

Project Sunrays

Readying Air Cargo Communities for COVID-19 Vaccine Air Transportation and Handling: Recommended Practices

FEBRUARY 2021

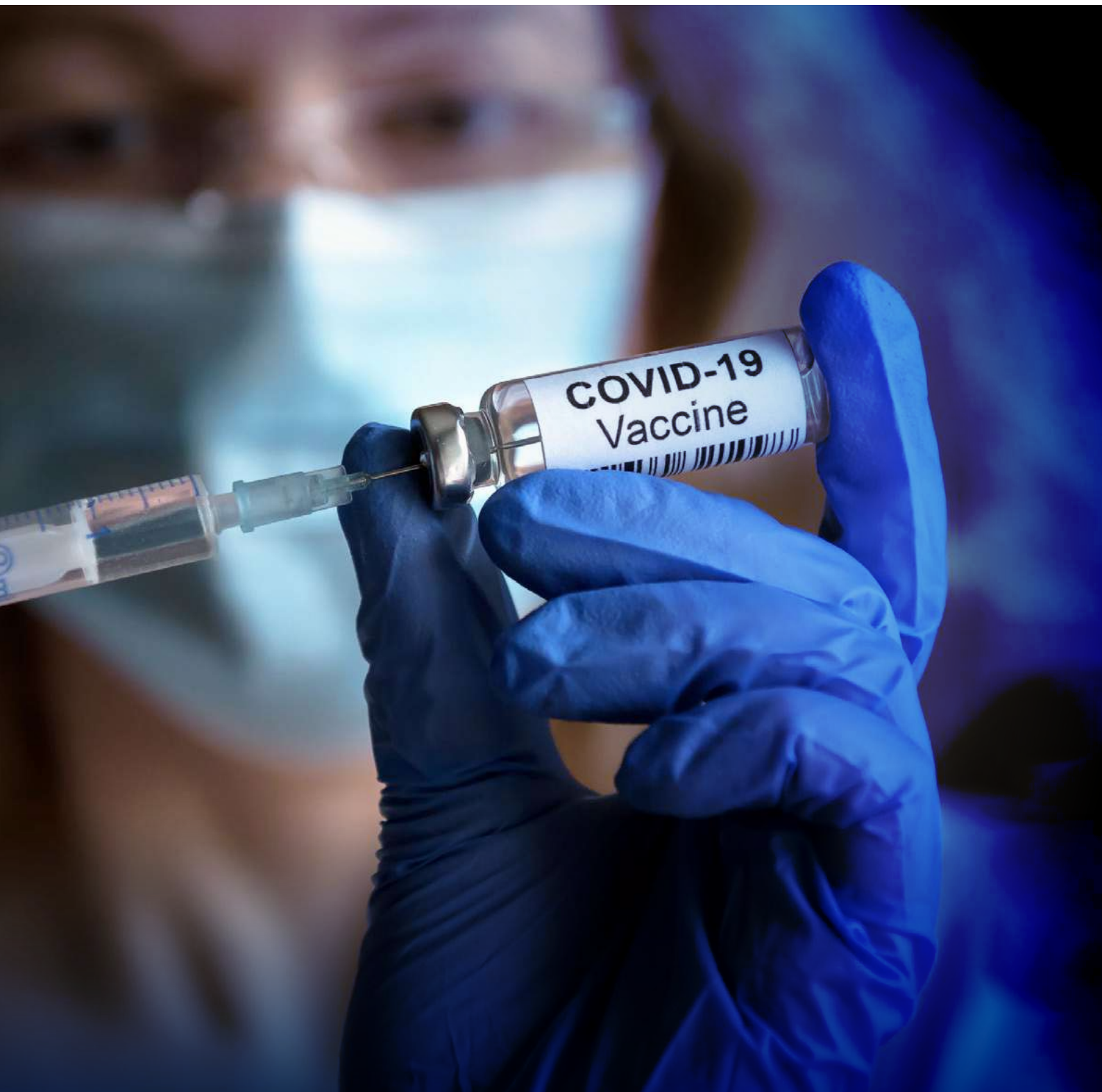


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1. Project Sunrays

1.1 Project Objectives and Scope

Driven by our commitment to help our members and the air cargo industry at large during the COVID-19 pandemic, Pharma.Aero and TIACA, with the support of other international organizations, teamed up in August 2020 to shine light on COVID-19 vaccine 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.

Project Sunrays aims 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 vaccine manufacturers and better visibility on future COVID-19 vaccine supply chain specifications impacting logistics, like manufacturing locations, production volumes, handling and storage specificities, track and trace requirements etc.
- Providing vaccine 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 vaccine 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.

1.2 Project Steering Committee

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

Project Sunrays includes continuous engagement efforts since August 2020 with vaccine 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, 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): the objective objective was 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.

A joint steering group of Board members from TIACA and Pharma.Aero



TIACA

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.

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 science and pharma shippers, certified air cargo 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.

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

BIONTECH



Johnson & Johnson



Research and compilation of information, available on public domain

AstraZeneca



CanSinoBIO



moderna

NOVAVAX
Creating Tomorrow's Vaccines Today



2. COVID-19 Vaccine Air Logistics Requirements

The world has been eagerly waiting for effective COVID-19 vaccine candidates to be approved by health authorities for mass vaccine rollout in order to save lives and re-start national economies. On 2 December 2020, Pfizer-BioNTech COVID-19 mRNA vaccine received emergency use authorisation by the United Kingdom Medicines & Healthcare Products Regulatory Agency (MHRA), kick-starting the largest global vaccination campaign in history.

As of 15 Jan 2021, 8 COVID-19 vaccine candidates have been approved at least by one country.

- [Pfizer-BioNTech](#)
- [Moderna](#)
- [Gamleya](#)
- [Oxford-AstraZeneca](#)
- [Serum Institute of India](#)
- [Bharat Biotech](#)
- [Sinopharm](#)
- [Sinovac](#)

The air cargo industry has an important role in the global distribution of COVID-19 vaccines and their peripherals, especially across continents. According to IATA, airfreight demand for the vaccines will be massive with aggregate volumes being the equivalent to 8,000 freighters based on 9 billion vaccine doses to meet global requirements.

COVID-19 vaccines are **high value** and **highly time and temperature-sensitive products**. Most require 2-8 deg C, some require -15 to -25 deg C while the Pfizer-BioNTech mRNA vaccine has an extreme storage temperature of -70 deg C. Once temperature deviations occur, the vaccines' potency will be lost and cannot be regained. Most COVID-19 vaccine candidates require two doses to offer the full benefit. The first dose helps the immune system create a response against SARS-CoV-2, the virus that causes COVID-19. The second dose further boosts the immune response to ensure long-term protection. Each vaccine requires different spacing between the doses, therefore, it is critical to ensure that the second doses of vaccines are delivered and administered to the patients on time.

The challenge of COVID-19 vaccine global distribution demands the air cargo industry to deliver the humanitarian shipments in the highest form of **speed, security, reliability and transparency**. To this end, open communication and community collaboration across the supply chain is paramount and cannot be underestimated.

Speed



- Timely and accurate bookings to support effective planning
- Guaranteed transit time
- Minimise unexpected delays
- Priority service

Security



- Co-ordinated approach and programs to prevent illicit trades, counterfeit, cyberattacks and theft
- Secured airport facilities and in-country transportation

Reliability



- Strong readiness across the supply chain
- Guaranteed delivery times
- Minimise temperature excursions and deviations
- Safe transportation and handling of the shipments

Transparency



- 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
- Information on existing airfreight capacity and lead times per trade-lane
- Reliable information on cool chain capabilities and capacity of logistics providers including each cargo facilities at origin, transit and destination points

3. COVID-19 Vaccine Air Transportation and Handling Recommended Practices

Patient safety and vaccine integrity is a collective responsibility with each supply chain partner playing a critical and integrated role to ensure this outcome is achieved. Each partner must perform to the highest standards and quality demanded by each respective vaccine producer, as well as comply with state and international regulatory authority requirements and regulations.

There are currently several internationally-recognised standards including the Good Distribution Practice (GDP) and the IATA Center of Excellence for Independent Validators in Pharmaceutical Logistics (CEIV Pharma), which have been pursued by logistics companies and airport communities to ensure excellence in the transportation and handling of pharmaceutical products. While this paper does not endorse one type of certification more than the other, the recommendations are made on the premise that each logistics company is fully aware of the minimum requirements provided in the GDP and IATA CEIV guidelines.

3.1 Speed Considerations



Freight Forwarders: COVID-19 vaccines should travel by the fastest and most reliable routes wherever possible. With reference to the GDP guidelines, pharmaceutical transportation should be based on a risk-based approach.

Elements such as process flows, handling equipment, capabilities, transit time should be qualified and included in the risk assessment matrix by the forwarding companies. All shipping lanes need to undergo route qualification and be demonstrated to the shippers. By adopting a risk-based approach, potential issues related to pharmaceutical quality and transportation delays would then be minimized.

