

Project Sunrays

Shining light on COVID-19 vaccines transport requirements and global airfreight readiness

DECEMBER 2020



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COVID-19 is killing people, weakening economies, radically transforming the current state of global development and is the biggest crisis affecting aviation. According to UN Conference on Trade and Development (UNCTAD), the COVID-19 pandemic is likely to reverse much of the economic and social progress already made towards the 17 Sustainable Development Goals (SDG) achievement: the economic and social disruptions caused by COVID-19 have resulted in about USD 6 trillion in losses in global trade, approximately 50% larger than the decline in trade that occurred during the 2008 recession.

No wonder why the world waits anxiously for COVID-19 vaccines to stop the pandemic and restart economies! ***As soon as approved and manufactured, the delivery of COVID-19 vaccines will be urgent, requiring speed, reliability, security, and special care that air cargo is offering.***

Air cargo plays a vital role to sustain the world economy and support social development.

According to the World Health Organization (WHO), vaccines prevented at least 10 million deaths between 2010 and 2015, and many millions more lives were protected from illness. Air cargo plays a vital role in supporting global immunization campaigns by efficiently transporting pharmaceuticals in a safe, secure, and temperature-controlled environment.

Airfreight is the fastest way of transporting pharmaceutical products. According to Accenture Seabury, pharmaceuticals accounted for up to 1.9% of all cargo volumes flown by air and contributed to 2.6% of the total airline cargo revenue already in 2017.

It is however important to note that pharma shippers are looking at opportunities to shift from air to other modes of transport to reduce their costs and carbon footprint. In recent times, technological developments in ocean freight have given companies an alternative to look for, and many pharmaceutical manufacturers have considered shifting part of their volume to ocean freight.

As a response to modal shift threat, the air cargo industry has invested heavily on certification and training programs, dedicated infrastructure, digital transformation, innovative packaging and containers demonstrating a strong commitment to excellence, continuous improvement, and customer satisfaction.

Air cargo supports the global fight against COVID-19 despite the logistics challenges amidst the pandemic

By transporting emergency products in the first months of the COVID-19 pandemic, such as personal protective equipment (PPE), medical devices, pharmaceuticals and goods supporting stay-home policies worldwide, air cargo has already been instrumental in helping governments, medical community and businesses fight this pandemic.

Last summer, as pharmaceutical companies raced to develop the COVID-19 vaccine, it was still unclear what impact this vaccine would have on the global supply chain.

Pharmaceutical manufacturers realised the massive logistical challenges ahead of them when the life-saving vaccines would need to be manufactured and distributed to almost 8 billion people worldwide with speed, quality, and reliability for time and temperature sensitive products with limited shelf life, and strict temperature conditions.

And most of the logistics professionals were concerned with the lack of information on product specifications, volumes, trade lanes, etc. impacting their ability to plan and prepare.

PPE logistics was already a big challenge due to product scarcity, airfreight capacity shortage, border closures, lockdown restrictions impacting front-line workers, commercial wars and diplomatic tensions, theft, etc.

In the months to come, the air cargo industry will again make an important contribution to the global public good and in fighting the pandemic by distributing COVID-19 vaccines globally, in addition to other vaccines and medical supplies, food, electronics, etc.

Vaccines transportation will pose even greater challenges to the industry

But vaccines are much more complex than PPEs to package, store, handle, and transport, due to time and temperature strict requirements. It requires dedicated expertise, specialized infrastructure, special attention and care and extensive collaboration amongst the supply chain partners. The current uncertainties on production timelines, volumes, trade lanes, transportation and storage requirements and product specificities, coupled with airfreight capacity crunch increase exponentially the number of difficulties to address for supply chain professionals.

Like for any other medical treatment, the air cargo industry is committed to ensure the safe, reliable, efficient, and fast delivery of the imminent COVID-19 vaccines. But the unprecedented urgency and scale of this logistics challenge necessitate global and local strategies to be defined and each logistics provider to be prepared.

From too little to too much information changing daily, logistics professionals need reliable information to prepare and make decisions related to additional investments in skills, cool chain infrastructure, security equipment, innovative packaging and containers, data sharing platforms, monitoring solutions, etc. In other words, decision making process in logistics sector looked like a risky gamble, especially in such a challenging economic environment.

1. Project Sunrays: shining light on COVID-19 vaccines transport requirements and global airfreight readiness

Driven by their commitment to help our respective members and the air cargo industry at large during this pandemic, Pharma.Aero and TIACA, with the support of other international organisations, teamed up in August 2020 to shine light on COVID-19 vaccines transport requirements and global airfreight readiness and to create useful guidelines in the handling, storage, and transport of COVID-19 vaccines once they are available.

The aim of project Sunrays is to provide timely and verified information for pharma industry and air cargo stakeholders to support them in their planning and decision-making process:

- Providing the air cargo industry with clarity of the needs and expectations from vaccines manufacturers and better visibility on future COVID-19 vaccines supply chain specifications impacting logistics, like manufacturing locations, production volumes, handling and storage specificities, track and trace requirements etc.
- Providing vaccines manufacturers and pharma shippers with more visibility on existing air cargo capabilities: infrastructure on the ground, airfreight capacity, expertise, as well as better understanding of constraints and needs from air cargo providers to serve them adequately.

Fostering effective communication and collaboration between vaccines manufacturers, shippers, and air cargo industry players will ensure that once the vaccine is available in the market, the air cargo industry is ready to respond to the needs of the shippers and transport vaccines in optimal conditions to all corners of the globe.

To deliver project Sunrays, TIACA and Pharma.aero have constituted a dedicated Steering Committee, composed of industry representatives and members of both associations and selected consultants and subject matter experts from 4ADVICE and Change Horizon to deliver the project.

Project Sunrays includes continuous engagement efforts since August 2020 with vaccines manufacturers to understand vaccines development and their specific transportation requirements. It combines market research, monitoring of public information and one-to-one weekly discussions with pharma shippers to **verify and validate the information and perform deep-dive investigation on specific areas.**

In parallel, we have also engaged with air cargo professionals to understand their level of preparedness, their capabilities, concerns and plans to get ready. It was done through regular discussions with airlines, forwarders, ground handlers, airports, ULD solution providers and packaging specialists; through close engagement with international associations like IATA, FIATA, ACI World; and through **2 global airfreight readiness surveys:**

- 1st survey from 8 to 20 September 2020: the objective was to have a better understanding on current readiness level in the air cargo supply chain for the future COVID-19 vaccines, plans to get ready and existing capabilities to handle, store, transport and deliver the vaccines. We received 181 answers.
- 2nd survey from 16 to 29 November 2020: with fast development in both pharma and logistics sectors, we wanted to assess the airfreight readiness progress made in the past three months, as well as understand air cargo industry's business plans for 2021. 196 answers were collected.

Outcomes of the research and engagement efforts were made available to TIACA and Pharma.Aero members through webinars and communication (on member-only channels) and to the entire industry through public webinars and free publications such as this white paper.

Steering Committee



Steering group composed by Board members from TIACA and Pharma.Aero

Pharma.Aero, is a cross-industry collaboration platform for pharma shippers, CEIV certified cargo communities, airport operators and other air cargo industry stakeholders, with the mission to achieve excellence in reliable end-to-end air transportation for pharma shippers.

As such, Pharma.Aero is uniquely positioned to engage air pharma industry, especially shippers, to collect much needed insights. **“Setting up reliable end-to-end air pharma transportation is part of the vision and mission of Pharma.Aero. Amongst our members i.e. life sciences and pharma shippers, certified airport communities and air cargo operators, we have a track record of industry-based collaboration,”** says Jaisey Yip, General Manager, Cargo & Logistics Development at Changi Airport Group, Vice-Chair of Pharma.Aero and Sunrays project lead.

TIACA, The International Air Cargo Association, is the unique international not-for-profit association representing and uniting all parts of the air cargo industry: shippers, forwarders, ground handlers, airports, airlines, manufacturers, IT providers, etc. TIACA members are traditional players and new entrants, small, medium, and large companies with regional and global reach. As such, TIACA is well positioned to lead the efforts for the air cargo industry to get ready, or at least as prepared as possible, to tackle the upcoming challenge. **“Collaboration will be key to success: I urge all players to start communicating up and down the supply chain; find out where the gaps are and develop plans to address them. It is TIACA’s mission to bring all stakeholders together and unite the industry towards common goals”** declared Emir Pineda, Manager Aviation Trade & Logistics at Miami International Airport, Board member of TIACA and Sunrays project lead.

This project aligns well with many other organization’s efforts, either specific to the COVID-19 vaccines deliveries or broader initiatives for the safe, efficient, and reliable management of pharmaceutical logistics. Only through collaboration with other organizations will we be successful in providing an effective distribution process for the COVID-19 vaccines.

Fig. 1: Sunrays project scope

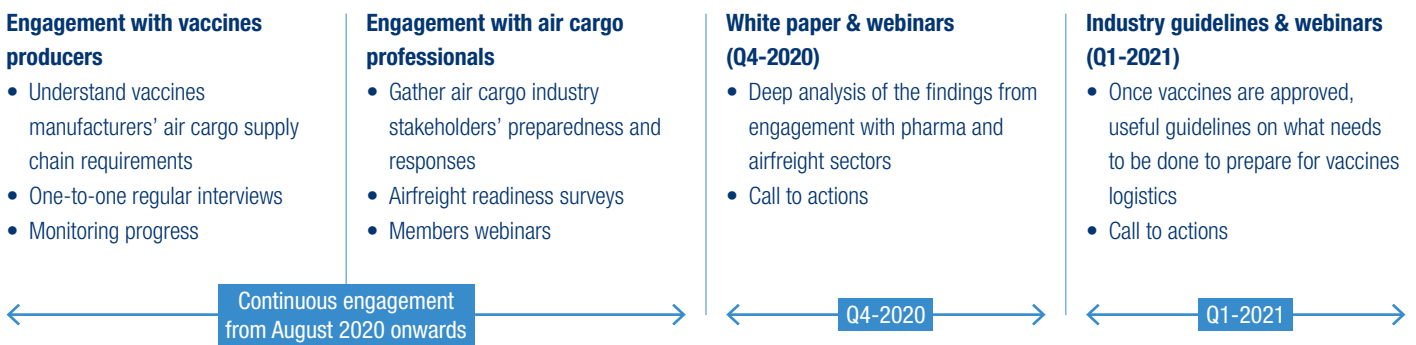


Fig. 2: Insights from the Pharma Industry/Industry

One-to-one interviews and weekly engagement with vaccines manufacturers



Research and compilation of information, available on public domain



2. COVID-19 vaccines logistics specifications

According to WHO, as of 2 December 2020, there were 51 candidate vaccines in clinical evaluation and 163 candidate vaccines in preclinical evaluation. While the pharmaceuticals companies are racing to develop a safe and efficient vaccine to stop the pandemic and restart the global economy, the logistics chain is getting ready, as much as possible given the numerous uncertainties.

As part of project Sunrays, we have monitored the front runners who are in Phase 3 of clinical trials and pharmaceutical companies we have a direct connection with. Phase 3, when the vaccine is given to thousands of volunteers, is the last clinical trial phase before review and approval by health authorities and introduction as part of a national immunization program.

Fast-track development of vaccines

Historically, it takes between 6 to 18 years to develop a vaccine and have it ready for use in the market, including 4 to 8 years from first phase of clinical trials on humans until post licensure and market entry. In the case of COVID-19 vaccines, most pharmaceuticals companies are not starting from scratch. Previous work to develop a vaccine against the coronavirus diseases SARS and MERS established knowledge about the structure and function of coronaviruses, allowing the accelerated development and the start of the clinical trial phase.

In logistics terms, fast-track development of vaccines means limited time for logistics specialists to design

and deploy adequate infrastructure, develop standard operating procedures (SOPs), and train staff accordingly to deliver the vaccine where and when it is needed.

Several different types of vaccines

Looking at the COVID-19 vaccines landscape document maintained by the WHO, for each vaccine candidate, it is indicated the vaccine platform, the type of vaccine, the number of doses, the timing of doses and the route of administration. Each of these elements have impacts on logistics. Different types of vaccines mean different product specifications, impacting the transport, storage, and handling requirements:

- The temperature requirements of the vaccine (temperature of the product itself, the transport temperature range, and the storage temperature) will impact the packaging containers (active or passive), use of dry-ice or not, volume and weight of the shipment
- The number of doses and intervals in between the doses will impact volumes and timelines

- The manufacturing strategies and purchasing deals will impact trade lanes, as well as the mode of transport required

Another characteristic of the vaccines that is still unknown will also impact the logistics players: the immunity duration (i.e. how long a vaccine will protect the patient: one year like the seasonal flu, several years, lifetime immunity like the measles vaccine?). Once available, such information will be useful to plan longer term volumes and logistics flows. But to date, none of the vaccine manufacturers are able to provide this information, and this might take some time before it is known.

Vaccines are fragile

Vaccines alone do not save lives: they require adequate regulatory framework, health workers and infrastructure, supply chain and cold chain capacities, as well as community acceptance to save lives.

The success of immunization campaigns is attributable in part to proper transport, storage, and handling of vaccines. Vaccines must be maintained at the temperatures recommended by vaccine manufacturers and protected from light at every step in the cold chain. They must be stored properly from the

time they are manufactured until they are administered. When exposed to temperatures outside the recommended ranges, they can have reduced potency and protection or be dangerous. That is why it is recommended to not administer a dose of vaccine that has been mishandled.

Most of the vaccines are sensitive to heat and/or cold, and any temperature deviations may deem the vaccines ineffective. Transport, storage, and handling errors can cost millions of

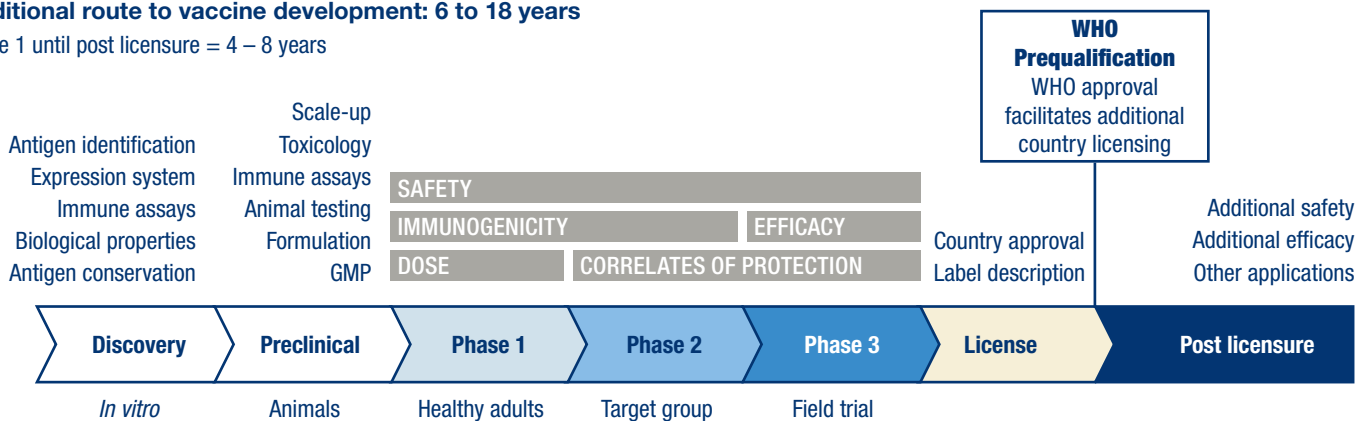
dollars in wasted vaccine, revaccination campaigns, and loss of patient confidence.

Proper maintenance of vaccines during transport is known as the cold chain. A proper cold chain is a temperature-controlled supply chain that includes all equipment and procedures used in the transport and storage and handling of vaccines from the time of manufacturer to administration of the vaccine.

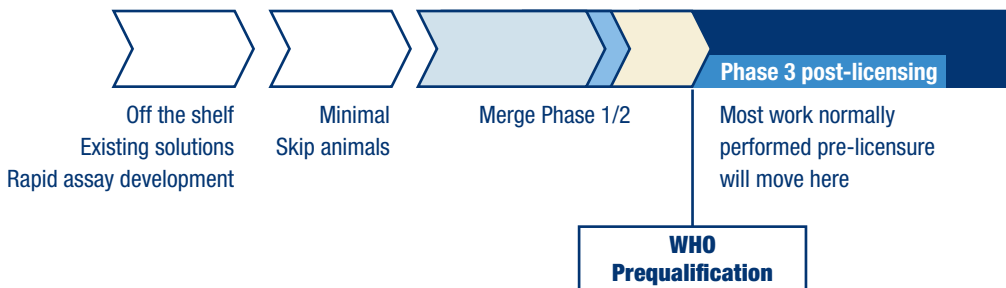
Fig. 3: Traditional vaccines vis-à-vis COVID-19 vaccines development years

Traditional route to vaccine development: 6 to 18 years

Phase 1 until post licensure = 4 – 8 years



Potential strategies to reduce time for COVID-19 vaccine development (~12 months)



Source: Sunrays Project

Temperature: let's not mix product, storage and transport temperatures!

