA), Israel
Samur Proteccion Civil (SAMUR), Spain
Universita Cattolica del Sacro Cuore (UCSC), Italy
SINUS Markt- und Sozialforschung GmbH (SINUS), Germany
Trilateral Research LTD (TRI UK), UK
Trilateral Research LTD (TRI IE), Ireland
Kentro Meleton Asfaleias – Center for Security Studies (KEMEA), Greece
Factor Social Consultoria em Psicossociologia e Ambiente LDA (FS), Portugal
Austrian Red Cross (AUTRC), Austria
Media Diversity Institute (MDI), UK
Societatea Națională de Cruce Rosie Din România – Romanian Red Cross (SNCRR), Romania
University of Antwerp (UANTWERPEN), Belgium
Sapienza University of Rome (SAPIENZA), Italy
University Rey Juan Carlos (URJC), Spain
Swansea University (SU), UK
Gotenborg University (UGOT), Sweden