Forwarders should take note of the vaccine packaging's shelf life and ensure that the total transit time does not exceed the booking requirements.

Forwarders should ensure that the shipment is accurately declared on the Master Airway Bill (MAWB) to avoid any miscommunication downstream along the supply chain which could result in shipment delays or worst, mishandling. In addition, documentation and paperwork should be checked in advance for accuracy and completeness to avoid unnecessary export and import customs clearance delays.



Airlines: Airlines should prioritize COVID-19 vaccine shipments and ensure uplift guaranteed as booked. At the same time, it should be ensured that the total transit time is within the range specified in the booking details. The

current dynamic airfreight market should be monitored closely, and any expected capacity changes should be responded to as quickly as possible. Airlines should plan their passenger aircrafts with maximum utilization. Charter flights should be arranged

quickly to provide the temperature range and the desired speed, when needed.

Airlines and their ground handlers should establish standard operating procedures (SOPs) and conduct operational simulations and drills to ensure that the actual shipments are handled in an expeditious manner.



Ground handlers: Upon receiving pre-arrival shipment alerts, ground handlers should review the information and prepare to receive the shipments by ensuring sufficient cool chain storage at the right temperature requirements,

availability of temperature-controlled airside equipment such as cool dollies, adequate power points for charging the active containers, ready access to dry ice (if re-filling of the active or passive containers are required), as well as sufficient manpower resources at the time of flight arrival.



Airports: The global distribution of COVID-19 vaccines may result in sudden surge in aircraft movements at airports, especially those playing a domestic or regional distribution role. Airports with slot co-ordination role should facilitate and

expedite ad-hoc slots and charter requests. Airports should take an inventory and conduct planning of their airfield and parking bays in the likelihood of a surge in operations due to flights conveying COVID-19 shipments. Airports should also assign parking ramp space nearest to cool chain facilities of the ground handlers for such flights for quick airside transfer.



Customs and Border Control: COVID-19 vaccines and the peripherals should be considered as essential humanitarian medical supplies. Export and Import tariffs or related taxes and charges should be reduced or

eliminated. Local Customs and Border Control authorities are recommended to establish enhanced co-ordination with the local health authority to facilitate pre-arrival and/or priority shipment clearance. Where possible, creation of green lanes could be explored to accelerate shipment clearance at the borders. Physical inspection of COVID-19 goods should be based on a risk-based approach (in accordance to the jurisdiction's acceptable risks) and are recommended to be conducted at the end users' facilities or appropriate storage facilities.

In the event that a new HS code is introduced for the COVID-19 vaccines, this information should be made known by local

custom authorities to the logistics community so that the shipments are properly declared to avoid unnecessary delays in customs procedures. Local air cargo communities should consider refresher course be made available to importers/exporters/forwarders in the clearance and transfer of vaccine shipments to ensure everyone is up-to-date on the proper procedures.

3.2 Security Considerations

INTERPOL has warned of organized crime threat to COVID-19 vaccines and issued a global alert to law enforcement authorities for them to prepare for such unlawful activities. Ensuring the safety of the COVID-19 vaccine supply chain is essential.

“As governments are preparing to roll out vaccines, criminal organizations are planning to infiltrate or disrupt supply chains.”

Jürgen Stock, INTERPOL Secretary General



Airports: Airports are recommended to work closely with their local security authorities and air cargo community and conduct risk and threat assessment and ensure that sufficient mitigating measures are implemented. Some examples may include police escorts met on airside for arriving vaccines, security personnel assigned to vaccine storage facilities and/or secured corridors being assigned between distribution facilities and airport warehouses, and vice versa.



Freight Forwarders/ Airlines/Ground Handlers: All air cargo stakeholders

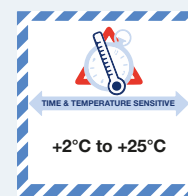
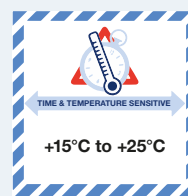
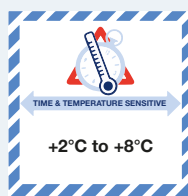
are encouraged to conduct internal risk and threat assessment for external, insider and cyber threats and ensure that any gaps are adequately addressed early. Forwarders and ground handlers could consider employing Transported Asset Protection Association (TAPA) security standards as security handling guidelines and practices.

INTERPOL has also warned that when COVID-19 vaccines become available, a surge in cyberattacks is likely to occur. In the area of data-sharing across different actors in the supply

chain during the air transportation, all stakeholders should apply appropriate data security actions and controls to minimise risk and heighten data security.

3.3 Reliability Considerations

As per standard procedures described in IATA Temperature Control Regulations (TCR), it is important that the PIL special handling code is declared for temperature-sensitive pharma shipments to ensure proper and correct handling. The code PIL must always be used in conjunction with one of the codes (i.e. CRT, ERT, COL, or FRO) indicating the correct transport temperature. The shipment documents and labels are to indicate the transport temperature accordingly.



Freight Forwarders: Forwarders should make sure that shipment information is correctly and clearly captured from the pharma shipper. All relevant information must be indicated on MAWB, especially the correct transport temperature, which needs to be applied during the entire air transportation process. To avoid improper handling and storage due to differing instructions on documents, forwarders should check and ensure consistency in handling instructions on MAWB and labels on the boxes before cargo lodgement at the cargo terminals.



Airlines: In the current aviation climate where most passenger flights are disrupted, airlines are encouraged to maintain a regular flight network and provide schedule visibility to their customers.

Airlines are also recommended to communicate clear information with respect to dry ice volume limitations. Airlines or their ground handler representatives should foster SOPs with their dry ice suppliers to ensure timely delivery since some locations may suffer from shortages due to high dry ice demand from other industries (medical storage facilities, research labs, governments) which can affect the ability to readily re-fill dry ice in active or passive containers, especially for transit or distribution airport hubs after the shipments have traversed a

long flight. This factor is also of particular importance in less developed or more remote parts of the globe.

Airlines should co-ordinate with their customers to ensure that lithium battery-powered data loggers and monitoring devices are approved by them ahead of time. Under the IATA Interactive Cargo initiative, the international organisation has set up an Interactive Cargo Task Force to provide stakeholders in the air cargo supply chain with a set of standards and guidance documents to ease the use of IoT devices to enable cargo interactions, including recommended practices on a simplified SOP on the approval of portable electronic devices onboard aircraft for air cargo. Airlines which are not involved in the Task Force could get in touch with IATA to be apprised of the best practices.

Note that there is a new Special provision A220 of the Dangerous Goods Regulations (DGR) which reads as follows: A220 Packages containing COVID-19 vaccines accompanied by data loggers and/or cargo tracking devices containing lithium batteries are not subject to the marking and documentation requirements of Section II of Packing Instruction 967 or 970, as applicable.

In preparation of the global roll out of the various vaccines with differing storage and handling requirements, airlines should perform network facility and readiness assessments and make this information available to their customers and partners such as the forwarders to facilitate effective risk-based route planning.

Airlines should ensure that the shipment is handled in accordance to the booking and that the correct temperature is maintained throughout the transportation journey. Airlines are recommended to establish COVID-19 vaccine groups and these teams should monitor the entire transportation process 24/7 from origin airport to destination airport (including the transit hub), and immediately intervene in possible malfunctions. In achieving these, airlines should ensure that digital initiatives are in place for track and trace. In case of obligatory offload situations, the cool chain should be maintained throughout.

In providing a detailed follow-up of the vaccine shipments, airlines are recommended to initiate a special identifier e.g. 'COV' such that the shipments could be easily identified and differentiated from other cargo. This would also help to support other stakeholders in the supply chain to consistently apply the special procedures that have been aligned and set in place.



Ground handlers: Upon receiving pre-arrival shipment alerts, ground handlers should review the information and prepare to receive the shipments by ensuring sufficient cool chain storage at the right temperature requirements, availability of temperature-controlled airside equipment such as cool dollies, adequate power points for charging the active containers, ready access to dry ice if re-filling of the active or passive containers are required, as well as sufficient manpower

resources at the time of flight arrival. In addition, staff should be fully trained in the proper handling of vaccine shipments and well aware of the temperature requirements of the vaccine handling and storage. The shipments shall be handled in accordance to the special handling code and correct transport temperature indicated on the MAWB. Special procedures, which have been aligned and set in place with the airlines, should also be complied.



Airports: Airports are encouraged to take up the coordinating role and work with their local air cargo communities and government authorities to conduct initial assessment of the level of the hub's preparedness and readiness for facilitating

the COVID-19 vaccine transportation and handling. Using a community approach, airport cool chain capacity and capabilities should be mapped out early to ensure adequate cool chain and human resources to effectively handle the shipments. When gaps are identified through this exercise, cool chain facilities and equipment could be scaled up in a collaborative and cost-effective manner.

