Rapid Vaccine Distribution to Over 7.5 Billion Humans

When a COVID-19 vaccine is developed and ready for distribution it will, in all likelihood, require cold chain services. But, what environmental and economic costs will be attached to this logistical endeavour?

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Who would have said a year ago that disruptions to supply chains, and more broadly, our way of life, would not come from a new company, a start-up, or a new economic model, but rather from a virus?

The disruption caused by COVID-19 has been extensive, we cannot control its spread, and we do not understand its behaviour. How it affects our health varies from person to person for unknown reasons, and may include mild symptoms, severe symptoms, or even asymptotic cases in individuals who spread the virus unknowingly.

The Race for a Vaccine is Underway

Over 193 vaccines are currently being trialled, 151 of which are in the pre-clinical phase, and over 42 of which have begun clinical trials (1). Over eight different types of vaccines are being trialled: messenger RNA (mRNA), DNA plasmid, protein subunit, adenovirus-vectored, measles-vectored, vesicular stomatitis virus-vectored, adenovirus associated-vectored, and inactivated virus vaccines.

Laboratories are signing agreements with manufacturers to organise future peaks in production. Factories are equipped to deal with this high level of demand. Once the first vaccines are available, a whole host of questions will ensue over and above those pertaining to how effective they are and any side effects. Who will be given priority? Will the vaccine be made mandatory? Who will pay for it? How can we make sure – as WHO pointed out – that every country has access to the vaccine and not only the wealthiest nations? How can we avoid a retreat into nationalist ideas regarding the vaccine? Finding one or more vaccines is only half the job.

Vaccine Distribution and Campaigns

The SARS-CoV-2 virus has disrupted existing supply chains. The reduction (indeed, the halt last April) in the number of passenger flights led to reduced capacity and a major shift. Logistics experts, airlines, and airports have been, and are still, working hand in hand to ensure pharmaceutical products reach their destination. Passenger planes have been adapted to take packages and pallets on board rather than people. Shipping costs have shot up. The price per kilometre transported has gone up tenfold, leading to a rise in the overall cost of hiring active or passive insulated shipping solutions, which need to be repositioned by plane. Passive insulated packaging, such as the pallet shipper, which can be repositioned by boat and over a longer time, have been in high demand due to their competitive advantage and flexibility.

Despite the fact that air traffic has partially resumed, it is far from the pre-crisis level. The imminent arrival of several vaccines to protect against COVID-19 brings several challenges, dependant on data, which are, as yet, doubtful.

Vaccines Need to Be Stored at Very Low Temperatures

The vaccines that should soon be available, if Phase III is approved, include three mRNA vaccines (Moderna, Pfizer/BioNTech, and Curevac), which need to be stored at sub-zero temperatures ranging from -20°C to -70°C. If this is the case, the vaccines will need to be administered in hospitals or medical centres equipped with powerful deep-freezers, and cannot be distributed by pharmacies. Vaccination schedules will need to be put in place to avoid wasting any doses. Packaging these vaccines in doses of 6-10 will mean having to administer them within roughly six hours (2). However, access to this type of vaccine will be limited to the wealthiest countries, or the most populated cities, where the necessary infrastructure is already in place.

In terms of transportation, active and passive insulated solutions using phase change material or dry ice make it possible to transport temperature-sensitive products at very low, sub-zero temperatures. It is likely that there will not be enough active containers to meet the urgent transportation demand, and this will lead to costly movements. Once again,

reusable passive solutions, especially flat-packable ones, will reduce transportation time, make reposition by boat simpler and offer greater flexibility. Passive solutions can be produced quickly and easily. They are much more flexible. Qualified for ISTA 7D profiles, they can retain sub-zero temperatures for at least five consecutive days. Sub-zero transportation is offered by a whole host of operators. What is likely to cause a problem is the volume needing to be shipped quickly. The current infrastructure is not able to cope with such levels.

Other Promising Vaccines

However, other vaccines (protein subunit, virus-vectored, inactivated virus), should be available soon. The good news is that they won't need to be shipped at sub-zero temperatures, simply between +2°C and +8°C. Distribution will, therefore, be much easier, and it will be possible to use existing infrastructure to distribute the vaccine in pharmacies and administer it through local GPs. Nevertheless, distribution will remain challenging in countries with hot climates and little infrastructure, as is already the case for existing vaccines.

To address the urgent need for a vaccine, reusable packaging like pallet shippers that can be flat packed for transportation and storage, will be in high demand. PMC loading can, therefore, be optimised with four pallet shippers. Some experts believe that it will take 12,000 cargo planes to supply to three-quarters of the world's population. A real logistical challenge that all operators are preparing for in a time of uncertainty. It is vital that pharma labs, airlines, logistics experts, and countries share information in order to coordinate vaccine distribution. Neel Jones Shah, TIACA board member said: "Covid-19 vaccine delivery will be one of the biggest logistical challenges in modern history. No one company can own the end-to-end vaccine supply chain and we need to start working together to ensure the industry is prepared." (3).

Not Forgetting the Environment

Nevertheless, this emergency distribution must not happen at the expense of the environment. Due to its medical and economic impact, the COVID-19 crisis has led to a lot of ideas about a post-pandemic future. Environmental issues can no longer be sidelined and we have seen that governments' economic recovery plans (like the one in France) place their focus on environmental concerns.

Optimising flows and opting for reusable packaging are two key aspects to be taken into account. Active containers can be reused, but they have to be moved by airfreight. Due to their significant weight, transporting them produces 50% more CO_2. Reusable passive solutions, which are flat-packable, hold many advantages. They reduce shipping, moving, and storage costs, as well as CO_2 emissions. Quick to manufacture, they speed up the supply chain. They are also cheaper, as they do not need to be rotated quickly or moved by plane, which is costly and produces high levels of CO_2 emissions. Returns are mainly carried out by sea. They can also be delivered pre-assembled, and at the correct temperature, directly to preparation sites.

Distributing and administering a COVID-19 vaccine remains a real challenge, and everyone involved is in a state of uncertainty as to the initial results, stability data, and recommendations in order to deal as effectively as possible with the biggest challenge the pharma supply chain has ever faced.

References

1. *Visit: www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines*
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