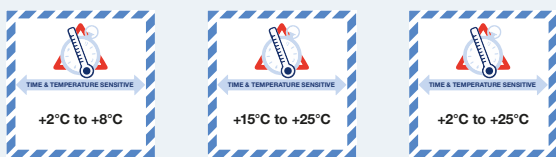
There is regularly some confusion when talking about temperature of the vaccines. It is important to understand the difference between the product, the storage, and the transport temperatures.

In the case of Pfizer-BioNTech vaccine:

- The product temperature is -70C°
- The transport temperature can be +15C° to +25C° depending on the packaging the manufacturer will use

To make sure its COVID-19 vaccine doses arrive at point of care in perfect conditions, the manufacturer designed a dedicated passive cool box using dry-ice that will maintain the product temperature of -70°C for 10 days before re-icing is needed. The box, which can store between 1000 and 5000 doses, will have to be transported in a temperature-controlled environment between +15C° to +25C°.

As per standard procedures described in IATA Temperature Control Regulations (TCR), the pharmaceutical shipments need to be identified with the corresponding special handling codes PIL (Pharmaceutical products) together with additional temperature information (FRO, ERT, COL or CRT). The transport documents and labels on the box will indicate the transport temperature accordingly:



Detailed specifications















In this white paper, we provide you with a set of information about 9 of them in the dedicated fact sheets:

- AstraZeneca / University of Oxford
- CanSino Biological Inc. / Beijing Institute of Biotechnology
- The Gamalyea Research Institute of Epidemiology and Microbiology
- GSK / Sanofi Pasteur
- Johnson & Johnson
- Moderna
- Novavax
- Pfizer / BioNTech
- SinoVac

Each fact sheet is the result of our research and/or one-to-one weekly discussions with vaccines manufacturers to verify the information, combined with the analysis of publications from manufacturers. This is not an easy process to gather reliable information due to confidentiality, non-disclosure agreements and competition between pharmaceutical brands and countries. And some information affecting transport, storage and handling just does not exist yet as most of the vaccines are still under development.












The aim of our fact sheets is to provide useful information related to the logistics of these finished vaccines and does not aim at producing an exhaustive medical description of each vaccine. In this white paper, we are not covering the logistics and specifications of the critical transport of the active pharmaceutical ingredients (API) and the peripherals as this is a standard process.




Fig. 4: How to read and use the fact sheet

 Medical specs	 Manufacturing info	 Development status
 <p>Number of doses and interval in between doses to provide indication on volumes and timelines; and route of administration (intramuscular, intranasal, etc) to give indication on other medical supplies needed (syringe, vials, etc.)</p>  <p>Product temperature and shelf life per temperature range (it is compared to a similar type of vaccine)</p>	 <p>Production plans and timelines</p>  <p>Manufacturing sites (assembly) to give indication on the origin of the transport</p>  <p>Volumes to be produced, and therefore transported (total volume forecast)</p>	 <p>Development phase</p>  <p>Approval status (limited or for widespread use, local, regional, global)</p>  <p>Clinical trials locations to provide information of where the vaccines have been shipped so far (to identify logistics players that are already involved and potential ready)</p>
 Transport requirements  <p>Transport temperature</p>  <p>Packaging requirements and / or specifications (volumes, weight ...)</p>	Confirmed vaccine doses procured by country <p>Purchasing countries & volumes to give information on destinations of the transport in the first months</p>	

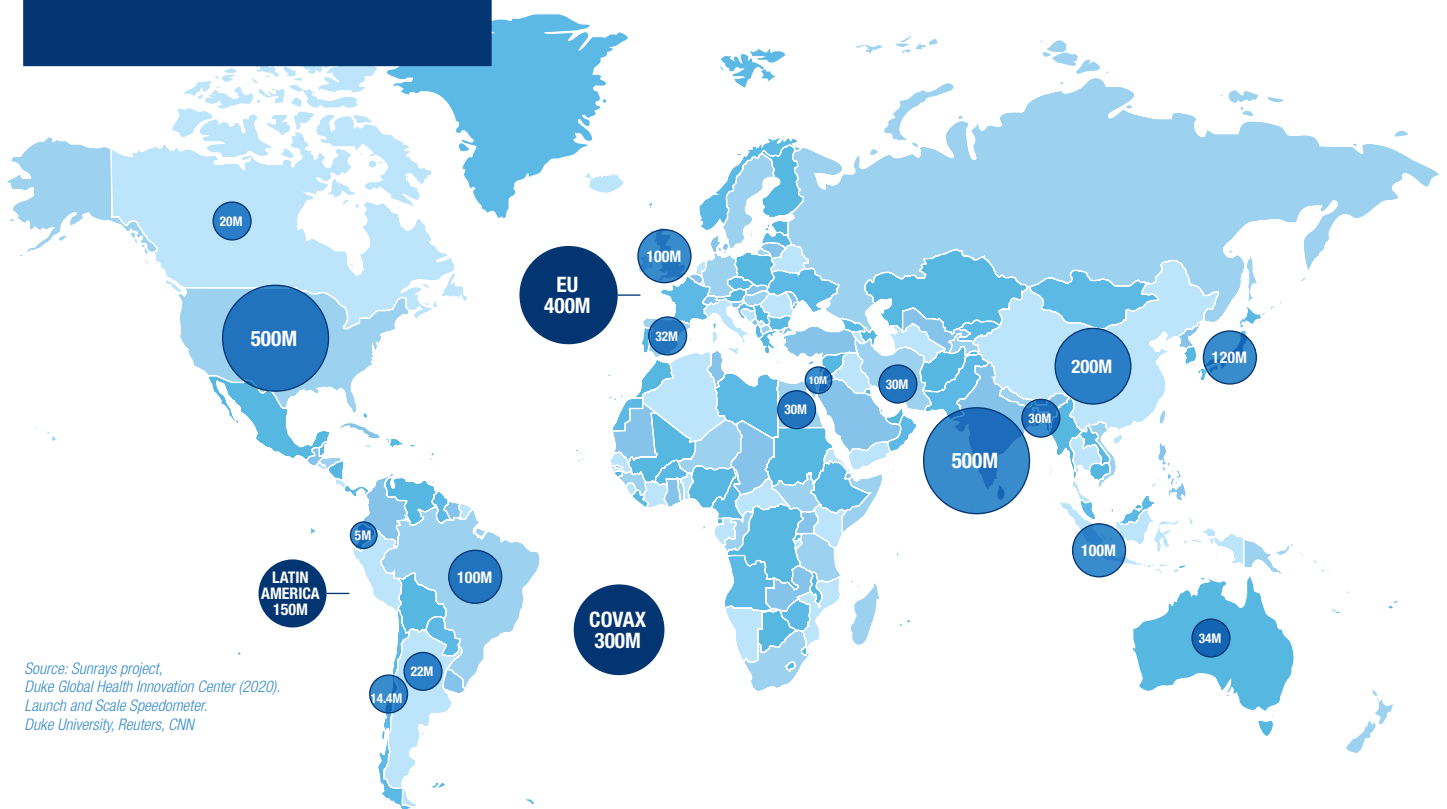
While project Sunrays takes reasonable steps to verify the accuracy of the information presented in these fact sheets, TIACA and Pharma.Aero do not make any (and hereby disclaims all) representations and warranties regarding the accuracy, completeness, of any information provided in this white paper. TIACA and Pharma.Aero also disclaim any and all liability or responsibility whatsoever for damage or other prejudice of any kind that may arise from or in connection with the procurement, distribution or use of any product included in any of these landscape documents.

AstraZeneca plc. is a British-Swedish multinational pharmaceutical and biopharmaceutical company headquartered in Cambridge, England. COVID-19 vaccine is developed in collaboration with Oxford University.

 Medical specs	 Manufacturing info	 Development status
 2 doses Intramuscular  Vaccine shelf life: <ul style="list-style-type: none"> • 2 years at -20°C • 3 months at +2°C to +8°C • 24 hours at +15°C to +25°C 	 Production could start end of 2020 / beginning of 2021  Manufacturing sites: <ul style="list-style-type: none"> • Australia • Brazil • China • India • Korea • Thailand • UK  Production capacity of 2 billion doses for 2021 Plans to expand to 3 billion	 Phase 3  Approval status: not yet approved for widespread use  Clinical trials locations: <ul style="list-style-type: none"> • Brazil • India • Japan • Russia • South Africa • UK • USA












 Transport requirements
 Transport temperature +15°C to +25°C
 Likely to be a passive box on +15°C (standard process)


Confirmed vaccine doses procured by country							
INDIA	500M	INDONESIA	100M	EGYPT	30M	ISRAEL	10M
USA	500M	UK	100M	ARGENTINA	22M	EU	
CHINA	200M	AUSTRALIA	34M	CANADA	20M	LATIN AMERICA	
JAPAN	120M	SPAIN	32M	CHILE	14.4M	COVAX	
BRAZIL	100M	BANGLADESH	30M	ISRAEL	10M		





Source: Sunrays project, Duke Global Health Innovation Center (2020), Launch and Scale Speedometer, Duke University, Reuters, CNN

Novavax, Inc. is a vaccine development company headquartered in Gaithersburg, Maryland, USA.

 Medical specs	 Manufacturing info	 Development status
 2 doses Intramuscular  Vaccine storage: <ul style="list-style-type: none"> • Refrigerated (+2°C to +8°C) 	 Production could start as of 2021  Manufacturing sites: <ul style="list-style-type: none"> • Czech Republic • India • USA  Production capacity 2 billion doses per year as of 2021	 Phase 3  Approval status: not yet approved for widespread use  Clinical trials locations: <ul style="list-style-type: none"> • Australia • Mexico • South Africa • UK • USA

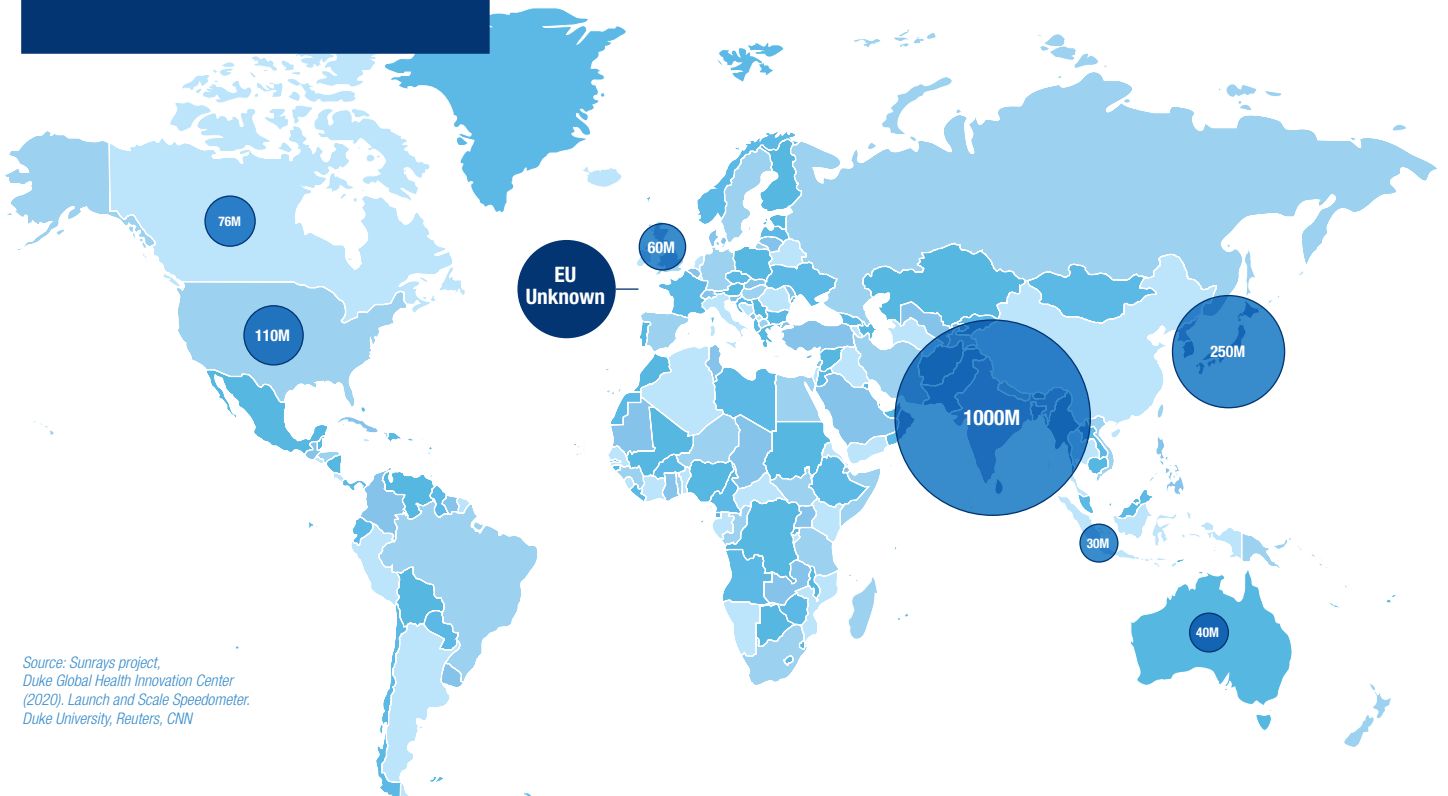
 **Transport requirements**

 **Transport temperature**
+15°C to +25°C

 **Likely to be a passive box on +15°C (standard process)**

Confirmed vaccine doses procured by country

INDIA	1000M	CANADA	76M	INDONESIA	30M
JAPAN	250M	UK	60M		
USA	110M	AUSTRALIA	40M	EU	Unknown















Source: Sunrays project, Duke Global Health Innovation Center (2020), Launch and Scale Speedometer, Duke University, Reuters, CNN




FACT SHEET


GlaxoSmithKline (GSK) is a British multinational pharmaceutical company headquartered in Brentford, UK, partnering with Sanofi, a French multinational pharmaceutical company headquartered in Paris, France.

 Medical specs	 Manufacturing info	 Development status
 2 doses Intramuscular  Vaccine shelf life: <ul style="list-style-type: none"> • 2 years at -20°C • 3 months at +2°C to +8°C • 24 hours at +15°C to +25°C 	 production likely to start Q3 2021  Manufacturing sites: <ul style="list-style-type: none"> • EU • USA  Production capacity of 90 million doses at the start of 2021, up to 360 million doses later in 2021	 Phase 3  Approval status: not yet approved for widespread use  Clinical trials locations: <ul style="list-style-type: none"> • Canada • USA



Transport requirements

 **Transport temperature**
+15°C to +25°C

 **Likely to be a passive box on +15°C (standard process)**

Confirmed vaccine doses procured by country

USA	100M	EU	300M
CANADA	76M	COVAX	200M
UK	60M		

















Source: Sunrays project, Duke Global Health Innovation Center (2020), Launch and Scale Speedometer, Duke University, Reuters, CNN



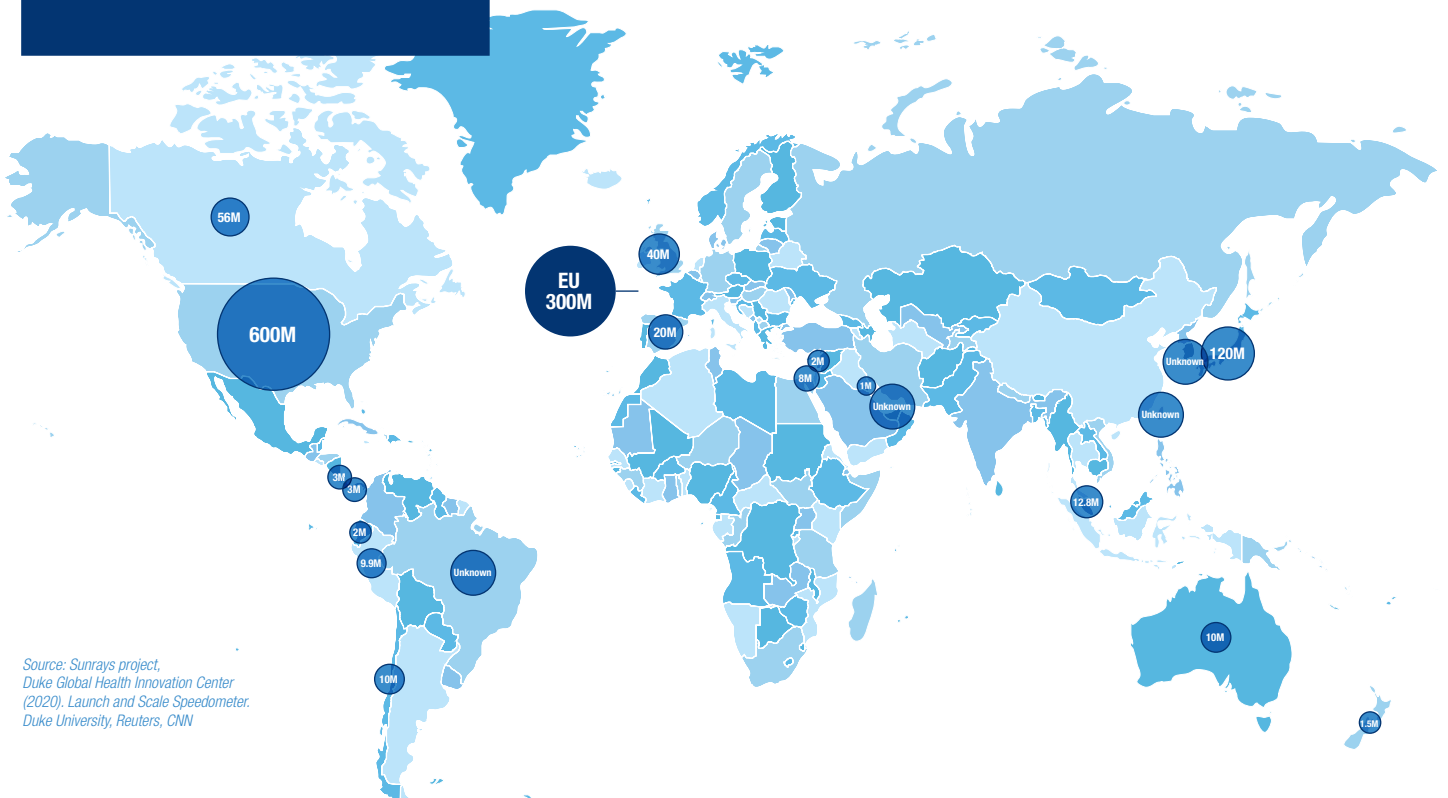
FACT SHEET

Pfizer is a multinational pharmaceutical corporation headquartered in New York, USA, partnering with BioNTech, a biotechnology company headquartered in Mainz, Germany that develops and manufactures active immunotherapies for patient-specific approaches to disease treatment.