3.4 Transparency Considerations

Once a location's existing cool chain capacity and capabilities is mapped out, such information should be made available to create transparency not only amongst the local air cargo community, but also with the vaccine manufacturers. All stakeholders are also encouraged to avail such information in an updated and accurate manner on platforms such as IATA ONE Source platform, Validaide, amongst others.

Ensuring correct temperature control throughout the supply chain is important to the transportation and handling of COVID-19 vaccines and other pharmaceutical shipments. Currently, a considerable amount of shipment information and data are recorded, stored and monitored in silos by individual supply chain players. Most data are typically not shared across the supply chain. Moreover, supply chain players use different systems and the data is stored in different formats. The development of a neutral and centralised data-sharing platform is an essential collaborative tool to increase visibility and traceability throughout the air cargo supply chain. Having a common data platform such as an airport community system where coherent and uniform data are shared would not only increase the visibility and traceability throughout the COVID-19 vaccine supply chain, but also identify and effectively address potential gaps within the supply chain, resulting in fewer damaged or lost shipments.

Towards the end, airports and/or relevant organisations are encouraged to take the lead and support initiatives to improve sharing of information, data and other elements to elevate supply chain transparency at the airport.



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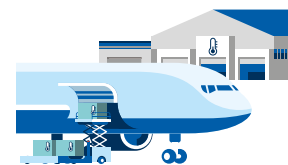
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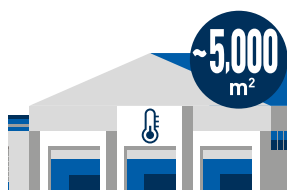
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4. Air Cargo Community Initiatives

Based on Project Sunrays' second global airfreight readiness survey, it was apparent that the group of respondents that are most prepared for COVID-19 vaccines distribution are those having the combination of team + collaboration with vaccine manufacturers + collaboration with their supply chain partners. Their readiness score was 8.65 out of 10.

Therefore, Pharma.Aero and TIACA highly encourage the industry to adopt a local air cargo community approach, if not done yet, as a way to strengthen collaboration at the local level for the COVID-19 vaccine logistical challenge, as well as to accelerate the sustainable and digital transformation of air cargo in the longer term.

As COVID-19 vaccine candidates progressed towards approval for usage, we have seen several air cargo hubs, including members of project Sunrays, establishing local task forces in advocating open communication and preparing their air cargo community for the logistical mission. Some illustrative examples of successful air cargo communities include:

4.1 Brussels Airport (BRU): BRUcure Task Force

The aim of the BRUcure Task Force is to prepare the local BRUcargo stakeholders and align all the resources and procedures for the correct handling of COVID-19 vaccines once they start moving through Brussels Airport. The Task Force targets the pharmaceutical shippers and the local BRUcargo community. Members of the task Task Force shippers, handling agents, airlines, Brussels Airport, forwarding agents, and other stakeholders involved in the handling and storage of COVID-19 vaccines.

One of the strengths that BRUcargo has built-up in the past decade is its community-focus. This became more evident when Air Cargo Belgium (ACB) was launched 4 years ago. For BRUcure, ACB is instrumental in building up a solid COVID-19 readiness framework, communicating both internally and externally and offering a neutral platform to share best practices and offer support among stakeholders to overcome potential capacity bottlenecks. BRUcure consists out of eight working packages, with a focus on 4 elemental working packages. ACB also plays a vital role in the roll-out of the different work packages. In these work packages, it aims to create

Project Goals

“BRUcure Taskforce aims to offer a robust logical pharmagatway at Brussels airport, for both import and export COVID-19 Vaccines. This in collaboration with the pharmaceutical shippers and the local BRUcargo community”



and implement a community solution, with the input of all stakeholders involved, through moderation of Brussels Airport Company and ACB. SOP on the approval of The BRUcure Task Force comprises of 4 elemental work packages:

- gathering information on shipper requirements, through regular direct contact with the vaccine producers, sharing of best practices with other airports and competent knowledge institutions;
- mapping and preparing local capacity of cool storage and handling facilities at 1st and 2nd line locations at the airport and temperature-controlled airside transport capabilities;
- creating a COVID-19-tailored SOP guideline to consolidate all existing procedures relevant to vaccine handling and setting up new procedures to minimize potential risks or operational bottlenecks; and
- offering full transparency through digitalization. To achieve this, the Task Force has leveraged on the existing digital infrastructure of the BRUcloud applications and the community will roll out a data sharing solution to offer full transparency of all pharma shipments.

Once this solid framework is in place, the project will focus on validating the entire airport community and issuing each stakeholder with a COVID-19 readiness label.

In order to manage the community stakeholders, ACB has assigned a dedicated person to the community control tower. The BRUcure community control tower function will coordinate and stimulate the cooperation between all stakeholders involved in the logistics of the COVID-19 vaccines at Brussels Airport. On the operational level, the control tower will monitor the vaccine shipments and processes at BRUcargo and initiate corrective and preventive actions to continuously improve the handling quality. It will be the single point of contact for all stakeholders related to the transport and distribution of the COVID-19 vaccines.

Since the end of November, flights to over 40 destinations have already been carried out to distribute the Pfizer-BioNtech and Moderna COVID-19 vaccines from Belgium to the world.

4.2 Edmonton International Airport (YEG): YEG CEIV Cargo Community Ready Response

In early fall 2020, Edmonton International Airport's (YEG) CEIV cargo community and partners began preparing for the safe arrival, storage and deployment of vaccines destined for our region in Canada, with much anticipation.

The Airport's CEIV community members are essential to delivering vaccines, through their specialized CEIV certified handling, transportation and storage infrastructure. The community includes freight forwarders, warehouse and

distribution and a ground handler (BBE Expediting Ltd. (BBE), Flying Fresh Air Freight (FFAF) and Swissport (Edmonton)).

Edmonton International Airport engages Provincial and Federal authorities, through the national strategic vaccine distribution response. Canada's land mass is vast with many remote locations for vaccine delivery. A combined national and provincial response for vaccine distribution must involve both the private and public sectors for success. This national distribution program went through a tender and was awarded to a single provider (FedEx Express Canada and Innomar Strategies) to work with each province across Canada. At a provincial level, the vaccine Task Force will ensure that the distribution program is supported with strategic partners like Edmonton International Airport cargo community members, while most of the distribution program will be handled and managed by the FedEx's integrator network across the province.

Edmonton International Airport is one of a few in Canada with the necessary cold chain facilities and expertise to handle vaccines with specific temperature storage requirements. The airport has invested extensively in its cargo infrastructure, including building out multiple temperature-controlled, cold-chain facilities since 2013. YEG's cargo community has over 10,000 square feet of multi-temperature facilities with these unique capabilities. YEG's CEIV community will support the vaccine distribution program in Canada with its ability to handle, store and transport vaccines, ensuring compliance with international regulations and pharmaceutical manufacturers' requirements.

Since Edmonton International Airport is uniquely positioned as Canada's gateway to the North, which includes remote regions in Canada's Arctic regions, their CEIV community is ready to collaborate and deploy its expertise in vaccine logistics, to ensure the proper handling and distribution of the COVID-19 vaccines to everyone who lives in these regions.

4.3 Miami International Airport (MIA): MIAVAC19 Task Force

In anticipation of the eventual development of a COVID-19 vaccine, Miami International Airport (MIA) formed the MIAVAC19 Task Force, a community partnership made up of both public and private entities. The airport Task Force includes members from the community such as: airlines, freight forwarders, ground handlers, integrated carriers, trucking companies, U.S. Customs and Border Protection (CBP), U.S. Food and Drug Administration (FDA), Florida Dept of Health (FDI), container manufacturers, dry ice distributors, local police and other private sector companies all working to plan and prepare for the distribution of the vaccines. The Task Force's action plan included identifying the exact amount of on-airport pharma cooler space, additional off-airport cooler space, mapping out the airport's parking capacity for large freighter aircraft, designating potential truck parking and staging areas, and

Miami International Airport



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planning training sessions for forwarders/importers regarding the latest federal guidelines for transporting vaccines.

One of the first things the community Task Force did was conduct an airport survey to determine how much cooler space was available at MIA. The survey confirmed that MIA is home to 368,064 square feet of refrigerated cargo space, including 27,212 square feet solely dedicated to storing pharmaceuticals and vaccines – the most at any U.S. airport in both categories.

The Task Force also identified several hurdles including: communication, maintaining ultra-low temperature, and availability of dry-ice in our community as things it needed to address. In the coming months as vaccine distribution intensifies, MIA will become a major distribution hub for vaccines being shipped to the Caribbean, Central and South America. The Task Force will play a critical part in making sure that vaccines are handled properly, cleared rapidly, and distributed throughout the region. Since the approval of the Pfizer-BioNTech and Moderna COVID-19 vaccines in December 2020, MIA has been handling regular shipment of vaccines both domestically and internationally.

An essential element which assisted MIA and its cargo community was being designated a CEIV Pharma Hub by IATA. MIA's pharma hub includes five logistics providers: Amerijet, LATAM, K&N, DHL, and Swissport. Other companies are now in the process of completing their certification.

