

COVID VACCINE: SUPPLY CHAIN CHALLENGES

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Key words: supply chain, vaccine, delivery challenges, Covid pandemic

The Covid pandemic paused the development of the world economy for quite some time. Experts link the beginning of recovery with the speed and quality of vaccination. That’s why the aim of the paper to analyze different logistics and supply chain questions, connected to the procedure of delivering and handling vaccines in Ukraine.

Preservation and proper transportation are directly proportional to a safe vaccine. Therefore, the table 1 refers main data based on information from official web sites about 5 vaccines that have passed the 3rd phase of clinical testing / evaluation. The Sputnik B vaccine will be excluded from this list because it is prohibited by law in Ukraine.

Table 1. Available vaccine details

	Pfizer-BioNTech	Moderna	AstraZeneca	CoronaVac (Sinovac)	Janssen COVID-19
Manufacturer	Pfizer (USA) and BioNTech (Germany)	US NIAID, BARDA and Moderna	Oxford University and AstraZeneca	"Sinovac Biotech" (China)	Johnson&Johnson
Storage conditions	From -80 °C to -60 °C	From +2 to +8°C for 30 days before punching the vials or from -25°C to -15°C within 4 months	From +2°C to 8°C for at least 6 months	From +2 to +8°C, stable for 3 years during storage	From +2°C to 8°C for up to the expiration and after first puncturing the vial up to 6 hours
Conditions of transportation	Softbox and AeroSafe thermal shipping containers available, which maintains a temperature range of -90°C to -60°C. The container itself be	Should begin to be transported with the frozen state. Refrigerated transport (+2°C to +8°C) is allowed more than once for up to 12 hours total. Transport time while walking or using a hand cart is not to exceed 1 hour; transport	To maintain the correct temperature in special boxes refrigerators from +2°C to +8°C Should be protected from light as well	The liquid inlet is stored in 200-liter bags and transported in airplanes in containers. Temperature in the refrigerator is from +2°C to +8°C	Refrigerated transport (+2°C to +8°C). Vaccine vials may be transported more than once (punctured and unpunctured). Dry ice usage is prohibited

	stored at 15°C to 25°C	time is not to exceed 12 hours			
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The first criteria for making a choice is the distance that the vaccine must travel from the place of production to the place where the patient receives it. The final destination was the capital of Ukraine - Kyiv, because this is where the best opportunity to send the vaccine to different cities of Ukraine.

By comparing the data, we can create a scale from the smallest distance to the largest, in relation to the time, both shorter delivery time and longer delivery time:

1. Pfizer-BioNTech COVID-19 BNT162b2 - approximately 1837 km by air from Puurs (Belgium) to the capital of Ukraine.
2. Modern "mRNA-1273" - approximately 2,862 km by air from Laboratorios Farmacéuticos Rovi in Spain.
3. AstraZeneca - approximately 5,207 km by air from Indian Serum Institute in Pune.
4. CoronaVac (Sinovac) - approximately 6,450 km by air from the Malaysian integrated pharmaceutical group in Shah Alam.
5. Johnson&Johnson - approximately 7,776 km by air from Baltimore (USA).

Hence, Pfizer-BioNTech COVID-19 BNT162b2 will cover the shortest distance, and Johnson & Johnson - the longest once. And we should take into account that the greater the distance, the higher the shipping cost.

The second point is the storage conditions of the vaccine. Paying attention to the comparison (table 1), we can determine that the vaccine Pfizer-BioNTech COVID-19 BNT162b2 has the most demanding storage conditions compared to others, which affects the price of such delivery. All other vaccines have approximately the same storage conditions (from +8°C to +2°C), but the expiration date differs: Moderna could be stored for only 30 days before puncturing vials; AstraZeneca for up to six months; CoronaVac for up to 3 years and Janssen COVID-19 until the expiration date indicated on each vial.

The next item is the conditions of transportation. For the Pfizer-BioNTech COVID-19 BNT162b2 vaccine, there have been specially designed transport boxes. There is also a Temperature Dependence. Moderna vaccine has a list of conditions for transportation: the vaccine should be pre-frozen, the first is a temperature from +2°C to 8°C, transportation in the refrigerator for up to 12 hours and transportation time when walking or using a handcart should not exceed 1 hour. AstraZeneca does not have harsh transportation conditions; one of the main ones is to ensure the right temperature in the refrigerator boxes. CoronaVac must be transported in special containers and have a temperature from +2°C to 8°C. For the Johnson&Johnson Janssen COVID-19 vaccine should be refrigerated transport from +2°C to +8°, dry ice usage is prohibited and temperature monitoring is obligatory.

Next supply chain challenge for vaccine delivery is transport choosing, which best meets all the conditions of transportation. We must also not forget that there are time limits within which the goods must be delivered. That is, vehicles such as shipping cannot be used at this point. That's why the choice falls on air travel, in terms of overcoming long distances in a short time.

Summarizing, Pfizer-BioNTech COVID-19 BNT162b2 has the shortest distance to overcome, but it has a number of difficult conditions for storage and transportation, which increases the cost of transportation. The Johnson & Johnson vaccine is the most remote point, but with simpler storage and transportation conditions than the Pfizer-BioNTech COVID-19 BNT162b2. Moderna has the second shortest distance on the scale and has a number of conditions that can and should be met during transport. The AstraZeneca vaccine seems to be the golden mean when calculating the distance between the points of departure and receipt. The vaccine does not have harsh storage and transportation conditions. CoronaVac is a vaccine that is on the scale of 2nd place from the end, which makes it expensive to transport as well as the latter, but there are definitely advantages to storage and transportation. That's why, choosing a vaccine from the point of view of logistics, the best vaccine for Ukraine is Moderna.

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