 Medical specs	 Manufacturing info	 Development status
 2 doses Intramuscular  Vaccine shelf life: <ul style="list-style-type: none"> • 6-7 months at -70°C • 5-6 days at +2°C to +8°C • 5-7 hours at +15°C to +25°C 	 Production could start as of 2021  Manufacturing sites: <ul style="list-style-type: none"> • Belgium • USA  Production capacity 50 million doses in 2020 and up to 1.3 billion doses in 2021	 Phase 3  Approval status: Approved in the UK, Bahrain, USA, Singapore, Canada. (date 15 DEC 2020)  Clinical trials locations: <ul style="list-style-type: none"> • Australia • Ecuador • EU • Japan • New Zealand • UK • USA












 Transport requirements
 Transport temperature +15°C to +25°C  Likely to be a passive box on +15°C (standard process)




Confirmed vaccine doses procured by country							
USA	600M	AUSTRALIA	10M	ECUADOR	2M	SOUTH KOREA	Unknown
JAPAN	120M	CHILE	10M	LEBANON	2M	TAIWAN	Unknown
CANADA	56M	PERU	9.9M	NEW ZEALAND	1.5M		
UK	40M	ISRAEL	8M	KUWAIT	1M	EU	300M
SPAIN	20M	COSTA RICA	3M	BRAZIL	Unknown		
MALAYSIA	12.8M	PANAMA	3M	QATAR	Unknown		



Source: Sunrays project, Duke Global Health Innovation Center (2020), Launch and Scale Speedometer, Duke University, Reuters, CNN

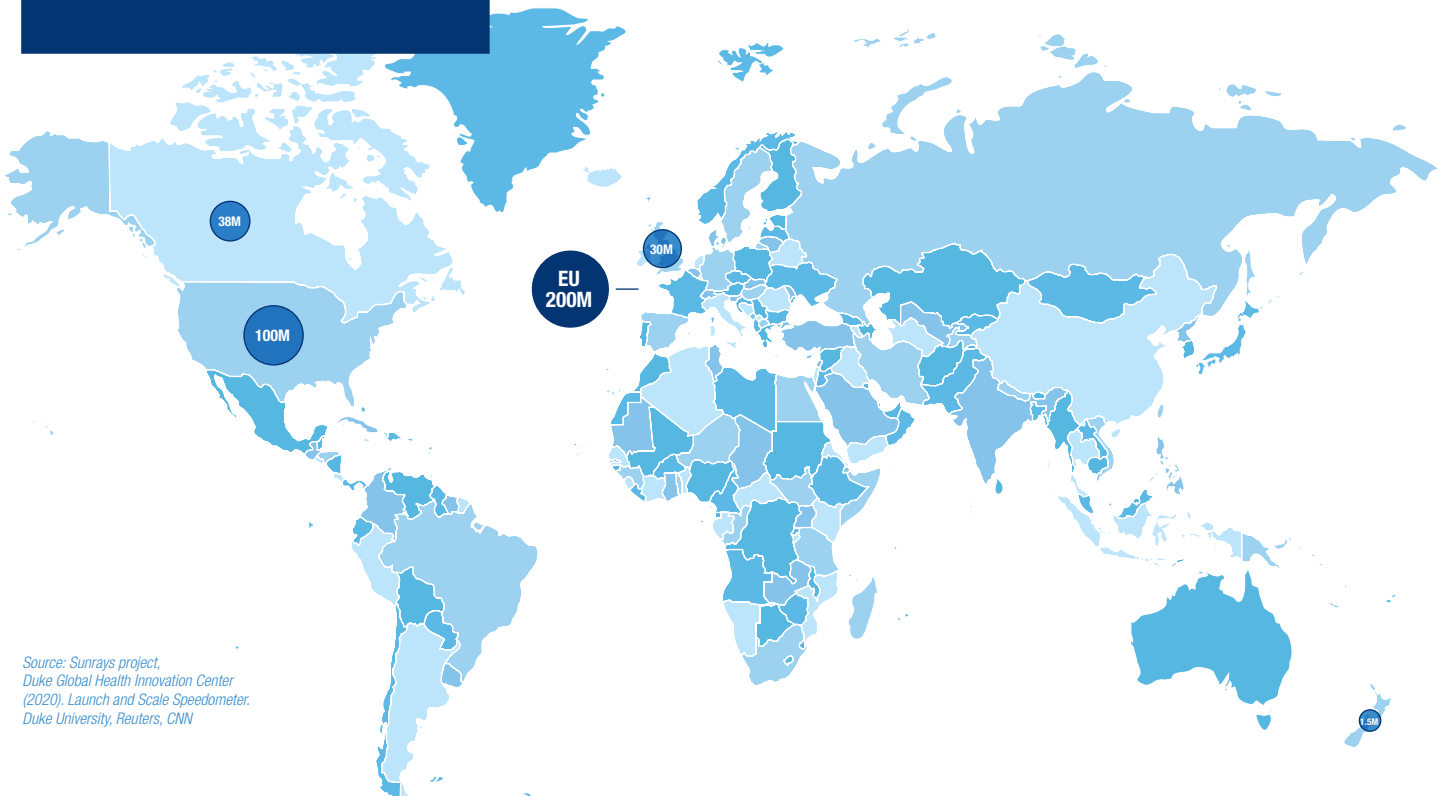
Johnson & Johnson is a multinational corporation developing medical devices, pharmaceutical and consumer packaged goods, headquartered in New Jersey, USA.

 Medical specs	 Manufacturing info	 Development status
 <p>1 dose Intramuscular</p>  <p>Vaccine storage:</p> <ul style="list-style-type: none"> • Refrigeration (+2°C to +8°C) 	 <p>Production could start as of 2021</p>  <p>Manufacturing sites (potential):</p> <ul style="list-style-type: none"> • Netherlands • USA  <p>Production capacity of 1 billion doses/year as of 2021</p>	 <p>Phase 3</p>  <p>Approval status: not yet approved for widespread use</p>  <p>Clinical trials locations:</p> <ul style="list-style-type: none"> • Brazil • Chile • Colombia • Mexico • Peru • Philippines • South Africa • Ukraine • USA

 Transport requirements
 <p>Transport temperature +15°C to +25°C</p>
 <p>Likely to be a passive box on +15°C (standard process)</p>












Confirmed vaccine doses procured by country




USA	100M	UK	30M	EU	200M
CANADA	38M	NEW ZEALAND	1.5M		



Source: Sunrays project, Duke Global Health Innovation Center (2020), Launch and Scale Speedometer, Duke University, Reuters, CNN

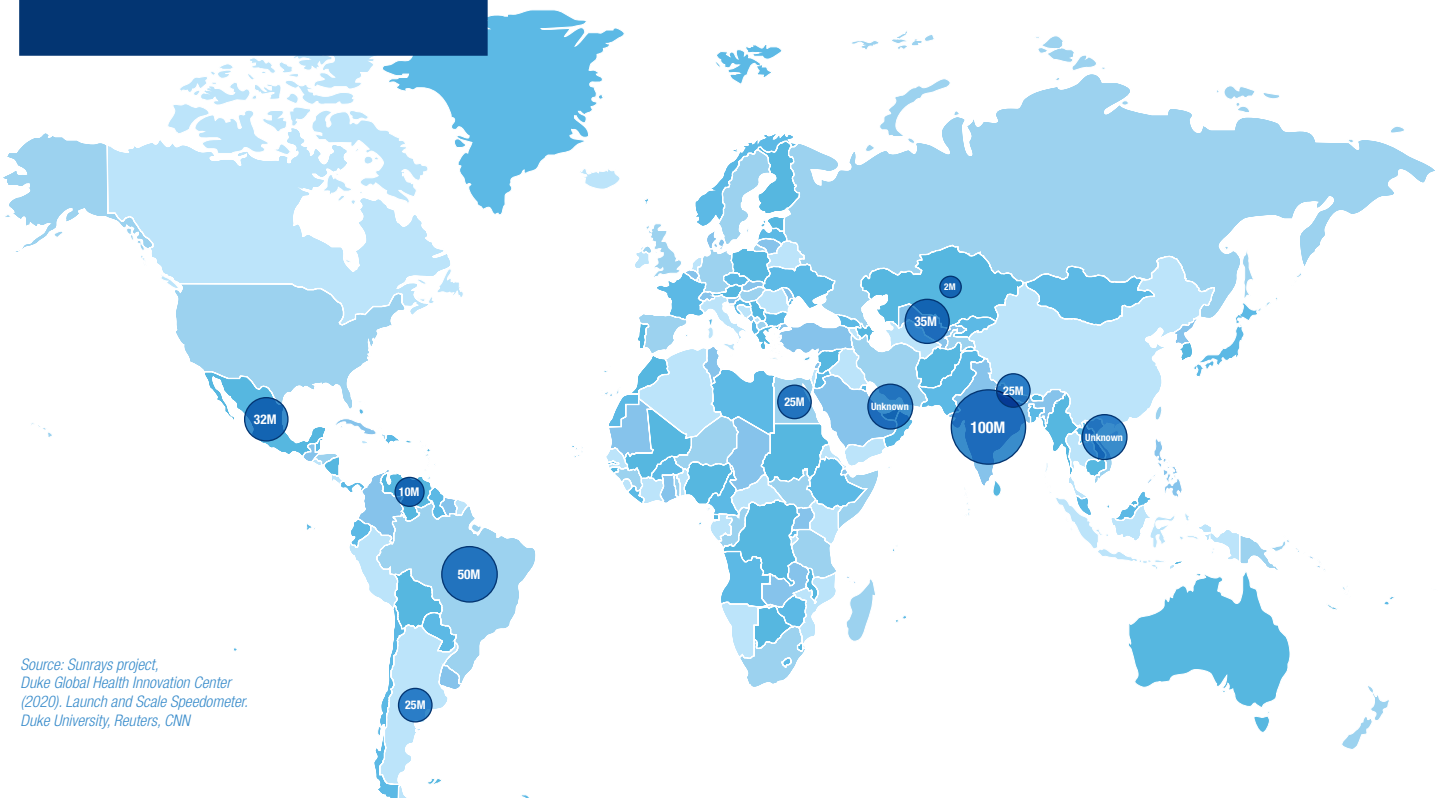
The Gamaleya Research Institute of Epidemiology and Microbiology is a medical research company headquartered in Moscow, Russia.

 Medical specs	 Manufacturing info	 Development status
 <p>2 doses Intramuscular</p>  <p>Vaccine storage:</p> <ul style="list-style-type: none"> • Complete +2C° to +8C° • Frozen (-18C°) 	 <p>Production could start as of end of 2020</p>  <p>Manufacturing sites:</p> <ul style="list-style-type: none"> • India • Russia  <p>Production capacity 500 million doses per year</p>	 <p>Phase 3</p>  <p>Approval status: not yet approved for widespread use</p>  <p>Clinical trials locations:</p> <ul style="list-style-type: none"> • Belarus • India • Russia • UAE

 Transport requirements
 <p>Transport temperature +15°C to +25°C</p>
 <p>Likely to be a passive box on +15°C (standard process)</p>












Confirmed vaccine doses procured by country

INDIA	100M	ARGENTINA	25M	KAZAKHSTAN	2M
BRAZIL	50M	EGYPT	25M	SAUDI ARABIA	Unknown
UZBEKISTAN	35M	NEPAL	25M	VIETNAM	Unknown
MEXICO	32M	VENEZUELA	10M		





Source: Sunrays project, Duke Global Health Innovation Center (2020), Launch and Scale Speedometer, Duke University, Reuters, CNN

Moderna is a biotechnology company focused on vaccine technologies based on messenger RNA and is headquartered in Cambridge, Massachusetts, USA.

 Medical specs	 Manufacturing info	 Development status
 2 doses Intramuscular  Vaccine shelf life: <ul style="list-style-type: none"> • 6 months at -20°C • 30 days at +2°C to +8°C • 12 hours at +15°C to +25°C 	 Production could start as of 2021  Manufacturing sites: <ul style="list-style-type: none"> • Switzerland • USA  Production capacity of 500 million to 1 billion doses/year	 Phase 3  Approval status: not yet approved for widespread use  Clinical trials locations: <ul style="list-style-type: none"> • Canada • Switzerland • USA

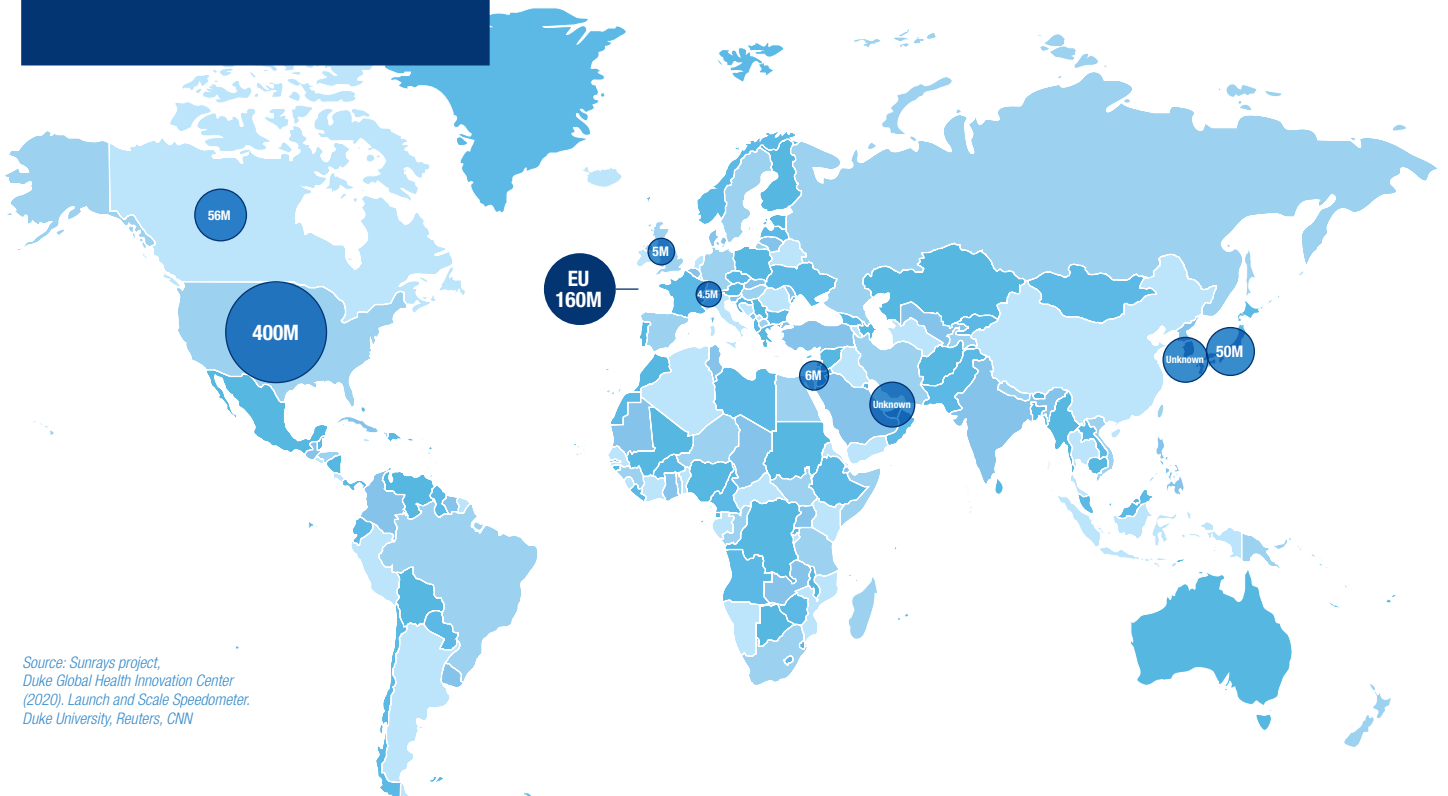
Transport requirements

 **Transport temperature**
+15°C to +25°C

 **Likely to be a passive box on +15°C (standard process)**

Confirmed vaccine doses procured by country

USA	400M	UK	5M	EU	160M
CANADA	56M	SWITZERLAND	4.5M		
JAPAN	50M	QATAR	Unknown		
ISRAEL	6M	SOUTH KOREA	Unknown		














Source: Sunrays project, Duke Global Health Innovation Center (2020), Launch and Scale Speedometer, Duke University, Reuters, CNN





sinovac


FACT SHEET

Sinovac Biotech Ltd. is a biopharmaceutical company headquartered in Beijing, China which focuses on research, development, manufacture and commercialization of vaccines.