MIAVAC19 Task Force provided their air cargo community a platform to share information, provide solutions, and collaborate in an effort to efficiently distribute the vaccine through MIA to their local community in South Florida and to communities throughout the Caribbean and Latin America.

4.4 Singapore Changi Airport (SIN): Changi Ready Public-Private Task Force

Co-led by the Civil Aviation Authority of Singapore (CAAS) and Changi Airport Group (CAG), the Changi Ready Task Force is a public-private collaboration involving government agencies, cargo handlers, airlines and freight forwarders to better prepare the Singapore air cargo community to meet the logistical demands of the COVID-19 vaccines distribution. This includes assessing and ramping up the hub's ability to handle different types of COVID-19 vaccines, all within stringent temperature-controlled environment to maintain the vaccines' efficacy, as well as to manage an expected surge in the volume of vaccines to be air transported to the region, once they are approved by regulators.

Since October 2020, the Changi Ready Task Force has sought to adopt a risk-based approach to identify the potential challenges and bottlenecks associated with air transportation and handling of COVID-19 vaccines and address them through workstreams such as mapping of existing cool chain capacity

and capabilities, data visibility, and processes. Through these working groups, they have since created higher transparency on Changi's cool chain capabilities and capacity including the temperature-controlled warehouses throughout the airport environment and even down to granular details such as the number of active containers charging points that our key stakeholders have. The Task Force has also refined some of the operational processes to facilitate expedited handling and clearance of vaccine shipments, as well as tightened security measures. In parallel, a separate working group have been formed to examine data gaps and how the community could enhance end-to-end shipment visibility through collaborative approaches. All these to ensure that the COVID-19 vaccines can be safely, reliably and efficiently handled through the Changi air cargo hub for distribution into Singapore and to the region.

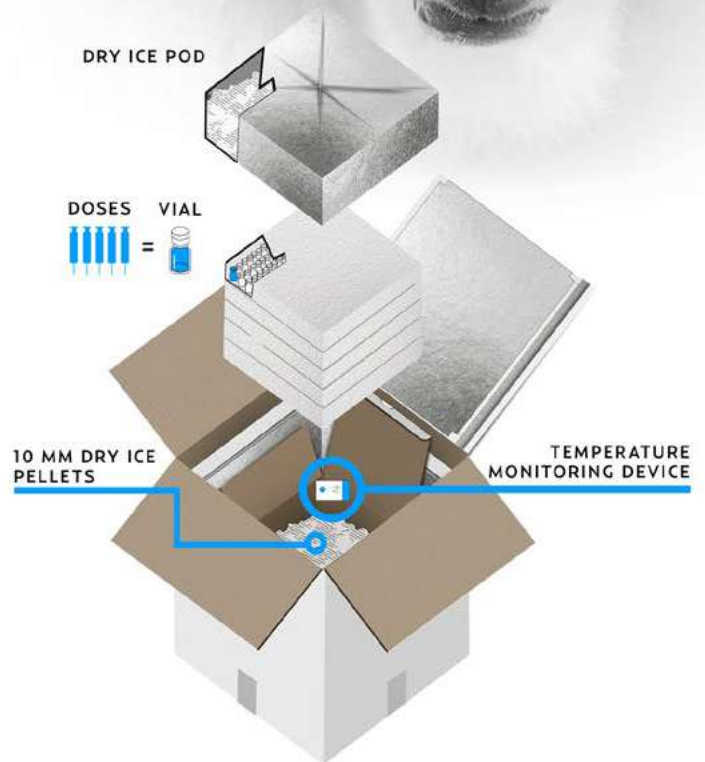
In early December, Singapore approved the Pfizer-BioNTech mRNA vaccine for pandemic use. Singapore and the local air cargo community subsequently received the first shipment of COVID-19 vaccines (Pfizer-BioNTech) on 21 December. Through a co-ordinated approach, the first and subsequent shipments were handled effectively and efficiently. Singapore is also positioning itself to be the hub for the movement of COVID-19 vaccines to the region.

THE VACCINE ULTRA-COLD CHAIN EXPERTS

DRY ICE FOR VACCINE COOLING



Thanks to its global presence, Cold Jet is a trusted supplier to major pharmaceutical and logistics companies in the distribution of the COVID-19 vaccine and has installed integrated Dry Ice Manufacturing with Automated Dosing Systems in global vaccine production and distribution facilities.



COLD JET OFFERS MULTIPLE SOLUTIONS FOR DRY ICE PRODUCTION IN VACCINE TRANSPORTATION:

Standalone Dry Ice Production



Automated Dosing Systems



Mobile Dry Ice Production Systems



email vaccine@coldjet.com for more info

4.5 Lessons learned and key takeaways from the local air cargo community initiatives

In preparing the local air cargo industry to receive the COVID-19 vaccine shipments and handle them in an effective manner, several airports and their local key stakeholders have embarked on community initiatives to ensure strong readiness in the transportation and handling of the COVID-19 vaccines. When highlighting some of the characteristics of such Air Cargo Community initiatives in earlier sections, we had the opportunity to interview the different communities: Brussels Airport Company (BRU), Edmonton International Airport (YEG), Miami International Airport (MIA) and Singapore Changi Airport (SIN) to understand some of their key takeaways and lessons learned.

“It is necessary that we plan ahead and ready ourselves to rise up to the COVID-19 vaccine global distribution challenge.”

Air cargo communities were in high anticipation of COVID-19 vaccine approval and deployment

SIN: COVID-19 has impacted lives, businesses and economies to varying extent. The successful development and deployment of COVID-19 vaccines would be a critical milestone in the global fight against the fatal virus. The vaccines are a critical means in supporting governments and businesses to restore global economies back to normalcy. The approval of COVID-19 vaccines has another meaning for the global aviation industry. The pandemic has had hit the aviation industry particularly hard. Vaccination of the region's population against COVID-19 and achievement of herd immunity would be a key step in

ensuring the safety of the public while restoring confidence in the aviation industry.

Start with clear community objectives

BRU: Being in the world's heart of pharmaceutical research and production, and with companies like Pfizer, Johnson & Johnson, GSK and MSD in our backyard, we quickly set up regular meetings with the pharma shippers to get a clear understanding on the vaccine flows and the transport requirements. It quickly became apparent that this would become an ideal community project for Air Cargo Belgium to tackle. In early October we then officially launched the **BRUcure Task Force** amongst our community stakeholders. Airlines, ground handlers, freight forwarders, 3PL and many more are amongst the more than thirty companies participating in several BRUcure working groups.

MIA: MIA as the hub for passenger and cargo in the Americas, with hundreds of flights to and from the region, it is only natural that we would serve as the distribution (airport) for the vaccines going into the Caribbean, Central and South America.

Knowing that MIA would play a critical role in vaccine distribution in the Americas, MIA took the lead in establishing an airport cargo community Task Force MIAVAC19 to plan and prepare for the vaccine distribution. Through research and open and transparent discussions with our stakeholders we were able to map out our infrastructure and identify challenges in our community. We were also supported by our Federal Agencies: CBP and FDA, State of Florida Health Department and the Florida Customs Brokers and Forwarders Association (FCBF). It was a total air cargo community collaborative effort, with the goal of saving peoples lives..

YEG: Our cargo community knew that we had a lot of planning ahead of us as we collected information on the planned rollout strategy across Canada. In preparation of receiving the COVID-19 vaccine and understanding how the supply chain will work across Canada, YEG engaged with key provincial and federal health authorities to understand our role in the national vaccine distribution program. As an airport, we are used to moving critical, temperature sensitive shipments. We had to ensure we were facilitating seamless operations of flights transporting vaccines including approvals, priorities, coordination with security and custom clearance processes were in place. YEG's team met internally in order to review questions, prioritize and align next steps, including our lines of communication with our cargo community stakeholders. As information became publicly available about the ultra-cold storage needs of some of the vaccine candidates, the team identified this temperature-range gap in our cold chain facilities and moved quickly to close it.

YEG's CEIV community is one of the few airport communities in Canada, with the proper cold chain infrastructure and expertise to handle, store and transport vaccines. We were well positioned to provide an end-to-end pharma solution. Since 2013, YEG has invested over \$150M in its cargo infrastructure, including building out multitemperature controlled cold chain facilities. Combined YEG's temperature-controlled facilities total more than 10,000 sq./ft. and cover all the required temperature ranges in the pharma supply chain, ambient (15C to 25C), cold (2C to 8C), and frozen (0C to -28C). In anticipation of the Pfizer vaccine, YEG expanded its handling and temperature storage capability, to include the ultra-cold (-50C to -90C) temperature range. This ultra-cold storage capability allows YEG to properly store vaccines, if there is any

unplanned disruption in the supply chain.

SIN: The timeline of COVID-19 vaccine development was unprecedented; they were developed and approved at breakneck speed. Some vaccine candidates are tapping on next-generation platforms. All these have created many complexities and unknowns, especially on the handling, transportation and storage requirements of the different types of vaccines.

Over the years, Singapore has built a strong track record as a leading biomedical hub and in pharmaceutical handling. As a community, Changi has continuously invested in upgrading our cool chain capabilities, capacity and standards. Notwithstanding this, it is necessary that we plan ahead and ready ourselves to rise up to the COVID-19 vaccine global distribution challenge. Within our local community Pharma@Changi, it was agreed at an early stage that a local joint public-private Task Force should be set up to enhance the readiness and robustness of our air cargo sector.

Be inclusive and set up a structure

MIA: The **MIAVAC19 Task Force** includes members throughout the supply chain: airlines, GHAs, freight forwarders, logistics providers, trucking companies, integrated carriers, federal agencies, Florida Health Department, local police, trade associations and local private companies. We have monthly virtual calls to discuss latest information, local challenges and solutions. The Task Force is working as a platform within our community to inform and provide support to our community and is in the initial stages of sharing best practices and lessons learned with other airport communities in the Caribbean and Latin America, the first being GRU Airport in Sao Paulo, Brazil.

“Project Sunrays was launched as a joint global initiative by Pharma.Aero and TIACA with the purpose 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.”

SIN: Since the formation of **Changi Ready Task Force**, we have established three workgroups focusing on mapping of cool chain capacity and capabilities; processes; and data visibility. Through these working groups, we have since created higher transparency on Changi's cool chain capabilities and capacity including the temperature-controlled warehouses throughout the airport environment and even down to granular details such as the number of active containers charging points that their key stakeholders have. We have also refined some of the operational processes to facilitate expedited handling and clearance of vaccine shipments, as well as tightened security measures. In parallel, we have formed a working group to examine data gaps and how we could enhance end-to-end shipment visibility through collaborative approaches. These developments enhance the air cargo community's ability to handle and transport COVID-19 vaccines more efficiently and reliably.

Within SATS, the groundwork was laid a few months ago. SATS started with a review of our cold-chain capabilities that examined the personnel, equipment, training and facilities before adapting our existing

pharmaceutical handling SOPs to handle the COVID-19 vaccine. We augmented our capabilities with the addition of 2 cool dollies. SATS also increased the number of charging points in anticipation of having to accommodate more active temperature-controlled containers. SATS also produces dry ice in-house and is expanding our dry ice production to 4.5 tonnes per day. We also set up an internal SATS Vaccine Taskforce with participation from all our cargo facilities across 9 countries to share data, information, processes, experiences and preparation readiness.

BRU: Through **BRUcure**, we have weekly working groups to jointly work on several initiatives, ranging from advising SOP guidelines, digital solutions to security requirements. Along with the working groups, a community control tower function through a project member of Air Cargo Belgium was appointed. This person acts as a single point of contact (SPOC) for all stakeholders involved in the COVID-19 distribution at BRU and over time will monitor the quality of the handling process of all COVID-19 vaccines passing through our airport.

YEG: The YEG CEIV Cargo Community Ready Response

Task Force collaborates and drives clear communication with our CEIV members on airport and also with our regional partners. Our CEIV community members continue to further develop and improve existing SOPs that support the safe movement, secure storage and transportation of vaccines in our region. With vaccine distribution contracts having been awarded nationally and provincially, we are actively engaged in supporting those companies who have been awarded all or parts of vaccine distribution contracts.

Global collaboration is equally important

As air cargo communities were getting themselves ready to handle the supply chain of the COVID-19 vaccines, in the meantime, Project Sunrays was launched as a joint global initiative by Pharma.Aero and TIACA with the purpose 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.

YEG: Project Sunrays has helped the YEG community through the updated, accurate and valuable information that was provided and then directly communicated back to our CEIV community and internal YEG team. The first whitepaper provided important and useful information that we were able to share and pass along to our YEG community members. Being a part of the Project Sunrays joint Task Force and having direct insight to other global CEIV communities' best practices and understanding the pharma shipper's needs gave us the ability to provide valuable feedback to our cargo community.

“By listening closely to the pharmaceutical shippers' requirements, we managed to distribute the vaccines without issues.”

MIA: Project Sunrays has helped MIA, who is a member of both TIACA and a founding member of Pharma.aero, by providing the latest information from shippers and the supply chain which we then shared with our stakeholders during our calls. The information from the first white paper/webinars/surveys has been shared with the nearly 80 Task Force members and has been used by them to better inform and

prepare themselves for the distribution of the COVID-19 vaccines.

BRU: Along with our local community taskforce, we joined forces with our global partners through Project Sunrays. Brussels Airport is both member of Pharma.Aero and TIACA so it was evident that we share our local pharma experience and gain much needed information. Alongside Project Sunrays, we also worked together with the University of Antwerp, where we can leverage on their network of transport economists, virologists and vaccinologists.

SIN: Project Sunrays has opened up opportunities to collaborate with other industry bodies including IATA and FIATA to attain deeper insights. Our involvement in Project Sunrays has given us access to and developed our thought leadership in COVID-19 vaccine transportation, handling and distribution requirements, through close working relationships with vaccine manufacturers and global industry partners. SATS gained valuable insights and information that have allowed them to be better prepared for the handling of the vaccines.

Initial priorities, lessons and experiences

BRU: We initially noticed struggles with digitally organizing such a large local taskforce with multiple companies involved. With people working from home and communicating through Microsoft Teams, we quickly noticed that, in some occasions we had to touch base on an individual basis per stakeholder. While it was time-consuming, it was essential, and we started to see benefits. Since November, we started receiving the first batches of the vaccines, which created a lot of sensitivity around security and media interest. By listening closely to the pharmaceutical shippers' requirements, we managed to distribute these without issues.

YEG: Through YEG's ongoing discussions with our public health authorities, surrounding the expected volume and timelines for the arrival of the vaccines, we learned that we needed to continuously monitor what information is accurate and what information is just making the news. YEG's key areas in the supply chain are totally dependent on the clear, concise and accurate information we receive, and then disseminate internally and that go out to our cargo community members. Accurate and timely communication allows the YEG team to inform our community members so they can respond appropriately throughout the supply chain.

There are many remote regions to the north where people live with limited cold chain infrastructure capacity, that will require special handling and attention to security when they are being delivered. YEG's CEIV community members are experts at delivering temperature-controlled products to these remote regions already, but with these vaccines there is additional heightened layers and challenges our CEIV members will need to overcome to ensure a safe and timely delivery is made. Our CEIV community members have been working on lane risk assessments to key remote areas, in order to mitigate risks, they can, identify, eliminate or control. The goal through these additional efforts will enable the service providers to deliver vaccines in good order, and to the manufacturers shipping standards.

SIN: Singapore received the first Pfizer vaccine on 21 Dec 2020. When SATS received news of the arrival of this first vaccine shipment, SATS Coolport, together with the SATS Ramp Handling and SATS Security teams, coordinated with the airline, the airport and freight forwarder to plan for the arrival. This included conducting drills that allowed us to devise the most efficient approach for the movement

of vaccines from the aircraft, through Coolport, to the freight forwarder handling the last-mile delivery. The shipment was carefully unloaded from the aircraft by our ramp handling team and escorted by our SATS auxiliary police team before being transported to SATS Coolport. The entire process from aircraft arrival to handling over to the freight forwarder took less than 60 minutes. With each handling of vaccine shipment, we constantly seek to enhance our SOPs to cover new scenarios and situations.

“Challenges in the supply chain will happen and you will need to trust your industry partners are following the shipping requirements during the distribution process.”

MIA: We would like to summarize our lessons learned as follows:

- Plan ahead - Start planning and preparing early, to cover the multiple complexities of the distribution process.
- Community Approach - Be as inclusive as possible to get feedback from throughout the supply chain and make sure to get their buy-in early.
- Security – An important factor that should not be overlooked. Security should be approached from both a physical and cyber perspective. Be aware and accept many companies will not reveal information about vaccine shipments for security reasons, no matter who you are or who you represent.
- Infrastructure Inventory - Map out your cooler space infrastructure takes a lot longer than you think. Business partners, airport

stakeholders and local associations responses may be delayed. Give yourself enough time to gather the details and then share them with your community.

- Secure necessary funding for any possible unforeseen project associated with vaccine distribution or at least identify funding source so it can be executed rapidly if needed.
- Transparency – Have an open and transparent communication with air cargo community.
- Focus on the achievable - Focus on actions that you can accomplish and not on those you cannot control or influence. At MIA we cannot control the volume of vaccines coming into the airport, but we can try and facilitate the process by making our airport as efficient as possible.
- Media – the media is always hungry for information so communicate as much as you can, and make sure it's accurate. Remember if you don't know something say you don't know.

The first vaccine shipment is just the beginning

BRU: We have recently finished the SOP guidelines working package; this work has been compiled into a document and shared with our community stakeholders. Our full focus is currently towards our data sharing platform that we want to roll out amongst our stakeholders. This platform will enable us to quickly and transparently monitor all PIL shipments passing through our cargo facilities, including COVID-19 shipments. Along with the data sharing platform, we are continuously following up with the COVID-19 vaccine shippers in order to understand their needs and product characteristics, this is done through direct one-to-one contact and our well-known BRU pharma shipper forum.