 Medical specs	 Manufacturing info	 Development status
 2 doses Intramuscular  Vaccine storage: <ul style="list-style-type: none"> Refrigerated (+2C° to +8C°) 	 Production could start as of 2021  Manufacturing sites: <ul style="list-style-type: none"> China Egypt (under negotiation) Indonesia  Production capacity 300 million doses per year	 Phase 3  Approval status: not yet approved for widespread use  Clinical trials locations: <ul style="list-style-type: none"> Brazil China Indonesia

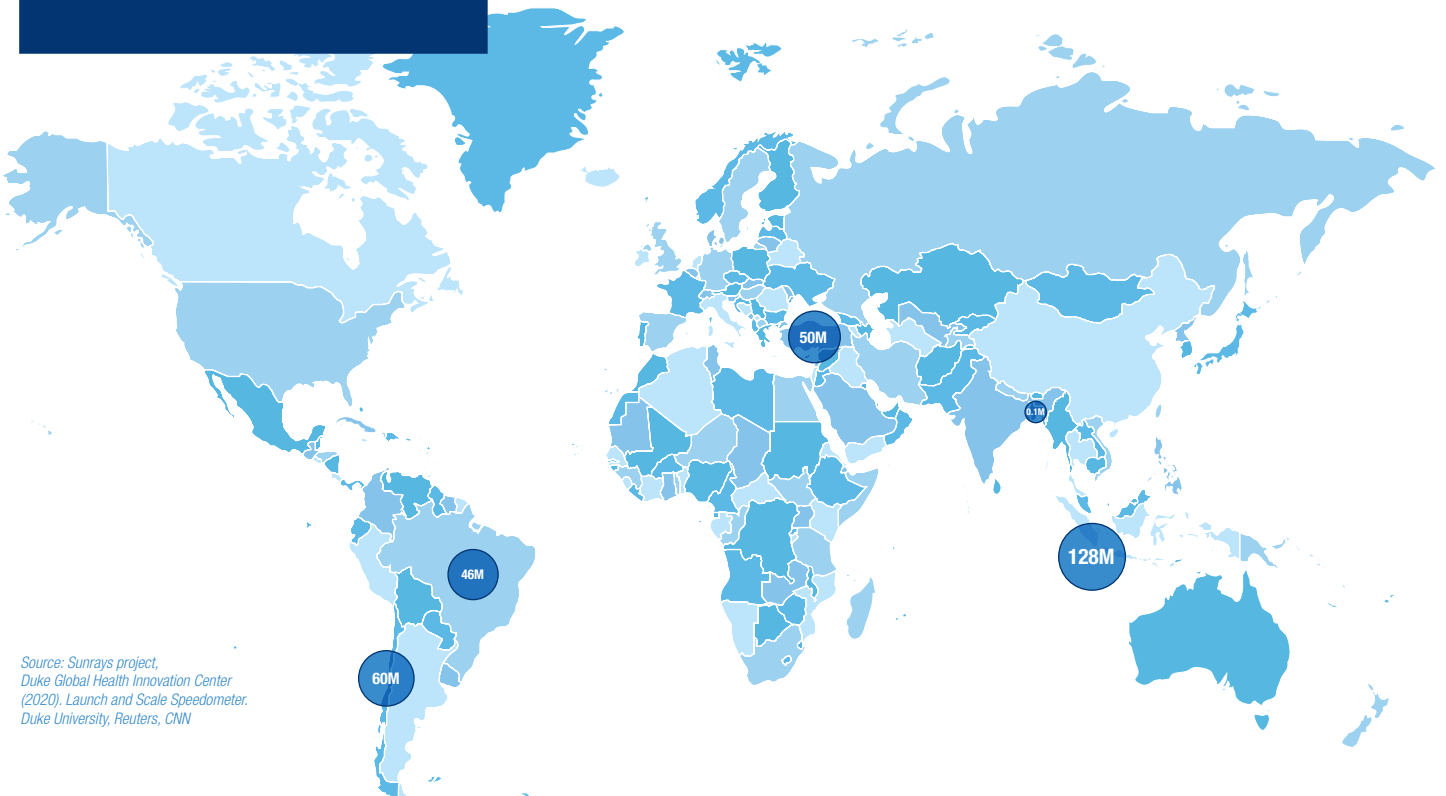
 **Transport requirements**

 **Transport temperature**
+15°C to +25°C

 **Likely to be a passive box on +15°C (standard process)**












Confirmed vaccine doses procured by country




INDONESIA	128M	BRAZIL	46M
CHILE	60M	BANGLADESH	0.1M
TURKEY	50M		



Source: Sunrays project, Duke Global Health Innovation Center (2020), Launch and Scale Speedometer, Duke University, Reuters, CNN

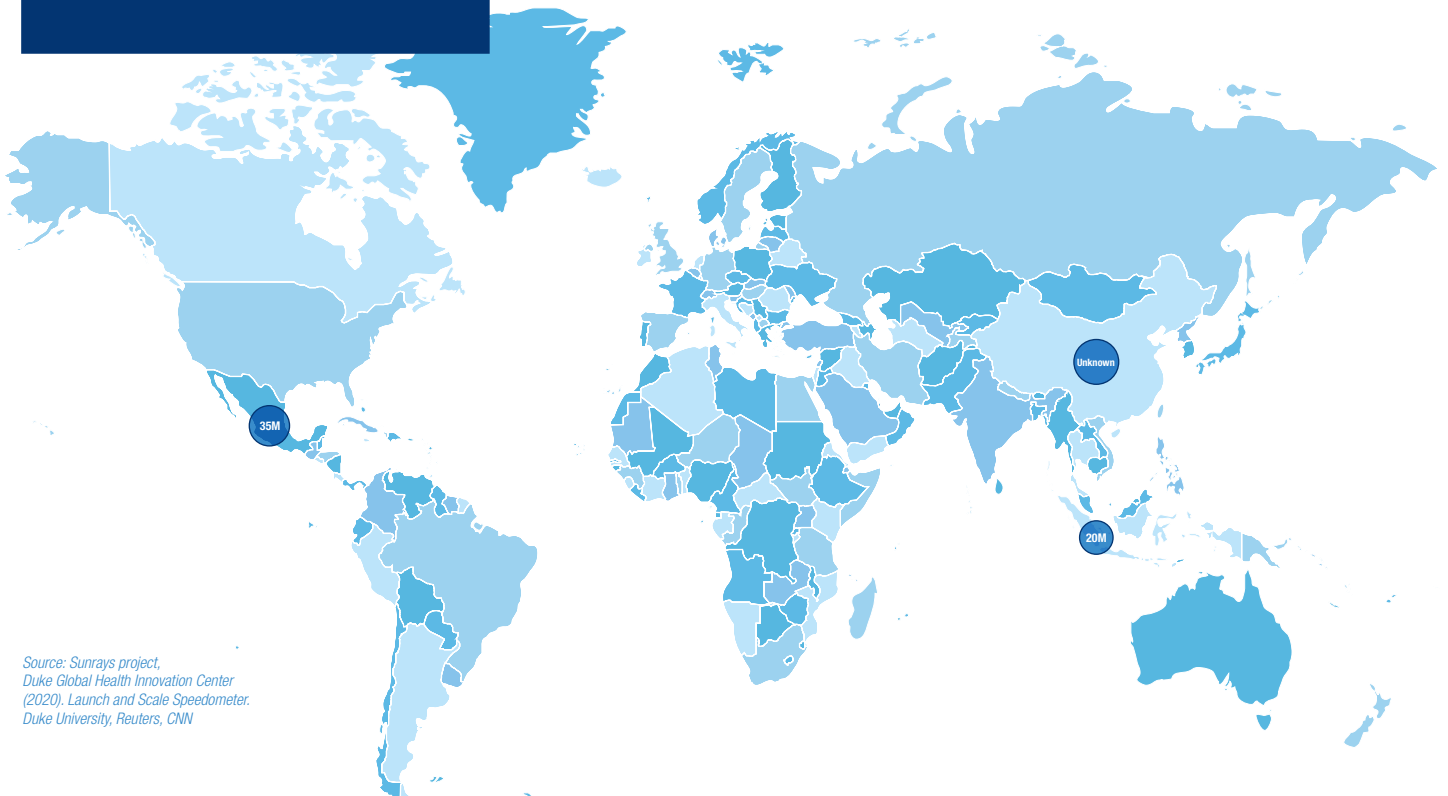
CanSino Biologics Inc. is a manufacturer of biological vaccine products headquartered in Tianjin, China.

 Medical specs	 Manufacturing info	 Development status
 1 dose Intramuscular  Vaccine storage: • Refrigeration (+2°C to +8°C)	 Production could start as of 2021  Manufacturing sites: • China  Production capacity of 100-200 million doses as of 2021	 Phase 3  Approval status: not yet approved for widespread use  Clinical trials locations: • China • Mexico • Pakistan • Russia

 Transport requirements
 Transport temperature +15°C to +25°C
 Likely to be a passive box on +15°C (standard process)

Confirmed vaccine doses procured by country

MEXICO	35M
INDONESIA	20M
CHINA	Unknown



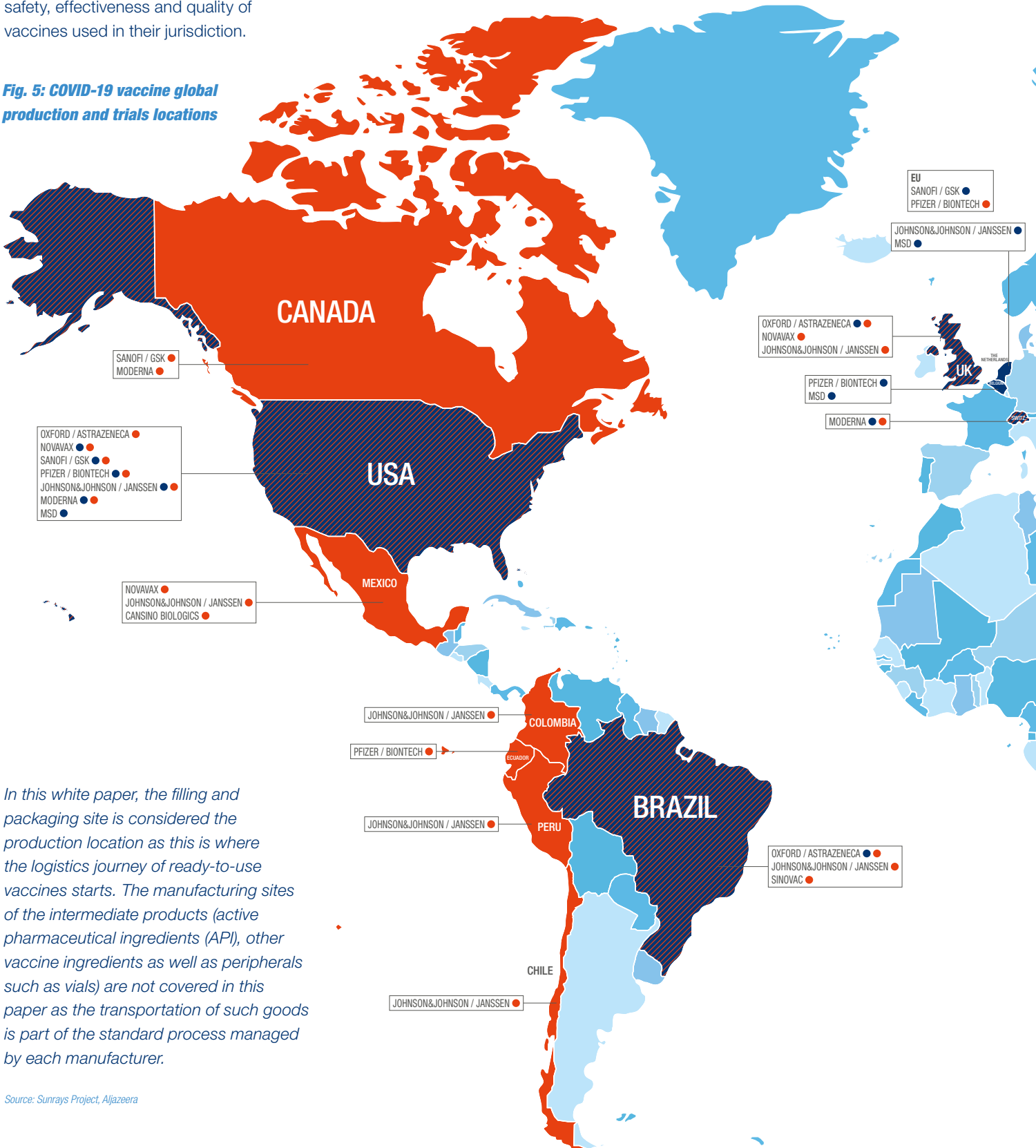
Source: Sunrays project, Duke Global Health Innovation Center (2020), Launch and Scale Speedometer, Duke University, Reuters, CNN

3. Where are the COVID-19 vaccines being produced?



The start of production of vaccines will highly depend on when the candidate vaccines will be approved for widespread use by the national government authorities, having an oversight of the safety, effectiveness and quality of vaccines used in their jurisdiction.

Fig. 5: COVID-19 vaccine global production and trials locations



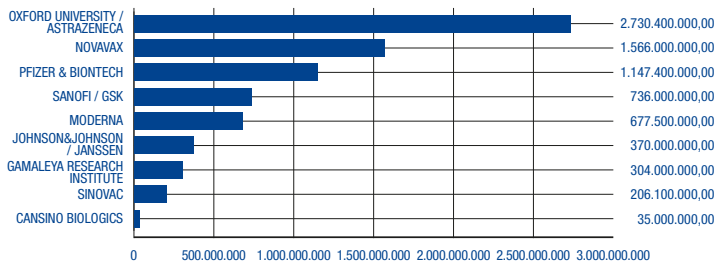
In this white paper, the filling and packaging site is considered the production location as this is where the logistics journey of ready-to-use vaccines starts. The manufacturing sites of the intermediate products (active pharmaceutical ingredients (API), other vaccine ingredients as well as peripherals such as vials) are not covered in this paper as the transportation of such goods is part of the standard process managed by each manufacturer.

Source: Sunrays Project, Aljazeera

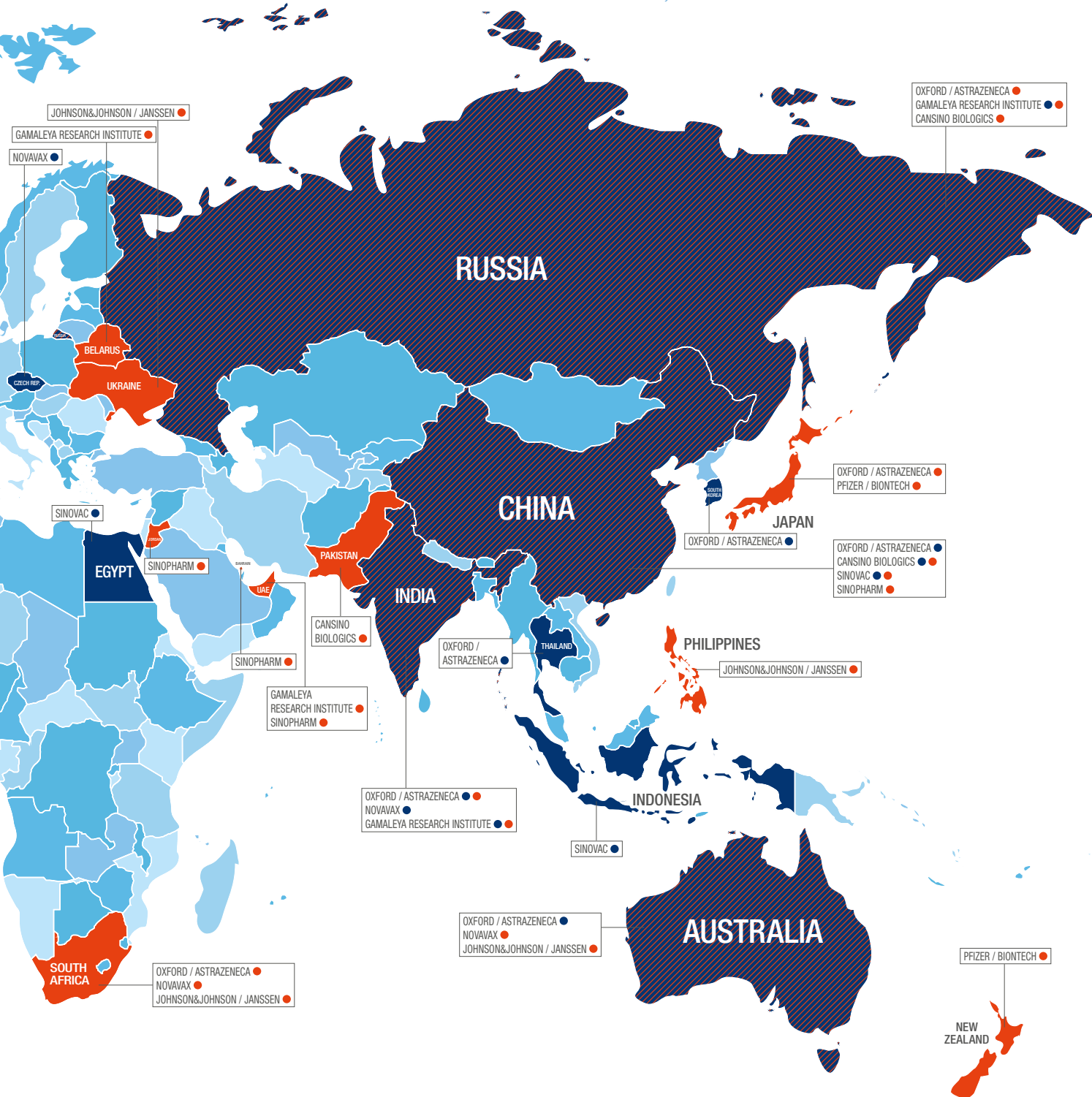
4. Vaccines purchasing deals

According to Duke Global Health Innovation Center, currently “before any vaccine candidates are even approved for market, there are already confirmed purchases over 7.1 billion doses, with another 2.6 billion doses currently under negotiation or reserved as optional expansions of existing deals”.

Fig. 6: Vaccine purchasing deals (by vaccine candidate)



Source: Sunrays Project, Reuters, CNN, Duke Global Health Innovation Center. (2020). Launch and Scale Speedometer. Duke University



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Brussels Airport and its community are joining forces in the BRUcure taskforce to safely and efficiently store, handle and ship the much-awaited COVID-19 vaccines, in collaboration with the major vaccine manufacturers.



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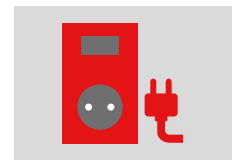
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5. National procurement strategies

Currently the vaccine procurement is done between vaccine manufacturers and individual countries or international institutions, like the European Union, the African Union, and COVAX.

COVAX is an initiative co-led by WHO, Gavi The Vaccine Alliance and the Coalition for Epidemic Preparedness Innovations (CEPI) to accelerate the development and production of vaccines and ensure a fair and equitable access for all countries, no matter their purchasing power. COVAX Facility seeks to procure, equitably allocate and deliver 2 billion doses of safe and effective COVID-19 vaccines by the end of 2021.

As of 20 November 2020, 95 higher-income economies have already signed up as self-financing members of the Facility, joining the 92 low-and middle-income economies who will have their participation supported by the Gavi COVAX Advance Market Commitment (AMC).

The COVAX AMC recently surpassed its 2020 fundraising target of USD 2 billion, with at least USD 5 billion more needed in 2021 to procure subsidised donor-funded doses of approved vaccines to vulnerable groups in AMC-eligible economies.

UNICEF acts as COVAX's logistics control tower and declared they are already in contact with 350 airlines and freight companies to safely deliver vaccines to all those who need them and 1 billion syringes to developing countries in 2021. It is likely that World Food Program (WFP) will also play a role in delivering vaccines to up to 32 countries where the organization has established logistics network and capabilities.

Vaccine procurement models

High Income Countries

High economic development countries have a choice of procuring vaccines making deals directly with manufacturers or by making up-front payment to COVAX Facility, which procures up to 50% of required vaccines for self-financing countries. COVAX Facility also guarantees rich countries will have an insurance policy if their individual deals with vaccine producers do not work out in case of vaccine candidate failure in effectiveness.

Middle- and Low-Income Countries

Some middle-income countries with manufacturing capacity have also been able to negotiate large purchase agreements as part of manufacturing deals. India's Serum Institute, for example, has committed to keeping half of all doses it produces for in-country distribution. Indonesia's president has

also recently announced the country will produce SinoVac vaccines as of December.

Some countries are hosting clinical trials and are using that as leverage in procuring future vaccines: this is the case for Indonesia with SinoVac, Brazil with AstraZeneca, and Morocco with Sinopharm.

In addition to the hundreds of millions of doses of COVID-19 vaccines which China will be sending to countries that have conducted last-stage trials for its top candidates, Chinese leaders have also promised a priority access to successful vaccines for the developing countries. In May 2020, China's president promised to donate USD 2 billion over two years to help countries deal with the pandemic and also offered a USD 1 billion loan to Latin America and the Caribbean countries to buy Chinese COVID-19 vaccines.

Africa Centres for Disease Control and Prevention (Africa CDC), a public health agency of African Union is working to guarantee access, financing, and procurement of COVID-19 vaccines for all member states by making direct deals with vaccine manufacturers. The target is to secure vaccines for at least 60% of continent's population within 2 year-time to reach the herd immunity.

92 low- and lower-middle-income countries are eligible to have their participation in the **COVAX Facility** supported by the COVAX AMC. For these "AMC countries" that may not have developed a vaccination strategy yet, nor can procure vaccines individually, COVAX Facility is procuring vaccines for them to cover up to 20% of their population.

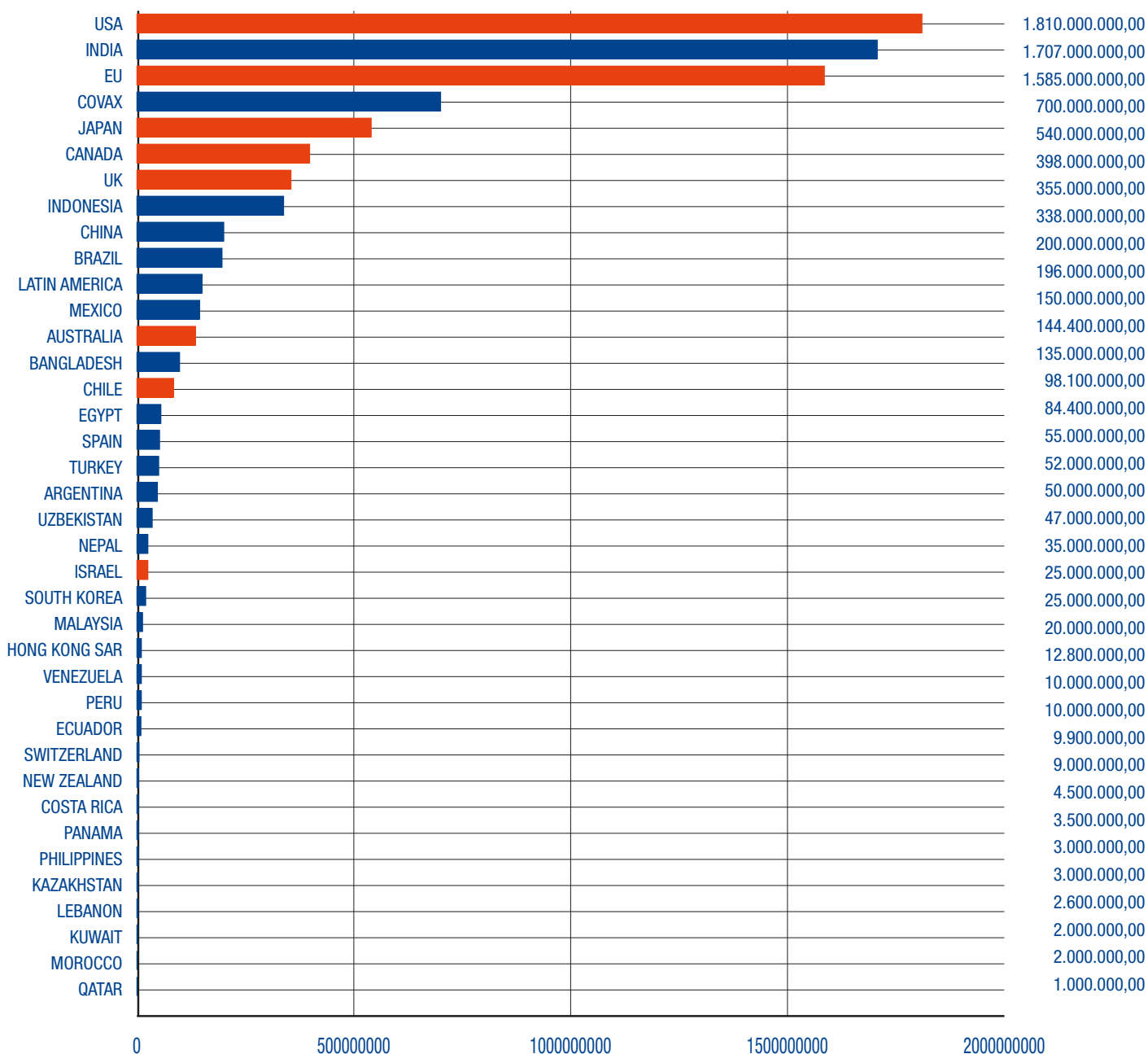
Humanitarian Needs

COVAX Facility is securing 5% or 100 million vaccines as a buffer for severe outbreak areas and humanitarian need, like vaccinating refugees, for example.

Despite the effort of COVAX to ensure rapid, fair and equitable access to COVID-19 vaccines once they are available for people in all corners of the world, regardless of their wealth, the first available doses may be taken by the richer countries. According to available data, a big proportion of the vaccine doses that have been bought so far are going to high-income countries and the following countries or regions have secured more doses than their entire population requires with their purchasing deals with several vaccine producers. In case there are many successful vaccines, these wealthy countries might not necessarily exercise all their options, leaving room to other countries and to COVAX to access more doses.

Canada and USA have secured enough doses to cover their entire population or more with just the 2 most-advanced vaccines manufacturers: Pfizer/BioNTech and Moderna.

Fig. 7: Vaccine purchasing deals (by country)



Source: Sunrays Project, Reuters, CNN, Duke Global Health Innovation Center. (2020). Launch and Scale Speedometer. Duke University

Fig. 8: Countries having secured more vaccine doses for more than 100% of their national population

Country or area	Total population (in thousands)	Total population covered by the current purchasing deals (all vaccines) (in thousands)	Total population covered by the current purchasing deals with 3 vaccine manufacturers (AstraZeneca + Pfizer-BioNTech + Moderna) (in thousands)	% of population covered in case all vaccines are approved	% of population covered in case the 3 vaccines are approved
Australia	25 500	41 900	21 900	164%	86%
Canada	37 742	162 000	48 000	429%	127%
Chile	19 116	73 700	43 700	386%	229%
Europe	747 636	780 000	430 000	104%	58%
Israel	8 656	10 000	10 000	116%	116%
Japan	126 476	270 000	145 000	213%	115%
United Kingdom	67 886	162 500	72 500	239%	107%
United States of America	331 003	955 000	750 000	289%	227%

Source: Sunrays Project, Reuters, CNN, Duke Global Health Innovation Center. (2020). Launch and Scale Speedometer. Duke University

6. Who will get the vaccines first?

Having the information on purchasing deals by country and region is interesting but it does not give the full picture of the timelines. Having one country order a certain number of doses from a manufacturer does not mean all these doses will be produced and delivered in one batch to this country. The massive global demand will mean that not everyone will be able to get the vaccine at the same time. It will take months, or years, to produce enough vaccine doses for everyone around the world.

WHO has issued global guidance on vaccine allocation and prioritization of populations in a likely case of limited vaccine supply:

Fig. 9: Priority groups for vaccination

Stage I (1-10% of population covered)
Priority groups: <ul style="list-style-type: none"> • Health workers • Older adults
Stage II (11-20% of population covered)
Priority groups: <ul style="list-style-type: none"> • Older adults • Groups with high risk of severe disease or death
Stage III (21-50% of population covered)
Priority groups <ul style="list-style-type: none"> • Essential workers • Other groups at higher risk of transmission or complications

Source: WHO

The first priority will be to get the vaccines to workers in health and social settings to limit the impact of COVID-19 on the functioning of the health and social systems and to vaccinate high-risk groups, including the elderly and those with medical conditions that put them at greater risk of serious illness and death following COVID-19 infection.

The numbers for each stage will vary by country or region, according to their local immunization strategy.

As an example, the leaders of the European Union (EU) have agreed to fair distribution of COVID-19 vaccines among its member countries once the vaccines become available. However, there is no common distribution model for the EU and vaccine logistics will be the responsibility and strategy of each individual countries.

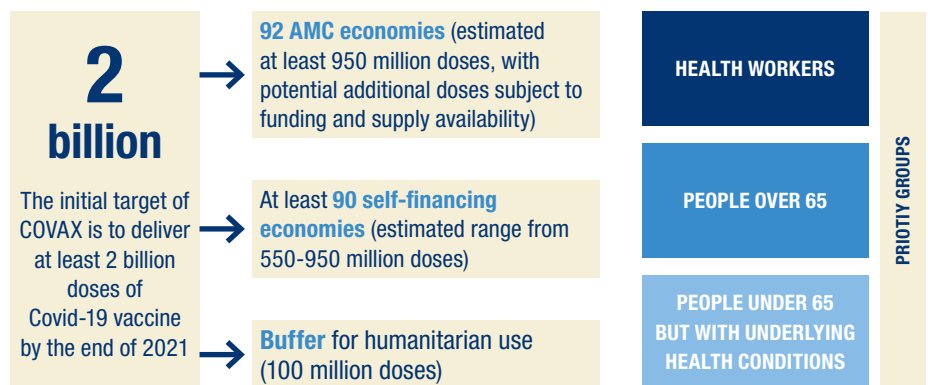
In the US, Operation Warp Speed announced in May 2020, aims at facilitating and accelerating the development, manufacturing, and distribution of COVID-19 vaccines, therapeutics, and diagnostics. Operation Warp Speed's goal is to produce and deliver 300 million doses of safe and effective vaccines with the initial doses available by January 2021 to essential care workers and people in the high-risk groups and have vaccines available for all Americans by April 2021.

COVAX aims to make available 2 billion vaccines worldwide by end of 2021 to countries participating in this initiative.

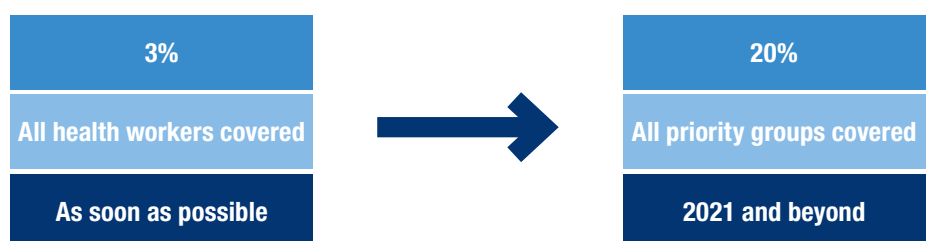
UNICEF acts as its Logistics Control Tower and is in contact with 350 airlines and freight companies to deliver vaccines and 1 billion syringes to developing countries in 2021. World Food Program (WFP) may play a role in delivering vaccines to up to 32 countries where the organization has established logistics network and capabilities.

In addition to the allocation principles, local governments have to decide if they make the vaccination mandatory or optional, free for all, some or none of their citizens, which healthcare entities and professionals will be authorized to administer the vaccines. All these considerations will have an impact on the volumes and logistics flows. The air cargo and logistics industry need to work closely with their local authorities to get ready and receive first-hand information about the local situation.