SIN: Moving ahead, we see a need to

establish pharma corridors to create higher visibility on key vaccines trade lanes to provide all stakeholders with greater assurance. SATS, particularly, has presence in key airports in the region and having built up a network of pharma-handling facilities with similar capabilities paves the way to establish secure temperature-controlled quality corridors between Singapore and these airports. These quality corridors will provide strong assurance to pharmaceutical companies in the handling of their products.

In the longer term when COVID-19 may become an endemic and that the COVID-19 vaccines become the new seasonal flu vaccine, we aim to play a regional distribution role by developing new capabilities to cater to the widespread distribution of the COVID-19 vaccines into the region.

Key takeaway message to the industry: collaboration and trust

MIA: Plan – Prepare – Inform – Execute – Evaluate – Repeat. Plan what you are going to do and prepare for changes, things do not always go as planned. Evaluate what's worked and what hasn't and adjust accordingly.

YEG: Trust your supply chain partners. Challenges in the supply chain will happen and you will need to trust your industry partners are following the shipping requirements during the distribution process. Since this is the largest crisis that our industry has ever seen and will hopefully never experience again in our lifetime, following the shippers' guidelines is critical. We need to count on each partner in the supply chain to perform, as each person receiving the vaccine counts on us to deliver it in good order for their health and wellbeing.

BRU: Collaboration. Our industry is a very fragmented sector, only through collaboration and clear communication we will be able to

distribute these sensitive vaccines in a correct and transparent way to all four corners of the world.

“Evaluate what’s worked and what hasn’t and adjust accordingly.”

SIN: The time has come for the industry to work even closer with one another to share data and information and collectively co-create effective solutions. A key success factor is to have open communication and embrace collaboration between the various stakeholders in the supply chain. We have seen initial successes of both global and local collaboration in the early stages of vaccine distribution and we strongly urge global air cargo communities to deepen collaboration efforts both locally and globally to overcome current and new supply chain challenges as they come.

Contributors:

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Samuel Speltdoorn, Cargo Business Development Manager, Brussels Airport Company

YEG: **Trevor Caswell**, Manager, Demand and Product Development (Cargo), Edmonton International Airport.

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SIN: **Jaisey Yip**, General Manager, Cargo & Logistics Development, Changi Airport Group

Gerald Choy, Assistant Manager, Cargo & Logistics Development, Changi Airport Group

Wong Chee Meng, Senior Vice President, Special Projects, SATS

5. Conclusion

COVID-19 vaccines will need to be disbursed in nearly 200 countries and territories around the globe and into the arms of nearly 8 billion people.

Air cargo will play a critical role in ensuring these life-saving products can be moved in a fast, secured, reliable, transparent and compliant fashion supporting national and international objectives to achieve global immunity.

As outlined in this white paper, collaborative and coordinated solutions will provide the optimized approach to achieving the required logistical success. Pharma.Aero and TIACA, through project Sunrays, urge all logistics partners to implement quality solutions based on the recommended practices contained within this document, as well as industry guidelines, regulatory obligations and manufacturer stipulations.

Where not already implemented, local air cargo communities are recommended to be established to ensure the highest degree of logistical awareness and preparation can be assured.

In order to protect ONE, we must protect ALL.



MORE THAN EVER, ON YOUR SIDE

1ST IN HONG KONG

2017 **2014**

IATA CEIV PHARMA
CERTIFICATION

WHO GDP CERTIFICATION
FOR PHARMACEUTICALS

 **Hactl**

Detailed specifications

In this update, we provide you with a set of information on 12 dedicated fact sheets:

- AstraZeneca / University of Oxford
- Novavax
- GSK / Sanofi Pasteur
- Pfizer / BioNTech
- Johnson & Johnson
- The Gamalyea Research Institute of Epidemiology and Microbiology
- Moderna
- SinoVac
- CanSino Biological Inc. / Beijing Institute of Biotechnology
- Bharat Biotech International Limited
- Serum Institute of India
- Sinopharm Group Co., Ltd

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 update, 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 in air cargo industry.

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

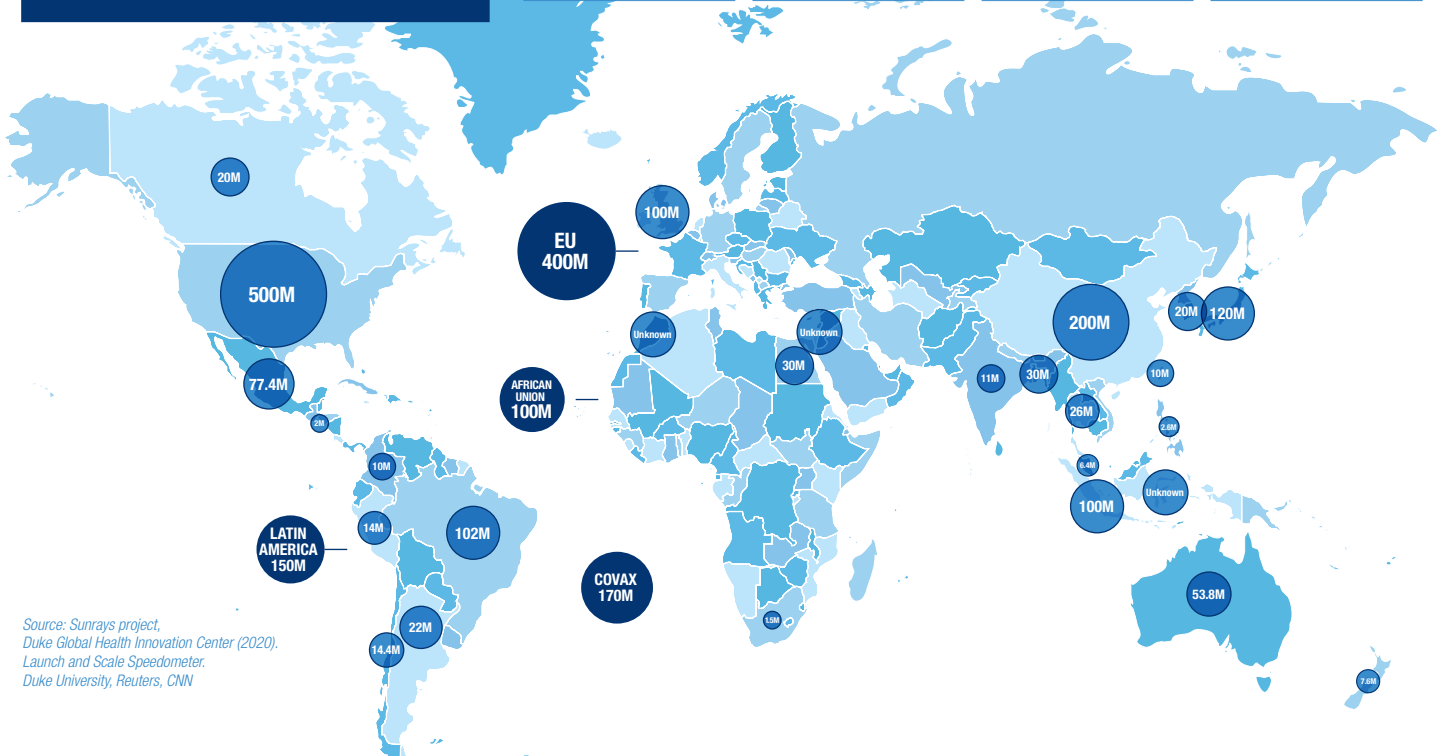
 Medical specs	 Manufacturing info	 Development status
Number of doses and interval in between doses to provide indication on volumes and timelines; and route of administration (intramuscular, intranasal, etc) to give indication on other medical supplies needed (syringe, vials, etc.) Product temperature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

While project Sunrays takes reasonable steps to verify the accuracy of the information presented in these fact sheets, Pharma.Aero and TIACA do not make any (and hereby disclaims all) representations and warranties regarding the accuracy, completeness, of any information provided in this white paper. Pharma.Aero and TIACA 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: • 6 months at +2°C to +8°C • 24 hours at +15°C to +25°C	 Production started end of 2020  Manufacturing sites: • Australia • Brazil • China • India • Korea • Thailand • UK  Production capacity of 2 billion doses for 2021 Plans to expand to 3 billion	 Phase: Approved  Approval status: 11 Countries Approved in Argentina, Brazil, Dominican Republic, El Salvador, India, Iraq, Mexico, Mongolia, Morocco, Pakistan, United Kingdom  Clinical trials locations: • Brazil • India • Japan • Russia • South Africa • UK • USA
Name: AZD1222		

 Transport requirements	Confirmed vaccine doses procured by country			
 Transport temperature +2C° to +8C°  Standard passive box (normal process)	ARGENTINA	22M	EL SALVADOR	2M
	AUSTRALIA	53.8M	INDIA	11M
	BANGLADESH	30M	INDONESIA	Unknown
	BRAZIL	102M	ISRAEL	Unknown
	CANADA	20M	JAPAN	120M
	CHILE	14.4M	MALAYSIA	6.4M
	COLOMBIA	10M	MEXICO	77.4M
	EGYPT	30M	MOROCCO	Unknown
			NEW ZEELAND	7.6M
			PALESTINA	Unknown
			PERU	14M
			PHILIPPINES	2.6M
			SOUTH AFRICA	1.5M
			SOUTH KOREA	20M
			TAIWAN	10M
			THAILAND	26M
			UK	100M
			USA	500M
			VIETNAM	30M
			AFRICAN UNION	100M
			COVAX	170M
			EU	400M
			LATIN AMERICA	150M



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

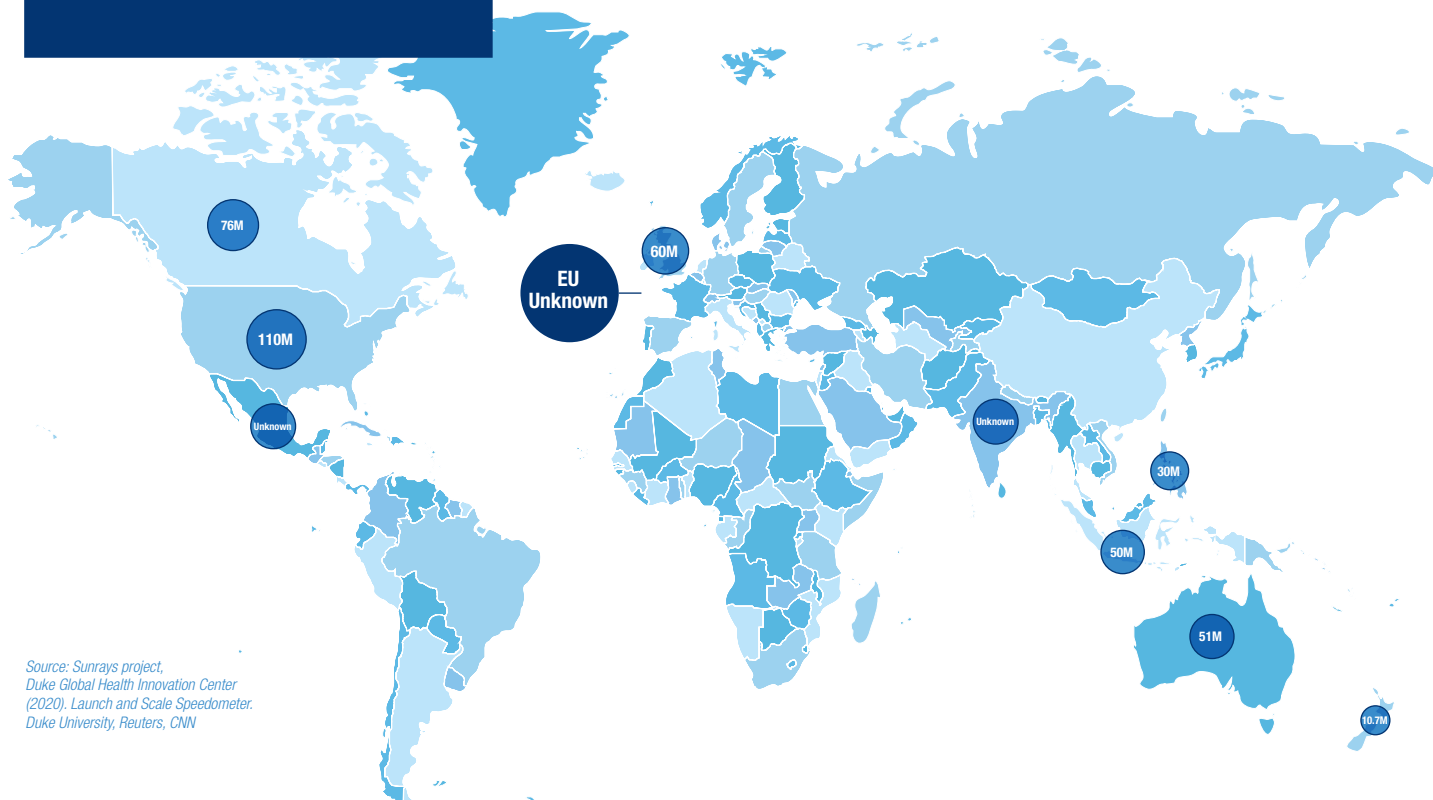
Novavax, Inc. is a vaccine development company headquartered in Gaithersburg, Maryland, USA.

 Medical specs	 Manufacturing info	 Development status
 2 doses Intramuscular  Vaccine storage: Refrigerated (+2°C to +8°C)	 Production could start in 2021  Manufacturing sites: - Czech Republic - India - USA	 Phase 3  Approval status: not yet approved for widespread use  Clinical trials locations: - Australia - Mexico - South Africa - Puerto Rico - UK - USA
Name: NVX-CoV2373		

 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

AUSTRALIA	51M	MEXICO	Unknown	USA	110M
CANADA	76M	NEW ZEELAND	10.7M		
INDIA	Unknown	PHILIPPINES	30M	EU	Unknown
INDONESIA	50M	UK	60M		



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: • 2 years at -20°C • 3 months at +2°C to +8°C • 24 hours at +15°C to +25°C	 Production postponed to Q3 2021  Manufacturing sites: • 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: • Canada • USA
Name: Recombinant Protein		

 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

CANADA	72M	COVAX	200M
UK	60M	EU	300M
USA	100M		



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



FACT SHEET

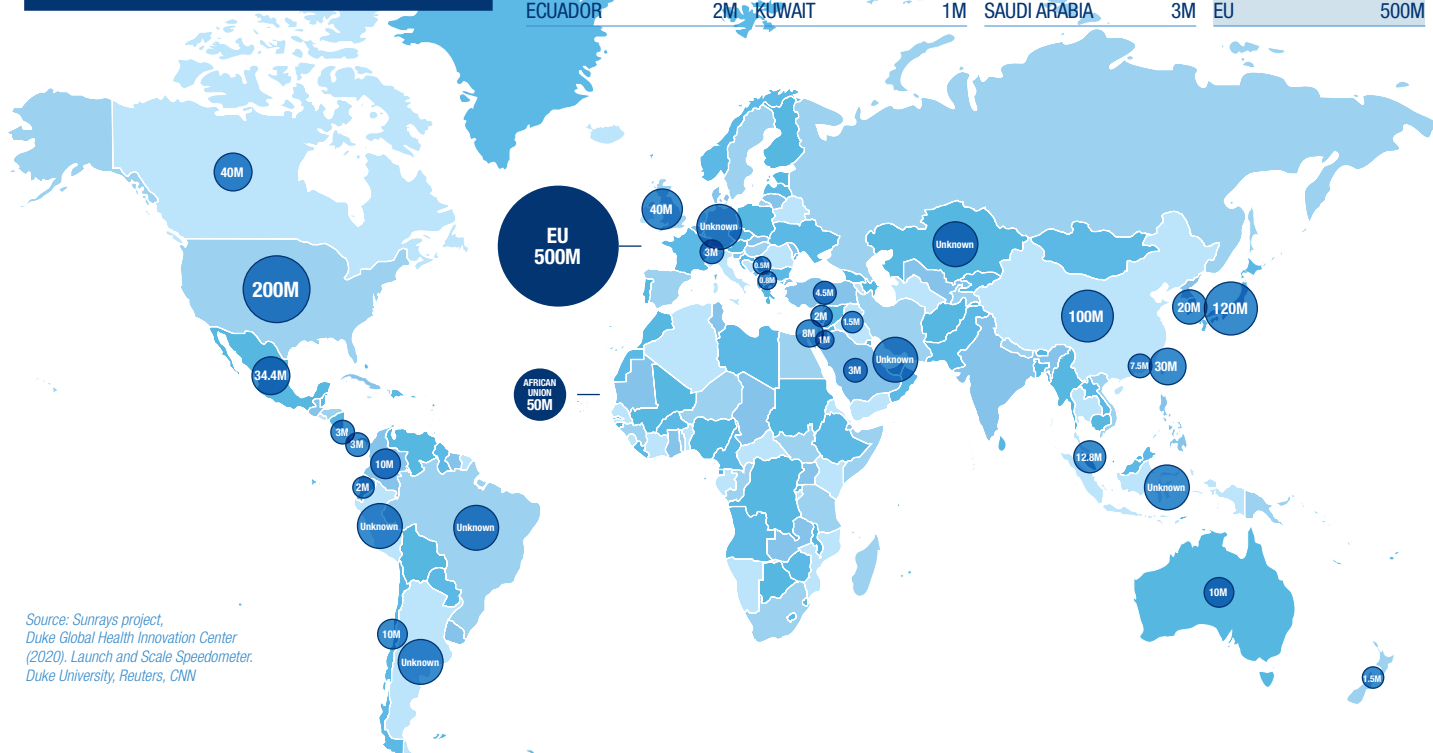
Pfizer is a multinational pharmaceutical corporation headquartered in New York, USA, partnering with BioNTech, a biotechnology company headquartered in Mainz, Germany that develops and manufactures active immunotherapies for patient-specific approaches to disease treatment.