Fig. 10: How Covid-19 vaccines will be distributed through COVAX



Vaccination phases for the population of participating countries



Source: Gavi, the Vaccine Alliance, COVAX

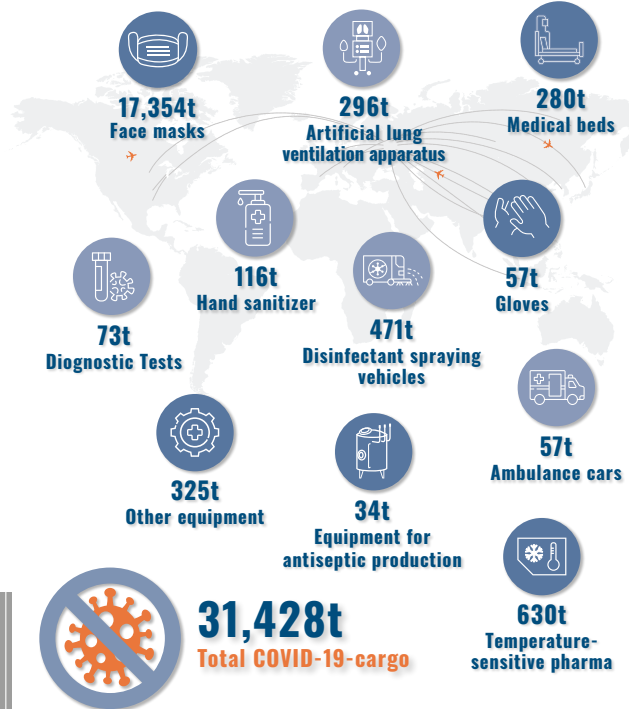


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7. Vaccines distribution models

The distribution models will vary depending on the type of vaccine, selected packaging material, shipping configuration used, routing, etc.

While it is clear there will be different types of vaccines at different product temperatures, this white paper covers only the distribution models for deep-frozen and frozen vaccines. For the other types of vaccines, the industry is already well prepared to handle, store and transport them following the industry standards and guidelines described in IATA's TCR. In addition, according to IATA, more than 27 airlines, 80 ground handlers and 192 freight forwarders are already CEIV Pharma certified having the adequate expertise, procedures, and infrastructure in place to handle regular pharma shipments.

CEIV Pharma

Working alongside aviation industry stakeholders and regulators, IATA created the Center of Excellence for Independent Validators in Pharmaceutical Logistics (CEIV Pharma) to help organizations and the entire air cargo supply chain to get on the right track to achieve pharmaceutical handling excellence.

CEIV Pharma addresses industry's need for more safety, security, compliance and efficiency, by the creation of a globally consistent and recognized pharmaceutical product handling certification.

By establishing a common baseline from existing regulations and standards, this certification ensures international and national compliance to safeguard product integrity while addressing specific air cargo needs.

CEIV Pharma encompasses, or even supersedes, many of the existing pharmaceutical standards and guidelines such as:

- IATA Temperature Control Regulations (TCR)
- European Union Good Distribution Practices (EU GDP)
- World Health Organization Annex 5
- United States Pharmacopeia Standards

Options to avoid any temperature deviation

For deep frozen vaccines (-70°C)

- Choose distribution centers with adequate deep-frozen capabilities
- Select providers with relevant dry-ice management expertise, including dry-ice stocks and re-icing stations with related procedures in place
- Ensure the end-to-end transportation is completed within the strict timeline allowed by the passive packaging (in the case of the Pfizer-BioNTech box, it would mean within 240 hours; but there are other boxes available on the market as well)
- Use cool dollies at the airport during transit

For frozen vaccines (-20°C)

- Use Packaging Securing Materials (PCM), gel ice or gel pack
- Use active containers
- Use cool dollies at the airport during transit
- Ensure the end-to-end transportation is completed within the strict timeline allowed by the passive packaging designed to maintain inside temperature of -20°C for a given time

Dry ice limitations

Note that there are restrictions linked to dry ice limitations based on aircraft type and subject to local civil aviation's approval upon application by the airlines, as well as needs for special training and procedures linked to dry ice management.

Dry ice in itself is not considered Dangerous Goods (DG) but the carbon dioxide gas it releases is. Different countries regulatory bodies have their own restrictions on the amount of dry ice an airline can carry. In addition, aircraft manufacturers also place limits on their aircraft models.

According to the US FAA, the limit of dry ice is 2.5 kg (5.5 lbs) per package and per passenger. Airline approval is required prior to transport and packages must not be airtight and must allow the release of carbon dioxide gas.

Recently the FAA granted an US airline a waiver to increase the amount of dry ice weight their B777-200/300 could carry, raising to it 6803kg but only if no passengers on board. These are new limits are for dedicated charters only. The limits have not been increased for flights that still carry passengers. Other US airlines are seeking similar increases to their dry ice limitations. This is not a unique solution but rather applies to any carrier who operates these aircraft types. Some air cargo carriers such as AirBridgeCargo who operates the AN124 have no dry ice limitations which affords them tremendous flexibility in the carriage of vaccines versus other carriers.

In case the choice is to complete the transport end-to-end within the strict timeline allowed by the passive packaging, it will be critical to ensure security and customs clearance procedures are expedited and no delay occurs at the border.

Note that passive refrigerants (PCMs, gel ice and gel packs) need to be pre-conditioned for optimal use, and therefore may require freezer capacity for the gel packs at manufacturing sites and potentially at distribution centers.

Passive containers do not need to be preconditioned so long they are in good working condition after visual inspection as the temperature is maintained by the help of dry ice.

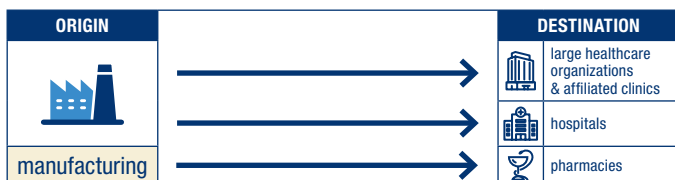
In case active containers are used, some challenges need also to be addressed: availability of enough containers at the right time and location, active management procedures in place at origin, transit and destination (to re-ice or recharging stations for the active containers).

For active containers, if the vaccines are already preloaded with the vaccines and sealed, the ground handler should ensure that the active containers are plugged into the power source to ensure the aircon built in the active containers are working.

Direct distribution or through distribution centers?

Direct distribution model: manufacturing to point of care (hospitals, pharmacies, healthcare organizations)

Fig. 11: Direct distribution model



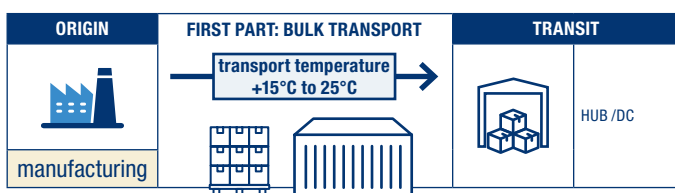
Source: Sunrays Project

This scenario illustrates the end-to-end solution (using integrator networks or chartered flights) that shippers might prefer to limit hand-over points during transportation, temperature deviation risks and unexpected delays.

The direct distribution model might also be chosen in case of scarcity of flights, small quantities, emergency deliveries, and lack of cold chain capabilities at destination.

Traditional distribution model, transiting in a hub or distribution center

Fig. 12: Traditional distribution model

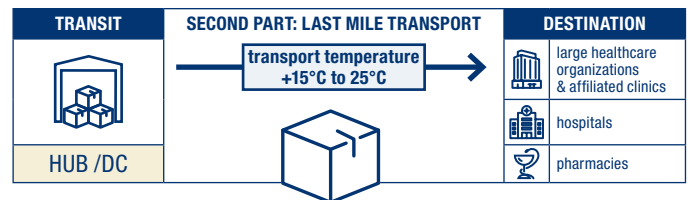


Source: Sunrays Project

The first part of the transport will be from the pharmaceutical company's manufacturing or own distribution center to a transit location, such as pre-defined hubs or assigned distribution centers. It is likely that big quantities of vaccines will be transported on this first part. If airborne, this first part can be either a direct flight or connecting flights through a transit airport.

At the distribution center, the vaccines will be stored either at product temperature level or at transport temperature (in the case of Pfizer-BioNTech vaccine, it means the distribution center will store them either at -70°C or between +15°C and +25°C with the special shipping box, which can maintain the inside temperature for 240 hours).

Fig. 13: The last mile distribution model



Source: Sunrays Project

From this pre-defined hub or assigned distribution center, it is likely that smaller quantities will be shipped to the point of care.

The last mile transport strategy will differ from one country or region to another. The graph above illustrates the US model for last mile transport. Other countries will have similar set up with one distribution center.

Operation Warp Speed

In the US, distribution model included in Operation Warp Speed relies mainly on US-based logistics provider McKesson Corporation, which was contracted by the Federal Government to manage the distribution of the COVID-19 vaccines. McKesson will act as a centralized managing distributor of future COVID-19 vaccines that are refrigerated (2-8°C) or frozen (-20°C) and ancillary supplies to point-of-care sites across the country. Ultra-frozen (-70°C and colder) will not be handled by McKesson.

Domestic logistics is likely to be done by trucks rather than air, and initially by the integrated carriers UPS and FedEx since they have the capacity to handle last mile delivery.

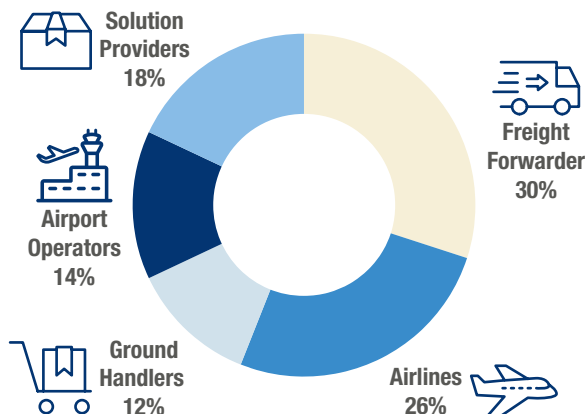
Some of the initial doses could also be produced overseas, which will rely on air cargo since US pharma manufacturers have production in Europe as well. In that context, some cargo flights may have already taken place as pharma manufacturers are pre-positioning large numbers of vaccines to enable faster distribution once FDA gives their EUA approval.

The most challenging last mile distribution scenario is with no doubt within the 92 AMC countries within the COVAX framework, as not all have their own distribution center. It means they will be supplied from an assigned distribution center by COVAX, further away from point of care. This could mean longer transit times and hard-to-reach destinations in countries where the cold chain infrastructure is either limited or absent.

8. How ready is air cargo

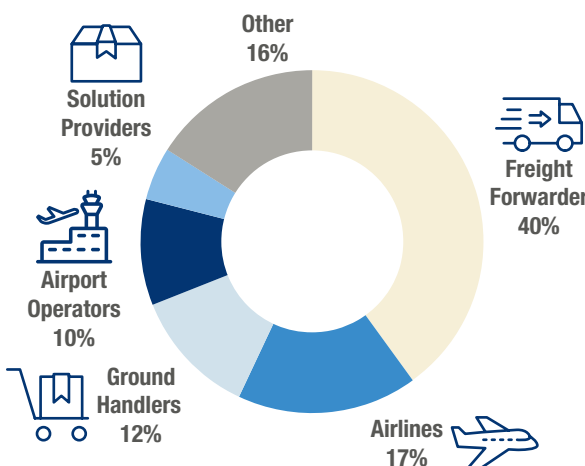
Project Sunrays conducted two industry surveys to collect insights from the airfreight sector on capabilities, readiness, concerns, needs and business plans for 2021. We have collected 181 answers for the first survey from 8 to 20 September 2020 and 196 for the second one from 6 to 29 November 2020.

Fig. 14: Sunrays airfreight readiness survey September 2020



Sunrays airfreight readiness survey,
September 2020
188 answers

Fig. 15: Sunrays airfreight readiness survey November 2020



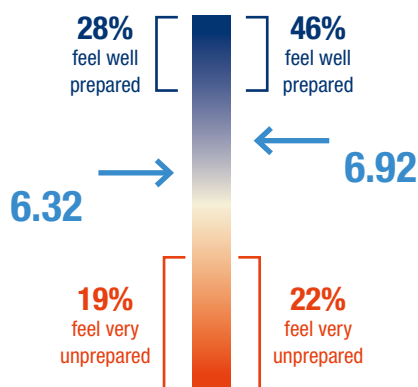
Sunrays airfreight readiness survey,
November 2020
196 answers

Airfreight readiness

In September, we had concerns about the lack of preparedness sentiment within the air cargo industry. Only 28% of the respondents felt very well prepared, scoring 8, 9 or 10 to the question “how well-informed and prepared is your organization in the global air transportation of COVID-19 vaccines”, with 10 feeling the most prepared and 1 being the least prepared. The industry average was 6.32 out of 10 but with lower scores for airports and ground handlers.

Two months later, it is encouraging to see more readiness with 46% of the respondents feeling well prepared and an industry average improving to 6.92 out of 10. Improvement is seen across all supply chains with a bigger jump for ground handlers moving from 5.55 out of 10 to 7.33 now. Is it a result of more engagement with their supply chain partners and vaccine manufacturers directly or indirectly, or involvement in local COVID-19 vaccines task forces?

Fig. 16: Sunrays airfreight readiness score (comparison between two periods)



In **September**, a concerning lack of readiness for COVID-19 vaccine logistics: only 28% of industry feeling well prepared

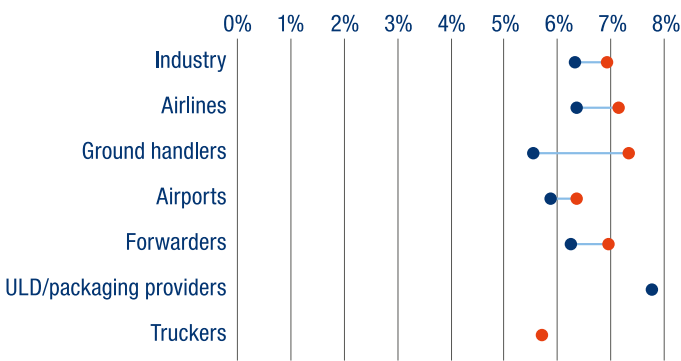
In **November**, 46% of industry feeling well prepared

Source: Sunrays Airfreight Readiness Surveys

The September survey showed a good level of readiness from ULD and packaging solution providers, probably explained since they are closer to the pharma shippers and are in more constant contact with them.

In November, a fair number of truckers providing Road Feeder Services (RFS) conducted the survey and indicated a low level of readiness: 5.7 out of 10. Mirroring our earlier call to not let the ground handlers behind and out of the conversation, **TIACA and Pharma.Aero urge the airlines to involve their RFS providers as early as possible in the process.**

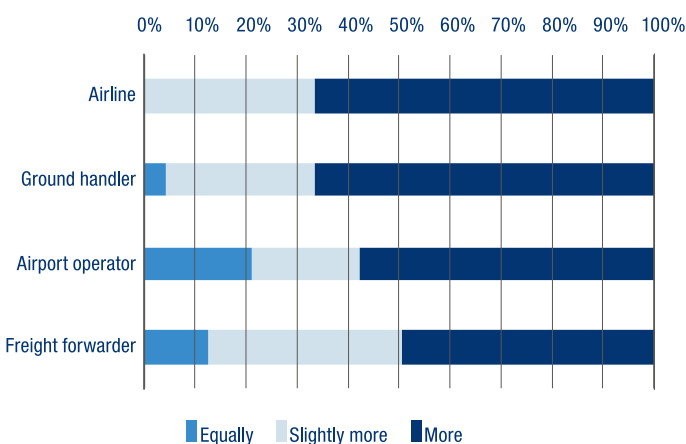
Fig. 17: Readiness score improvement (by key stakeholder)



Source: Sunrays Airfreight Readiness Surveys

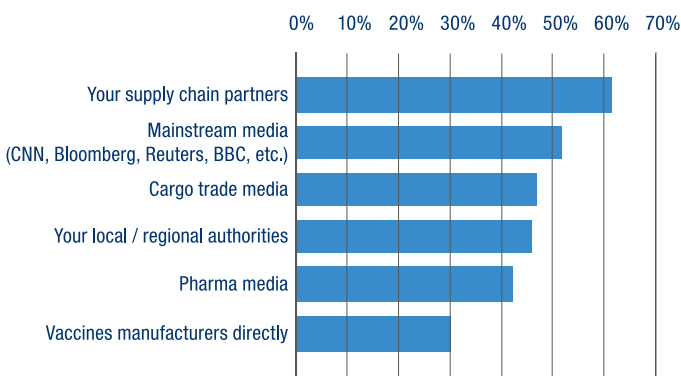
91% of the respondents feel more or slightly more informed now compared to 3 months ago. Main sources of information are their supply chain partners, the press (mainstream, cargo trade or pharma) and the local and regional authorities. 30% indicated they get information directly from vaccines manufacturers and 21% obtained information from Project Sunrays.

Fig. 18: Do you feel more prepared than 3 months ago?



Source: Sunrays 2nd Airfreight Readiness Survey

Fig. 19: What are your sources of information?



Source: Sunrays 2nd Airfreight Readiness Survey

75% of the respondents have indicated they are still missing information to get ready: it is not surprising to see that air cargo professionals are still waiting for final product

specifications such as temperature ranges for transport, handling and storage of vaccines.

The other questions they would need an answer to which directly impact planning are: how much, where, and when?

Other types of information that the air cargo industry would require greater clarity to include but not limited to:

- Airlines' acceptance policy regarding dry ice as well as monitoring devices
- Dry ice quantities and limitations on aircraft
- Local authorities' plan, regulations, support, contacts
- Security measures to protect vaccines from pilferage

Importance of early engagement with vaccines manufacturers

Not surprisingly, companies already engaging the vaccine manufacturers feel much more prepared for the coming challenge of COVID-19 vaccines logistics:

- In September, the organizations that declared they were already in close contact with the vaccines' manufacturers were feeling more ready (7.67 out of 10) than the ones with not contact yet (5.09 out of 10).
- In November, these figures jumped to 8.17 out of 10 for companies in close contact with vaccine manufacturers and 7.36 for the ones who have started to engage them in the past 3 months.

62% of the air cargo players providers with established early working relationships with vaccine manufacturers have also declared they have put the right structure in place with dedicated teams and are collaborating with their other supply chain partners and subcontractors to handle the logistics of COVID-19 vaccines. **This group of air cargo industry players having the combination of team + collaboration with vaccines manufacturers + collaboration with their supply chain partners is feeling the most prepared about the coming challenge: their readiness sentiment is 8.65 out of 10.**



Fig. 20: Do you feel more, equally or less collaboration in the industry to address this unprecedented challenge?

Equally
Less
More

Source: Sunrays 2nd Airfreight Readiness Survey

53% of the respondents felt that there is more collaboration in the industry to address this unprecedented challenge.

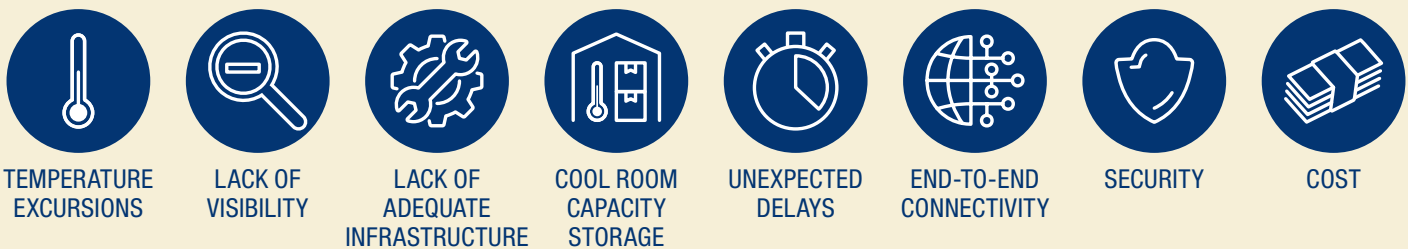
There is a shared feeling that the COVID-19 vaccines market will be taken by the big multinationals who have more direct contact with shippers and national authorities. Small and medium size players are struggling more to get information and feel they have little opportunities to promote their services and their readiness.

Overall, there is a need for more and better cargo community approach at all levels, as well as a trade-lane approach. For instance, airports at origin, transit and destination shall work closely together and not compete to minimize disruptions and maximize efficiency, reliability, and speed.

Top 8 concerns, real or perceived

In September survey, the air cargo professionals identified the **main 8 risks, real or perceived**, linked to the transport of COVID-19 vaccines in unprecedented quantity, limited timeframe and in the current economic downturn.

Fig. 21: Top 8 concerns of the air cargo industry



Security

Security and cyber-security measures need to be put in place to avoid theft and counterfeit.

It is difficult to ascertain the multiple levels of threats the vaccine distribution process can face. The air cargo industry deals with high security shipments regularly and many companies specialize in the secured transport of expensive art, fashion items such as watches/jewelry, and other items like gold or currency shipments. Others have long battled the transport of illicit drugs and more recently the threat from terrorism in the form of bombs or other devices designed to bring down aircraft.

The big difference with the COVID-19 vaccine is the scale of the demand, as everybody wants it. Manufacturers have been incredibly careful in not sharing too much information on the transportation of the vaccines, sharing only limited intelligence with those directly involved with the movement of the vaccines.

The types of threat vaccine distribution will encounter will depend often on the region or country where it is being transported.

BBC revealed on 3 December 2020, that within hours of the UK authorizing Pfizer vaccine, potential cyber-attacks targeting private companies and public institutions involved in the vaccine manufacturing, approval, or distribution processes have already been reported. This is just the first of potentially many more security threats associated with the COVID-19 vaccines.

The threat will not only come from the location but will vary in its sophistication. It could come from hackers as previously mentioned, pharma counterfeits, organized crime, or rogue nations.

The air cargo industry needs to be prepared at all levels. Each organization involved in the supply chain needs to stay vigilant and connected with local, state, and federal authorities to anticipate, identify, alert, and stop these physical and cyber threats.

In some countries the military may have an active role in securing the vaccines, or the use of additional security personnel may be needed to escort shipments in others.

Airports and their corresponding ground handlers and airlines may have to step up their surveillance of flights carrying COVID-19 vaccines. Additional staff may have to be hired or trained to address these new challenges.

To address these threat and others, it is always best plan and prepare:

- review their internal security protocols
- implement new procedures to address current threats
- fill gaps in security net (i.e. adding CCTVs)
- train staff, regular and additional
- update insurance policy
- test your system and fine tune as needed
- have active communications with other companies involved in the supply chain transport

Importance of local cargo communities and local COVID task forces

At many locations, mostly led by the airport, we see local COVID-19 task forces being set up between private and public stakeholders to collaboratively identify and address challenges such as: dry-ice accessibility, border clearance process, security risks and associated measures, landside/truck parking/staging areas, training and staffing requirements, infrastructure needs such as expansion of temperature-controlled facilities.

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Risk management

As anticipating and managing risks are part of the DNA of the air cargo industry, each individual player had already come up with mitigation strategies, despite the lack of information including:

Fig. 22: Risk mitigation and management strategies

 <p>Minimize temperature excursions and further increase reliability by:</p> <ul style="list-style-type: none"> • Training more staff • Setting up a 24/7 control tower to handle irregularities • Providing cold chain equipment such as cool dollies for ramp transportation • Optimizing ramp and loading processes • Performing risk assessments on and validations of trade-lanes 	 <p>Mitigate potential capacity crunch by:</p> <ul style="list-style-type: none"> • Adding airline and warehouse cargo capacity • Facilitating approval of additional charter flights & planning special slots • Educating customers on load optimizations & container utilization to maximize space on aircraft
 <p>Address the potential lack of adequate infrastructure by:</p> <ul style="list-style-type: none"> • Mapping current capabilities at origin, transit, and destination points • Expanding cargo facilities to include new cold storage infrastructure • Securing availability of containers, dry-ice, and adequate temperature-controlled space 	 <p>Increase end-to-end visibility by:</p> <ul style="list-style-type: none"> • Using or encouraging use of monitoring devices • Deploying IT solutions such as digital cargo community platforms

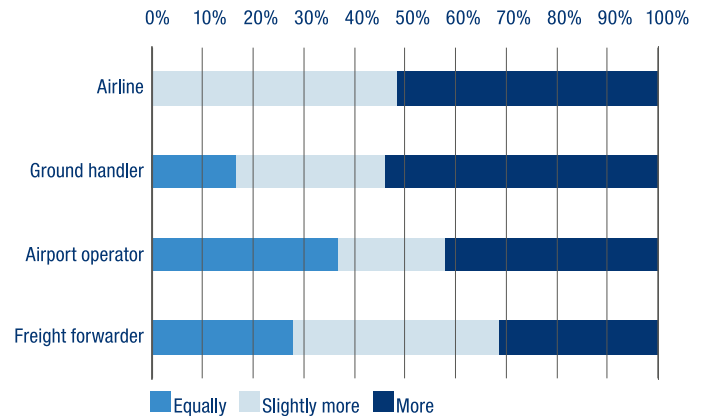
Best practices from the air cargo players already involved in logistics of clinical trials

In the September survey, organizations involved in logistics of COVID-19 vaccines in clinical trials shared their advice and recommendations to get ready:

- Setting up a specialized team to manage COVID-19 vaccine shipments (applicable to all stakeholders)
- Integrating methods and solutions to track, collect and share data on the shipment (this is more geared towards solution providers such as ULD, Packaging companies, and IT platform providers)
- Developing new/better packaging and dry-ice solutions (for ULD and Packaging providers)
- Defining final mile delivery solutions (mainly forwarders)
- Expanding network capabilities with CEIV Pharma certified partners and adequate cargo facilities (more applicable to airlines, forwarders, handlers, airports)

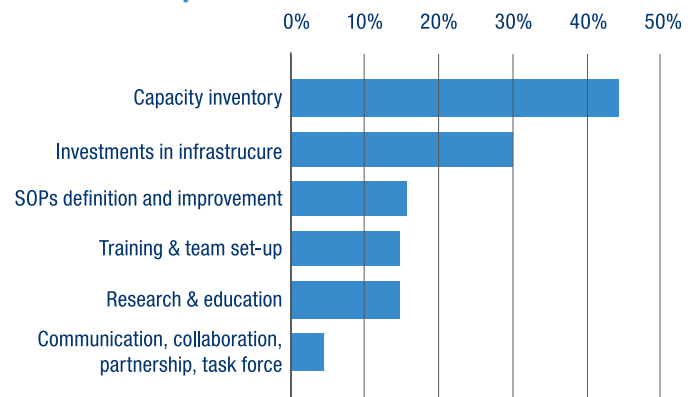
79% of the respondents of the November survey feel more or slightly more prepared now compared to 3 months ago. They gave us more details about what they have done and put in place to increase their preparedness levels in the past 3 months:

Fig. 23: Do you feel more prepared than 3 months ago (by key stakeholder)?



Source: Sunrays 2nd Airfreight Readiness Survey

Fig. 24: What have you done or put in place to increase your readiness in the past 3 months?

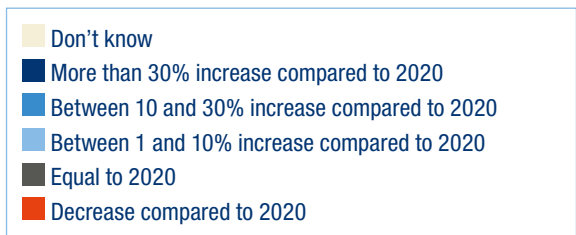
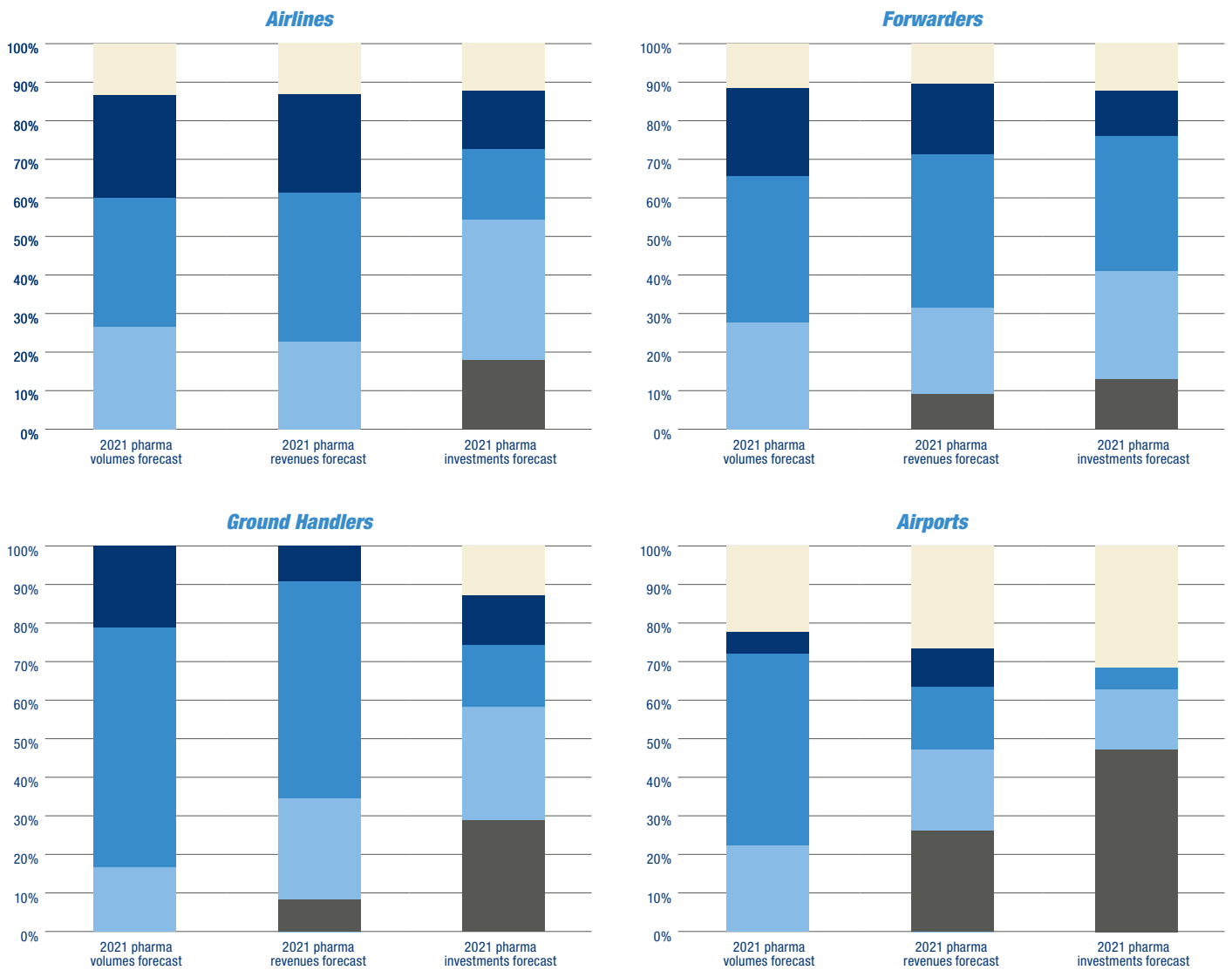


Source: Sunrays 2nd Airfreight Readiness Survey

9. Industry's forecasts for 2021 pharma business: volumes, revenues, and investments

In our second airfreight survey, we asked several questions related to 2021 business forecasts: 88% of the respondents expected an increase in their pharma volumes in 2021 compared to 2020, 79% an increase in their revenues, while 64% projected an increase in their investments to sustain their pharma business next year.

Fig. 25: Industry stakeholders' 2021 pharma business forecast

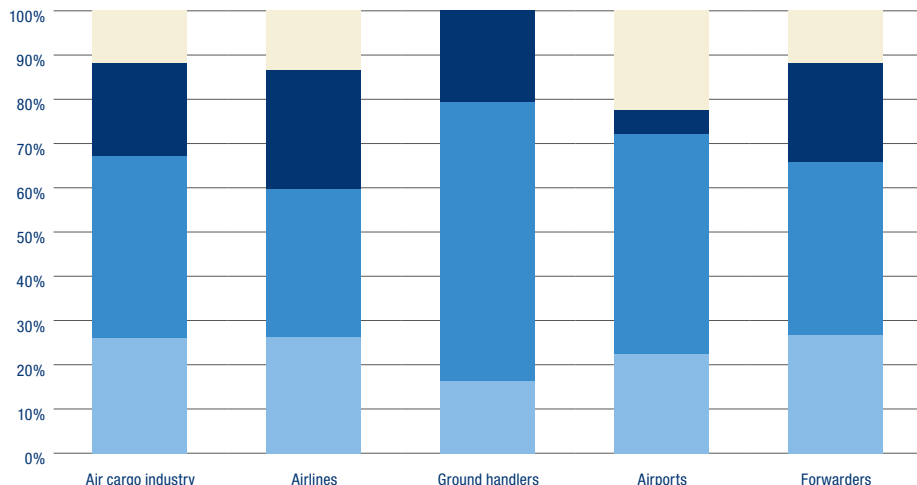


Source: Sunrays 2nd Airfreight Readiness Survey

Volumes

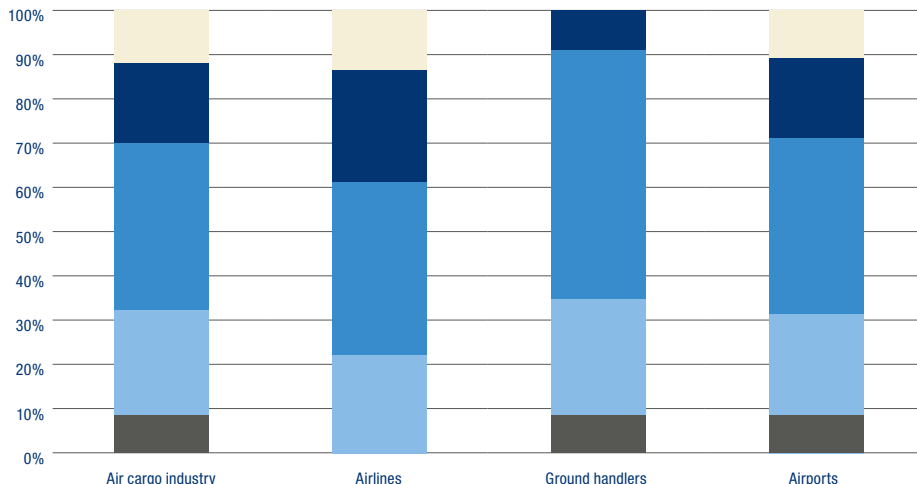
While almost all respondents expected pharma volumes growth next year, many have indicated they are unable to have an accurate forecast figure given the uncertainties on the COVID-19 vaccines production timelines and the distribution models that will be chosen. The pharma business outside of COVID-19 vaccines, on the other hand, remains a growing market for air cargo.

Fig. 26: Industry stakeholders' 2021 pharma volume forecast



Source: Sunrays 2nd Airfreight Readiness Survey

Fig. 27: Industry stakeholders' 2021 pharma revenues forecast



Source: Sunrays 2nd Airfreight Readiness Survey

- Don't know
- More than 30% increase compared to 2020
- Between 10 and 30% increase compared to 2020
- Between 1 and 10% increase compared to 2020
- Equal to 2020
- Decrease compared to 2020

Revenues

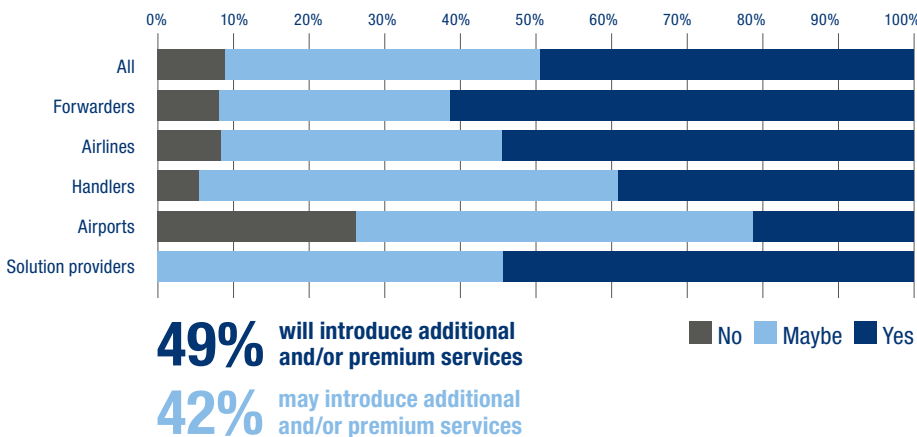
Note that as airports do not collect revenues by commodity, this question was not relevant.

Services

49% of respondents of the first survey in September 2020 confirmed they will introduce additional and/or premium services, another 42% said they may, for shippers and clients, such as dedicated teams, special care service, 24/7 availability, airside thermal protection, guaranteed insurance on vaccine transported, express booking, fast break down, clearance at any time, tailor-made product with special handling and monitoring of the temperature control, along with timely information to the shipper.

Another 42% said they may.

Fig. 28: Introduction of additional and premium services (by key stakeholder)



49% will introduce additional and/or premium services

42% may introduce additional and/or premium services

■ No ■ Maybe ■ Yes

Source: Sunrays 2nd Airfreight Readiness Survey



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Investments

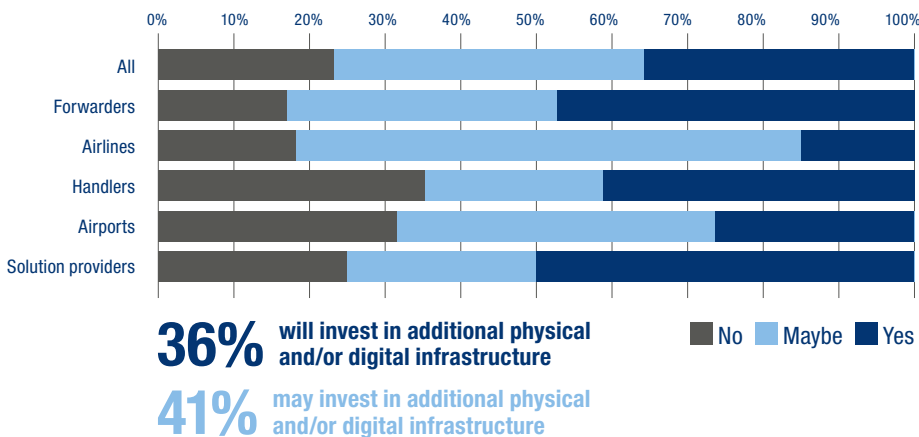
36% of respondents of the first survey in September 2020 confirmed they will (and other 41% said they may) invest in additional physical and/or digital infrastructure, including: additional staff, training, cool rooms, storage facilities, containers, mobile temperature readers, data loggers, sockets, aircraft charters, and also software and data platforms such as Cargo Community Systems.

33% of the respondents of the second airfreight readiness survey indicated that they plan to recruit more people; 37% plan to expand or upgrade their cargo facilities; and 40% plan to secure more cool chain ground service equipment, ULDs, containers, dry-ice to handle COVID-19 vaccines business.

For the ones who answered they do not know if they will invest more next year in their pharma business, some indicated that they are prepared to do so upon customers' needs and requests.

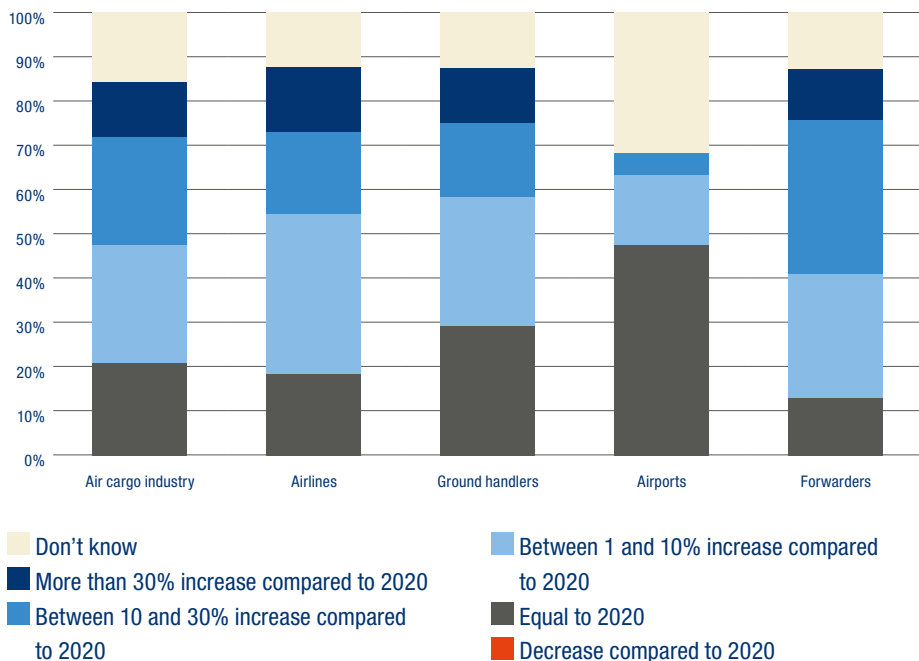
For those who answered no, many indicated they had already expanded or upgraded their cool chain facilities and invested in their pharma business in the past 3 years. This echoed the feedback received on the 1st airfreight readiness survey in September 2020 showing the industry is already well equipped to handle temperature-controlled shipments, with a large number of temperature-controlled facilities available and 54% of air cargo players confirming they have adequate cool chain ground equipment already in place.

Fig. 29: Investment in additional physical and digital infrastructure (by key stakeholder)



Source: Sunrays 2nd Airfreight Readiness Survey

Fig. 30: Industry stakeholders' 2021 pharma investments forecast



Source: Sunrays 2nd Airfreight Readiness Survey

Airlines respondents indicated they have set up 24/7 operations centre to monitor the vaccine shipments and increased cool chain capacity at certain stations either by leasing cold-storage space and equipment, upgrading owned facilities, or contracting secondary ground handlers. Several airlines indicated that they are securing adequate lease agreements with suppliers of temperature-controlled containers and cool dollies, investing in reefer trucks and thermal blankets etc. Many of them are also securing dry-ice availability.

Ground handlers specified they are investing in new, additional, or improved cool dollies and temperature-controlled facilities and vehicles, additional electrical sockets and reefer mobile units, CEIV Pharma certification, additional training for all operational staff, as well as in data sharing platform. There are some that are producing their own dry ice.

Some of the freight forwarders' plans: chartering flights to increase capacity, building cold storage facilities near all major airports, widening their storage and warehouse capabilities, acquiring more temperature-controlled vehicles, renting special equipment to handle deep-frozen products, securing availability of active ULDs, installing latest monitoring devices to help maintain the temperature of shipment, expanding the use of digital platform to monitor and control end to end process. Investment in personnel includes increase of manpower, hiring of full-time pharmacist, development of adequate training programs. Some forwarders indicated they will also procure cool boxes to deliver the vaccines and will be able to arrange dry-ice availability and re-icing upon request.

Fig. 31: Are you currently able to handle/store/transport temperature-controlled shipments?

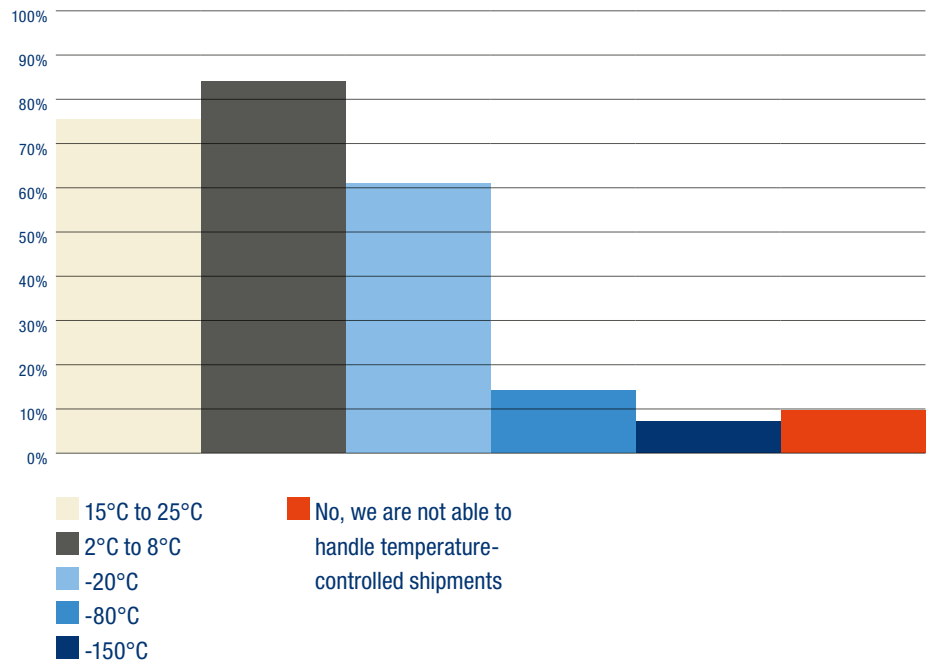
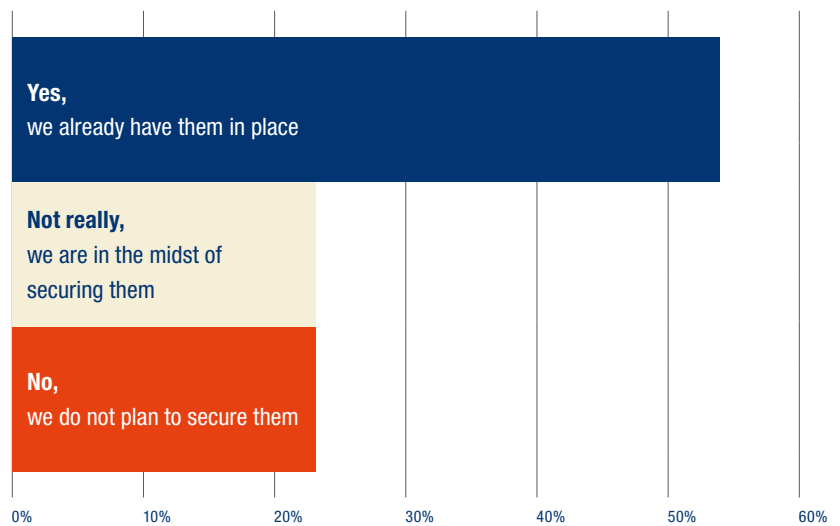


Fig. 32: Do you have access to cool chain ground equipment and ULDs?



Source: Sunrays 1stAirfreight Readiness Survey, Change Horizon

Conclusion

While the first COVID-19 vaccines are ready to be distributed and administered to the first patients, TIACA and Pharma.Aero applaud the current readiness progress and exceptional industry collaboration happening in the air cargo industry.

Top 5 shippers' requirements related to COVID-19 vaccines transportation

1. Integrity

- No temperature excursion

2. Speed

- Express service
- Border agencies need to be aligned to have no delay's

3. Security

- Security program to prevent counterfeit & theft

4. Reliability

- Guaranteed delivery times
- Recorded information on shipment status (temperature, conditions at each milestone) to verify integrity of the product

5. Transparency

- Information on existing airfreight capacity and lead times per trade-lane
- Real-time (or near-real time) tracking, monitoring and information sharing on shipment (location, status, temperature) and alerts in case of deviation in time to react and correct
- Reliable information on capabilities of logistics providers including each cargo facilities at transit and destination points

In September, we had concerns about the lack of preparedness sentiment within the global air cargo industry. Two months later, it is encouraging to see higher readiness with 46% of the respondents feeling well prepared and an industry average improving to 6.92 out of 10.

- Improvement is seen across all air cargo players with a bigger jump for ground handlers moving from 5.55 out of 10 to 7.33 now.
- 62% of the air cargo players with established early working relationships with vaccine manufacturers have also declared that they have put the right structure in place with dedicated teams and are collaborating with their other supply chain partners and subcontractors to handle the logistics of COVID-19 vaccines. This group of air cargo industry players having the combination of team + collaboration with vaccines manufacturers + collaboration with their supply chain partners is feeling the most prepared about the coming challenge: their readiness sentiment is 8.65 out of 10.
- 91% feel more or slightly more informed now compared to 3 months ago, getting information from their supply chain partners, the media, their local authorities, or shippers directly.
- 79% feel more or slightly more prepared now compared to 3 months ago, as they have put in place concrete actions to secure more capacity, upgrade and expand their cool chain capabilities, hire and train more staff, review and improve their processes, secure more cool chain equipment, etc.
- 53% of the respondents felt that there is more collaboration in the industry to address this unprecedented logistical mission.
- 88% of the respondents expected an increase in their pharma volumes in 2021 compared to 2020 and 79% an increase in their pharma revenues
- 64% projected an increase in their investments to sustain their pharma business next year: 33% of the respondents indicated that they plan to recruit more people; 37% plan to expand or upgrade their cargo facilities; and 40% plan to secure more cool chain ground service equipment, ULDs, containers, dry-ice to handle COVID-19 vaccines business.

The optimal transportation of the vaccines can be translated into the most efficient, safest, widely distributed vaccine possible. This will require collaboration along the entire supply chain, open communication, and early planning to make sure the transportation goes smoothly. The entire global supply chain is now working on this challenge.

All industry partners need to continue working together with full transparency to meet shippers' needs and expectations: integrity, speed, security, reliability, and transparency.

Call to action: areas of priorities

Strengthening industry collaboration

- **TIACA and Pharma.Aero urge the air cargo and pharma industries to further strengthen dialogue and cooperation and leave no one outside of the conversation:** vaccines manufacturers need to share reliable information needed by all their logistics providers as early as possible to allow them to prepare and invest accordingly, and air cargo players should also ensure their sub-contractors and supply chain partners, including trucking companies, received the right level of information as early as possible.
- **TIACA and Pharma.Aero call the industry to adopt local air cargo community approach if not done yet** as a way to strengthen collaboration at local level for the vaccine challenge, as well as to accelerate the sustainable and digital transformation of air cargo in the longer term.

Ensuring high level of security

- Security and cyber-security measures need to be put in place to avoid theft and counterfeit.
- Each organization involved in the supply chain needs to stay vigilant and connected with local, state, and federal authorities to anticipate, identify, alert, and stop these physical and cyber threats.

Ramping-up air cargo capabilities

- Dry ice, active containers, trained staff, and cold chain space availability should be secured early
- Infrastructure investment decisions should be made as early as possible

Improving visibility

- Each air cargo stakeholder should map its existing capabilities at each location and make this information available: IATA ONE Source platform, Validate platform, amongst others and **TIACA and Pharma.Aero urge every stakeholder to ensure its data is made available** and accurate on the platform
- The use of tracking and monitoring devices should be encouraged and the approval process for their safe use in flight needs to start as soon as possible
- Rollout of digital solutions and data sharing platforms should be accelerated

Removing barriers

- Governments, customs authorities, and border agencies should be ready to facilitate and expedite all COVID-19-related goods
- International organizations, NGOs and donors should support cool chain capacity building efforts in least developed countries to ensure no one is left behind in the upcoming global immunization campaign

Project Sunrays will be publishing a final report containing useful guidelines for the air cargo industry to handle, store, transport and deliver the COVID-19 vaccines in an effective manner.

Airfreight pharma logistics company directory



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Contact Kenneth Gibson, TIACA:
kgibson@tiaca.org
or Frank Van Gelder, Pharma.Aero:
SecGen@pharma.aero

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Vaccine Development – 101, FDA: <https://www.fda.gov/vaccines-blood-biologics/development-approval-process-cber/vaccine-development-101>

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