 Medical specs	 Manufacturing info	 Development status
 2 doses Intramuscular  Vaccine shelf life: • 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 started end 2020  Manufacturing sites: • Belgium • USA • Germany  Production capacity 50 million doses in 2020 and up to 2 billion doses in 2021	 Phase: Approved  Approval status: 54 Countries → full list page 37  Clinical trials locations: • Australia • Ecuador • EU • Japan • New Zealand • UK • USA • Germany • China • Argentina
Name: BNT162b2		

 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

ARGENTINA	Unknown	GERMANY	Unknown	LEBANON	2M	SERBIA	0.5M
AUSTRALIA	10M	HONG KONG	7.5M	MALAYSIA	12.8M	SOUTH KOREA	20M
BRAZIL	Unknown	INDONESIA	Unknown	MEXICO	34.4M	SWITZERLAND	3M
CANADA	40M	IRAQ	1.5M	NEW ZEELAND	1.5M	TAIWAN	30M
CHILE	10M	ISRAEL	8M	NORTH MACEDONIE	0.8M	TURKEY	4.5M
CHINA	100M	JAPAN	120M	PANAMA	3M	UK	40M
COLOMBIA	10M	JORDAN	1M	PERU	Unknown		
COSTA RICA	3M	KAZAKHSTAN	Unknown	QATAR	Unknown	AFRICAN UNION	50M
ECUADOR	2M	KUWAIT	1M	SAUDI ARABIA	3M	EU	500M



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
 1 dose Intramuscular  Vaccine storage: Refrigeration (+2°C to +8°C)	 Production could start end Q1 2021  Manufacturing sites (potential): - Netherlands - USA	 Phase 3  Approval status: not yet approved for widespread use  Clinical trials locations: - Belgium - Brazil - Chile - Colombia - France - Germany - Mexico - Netherlands - Peru - Philippines - South Africa - UK - Ukraine - USA
Name: Ad26.COV2.S		
 Production capacity of 1 billion doses/year as of 2021		

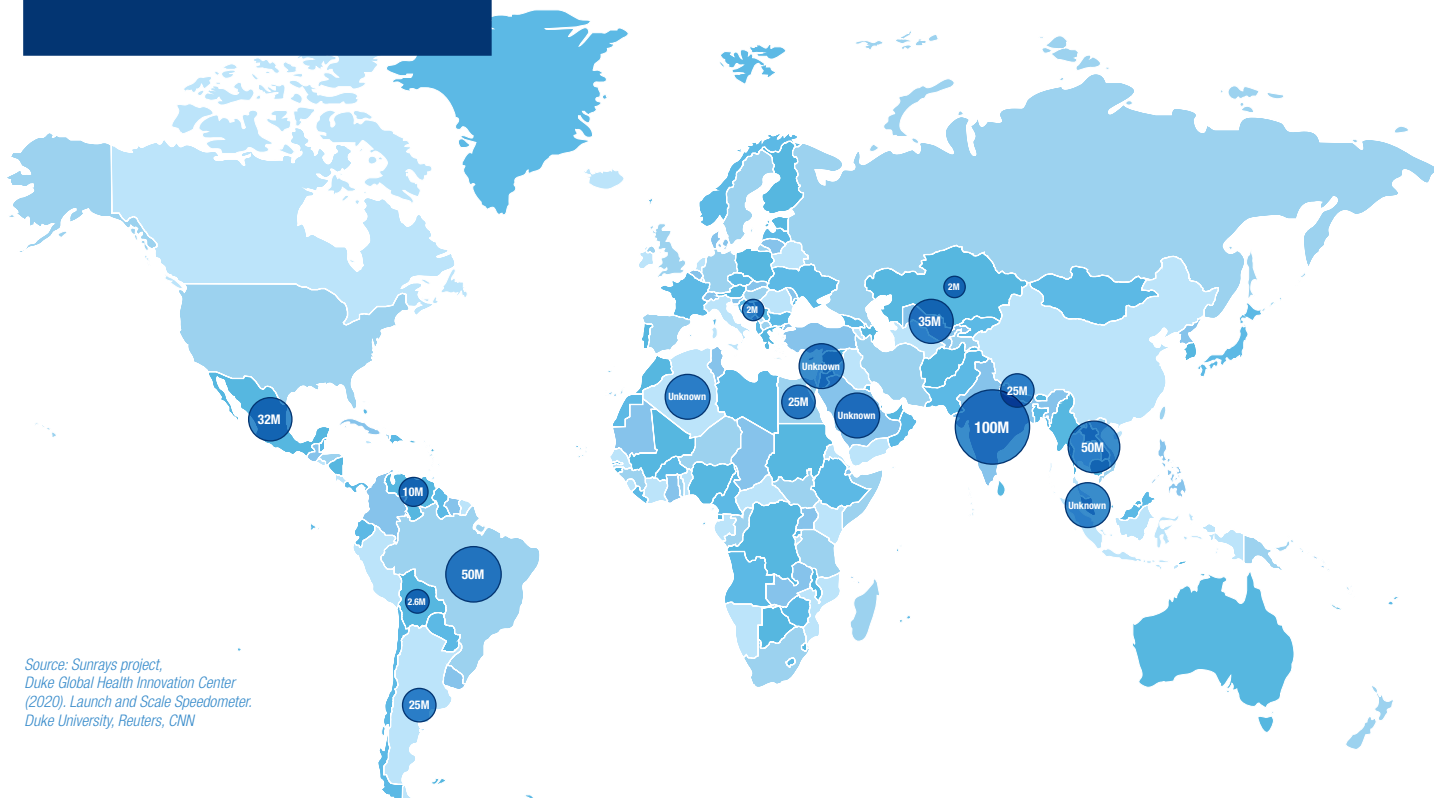
 Transport requirements	Confirmed vaccine doses procured by country			
 Transport temperature +15°C to +25°C  Likely to be a passive box on +15°C (standard process)	CANADA	38M	MEXICO	Unknown
	CHILE	4M	NEW ZEELAND	2M
	COLOMBIA	9M	SOUTH KOREA	6M
			UK	30M
			USA	100M
			AFRICAN UNION	120M
			COVAX	500M
			EU	200M



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																																
2 doses Intramuscular  Vaccine storage: • Complete +2C° to +8C° • Frozen (-18C°)	Production started end of 2020  Manufacturing sites: • India • Russia  Production capacity 500 million doses per year	 Phase: Approved  Approval status: 13 Countries Approved in Algeria, Argentina, Belarus, Bolivia, Guinea, Hungary, Paraguay, Republic of Serbia, Russia, Turkmenistan, United Arab Emirates, Venezuela, West Bank  Clinical trials locations: • Belarus • India • Venezuela • Azerbaijan • Russia • UAE																																
Transport requirements  Transport temperature +2°C to +8°C  Likely to be a passive box (standard process)	Confirmed vaccine doses procured by country <table><tr><td>ALGERIA</td><td>Unknown</td><td>EGYPT</td><td>25M</td><td>MEXICO</td><td>32M</td><td>SERBIA</td><td>2M</td></tr><tr><td>ARGENTINA</td><td>25M</td><td>INDIA</td><td>100M</td><td>NEPAL</td><td>25M</td><td>UZBEKISTAN</td><td>35M</td></tr><tr><td>BOLIVIA</td><td>2.6M</td><td>KAZAKHSTAN</td><td>2M</td><td>PALESTINA</td><td>Unknown</td><td>VENEZUELA</td><td>10M</td></tr><tr><td>BRAZIL</td><td>50M</td><td>MALAYSIA</td><td>Unknown</td><td>SAUDI ARABIA</td><td>Unknown</td><td>VIETNAM</td><td>50M</td></tr></table>		ALGERIA	Unknown	EGYPT	25M	MEXICO	32M	SERBIA	2M	ARGENTINA	25M	INDIA	100M	NEPAL	25M	UZBEKISTAN	35M	BOLIVIA	2.6M	KAZAKHSTAN	2M	PALESTINA	Unknown	VENEZUELA	10M	BRAZIL	50M	MALAYSIA	Unknown	SAUDI ARABIA	Unknown	VIETNAM	50M
ALGERIA	Unknown	EGYPT	25M	MEXICO	32M	SERBIA	2M																											
ARGENTINA	25M	INDIA	100M	NEPAL	25M	UZBEKISTAN	35M																											
BOLIVIA	2.6M	KAZAKHSTAN	2M	PALESTINA	Unknown	VENEZUELA	10M																											
BRAZIL	50M	MALAYSIA	Unknown	SAUDI ARABIA	Unknown	VIETNAM	50M																											

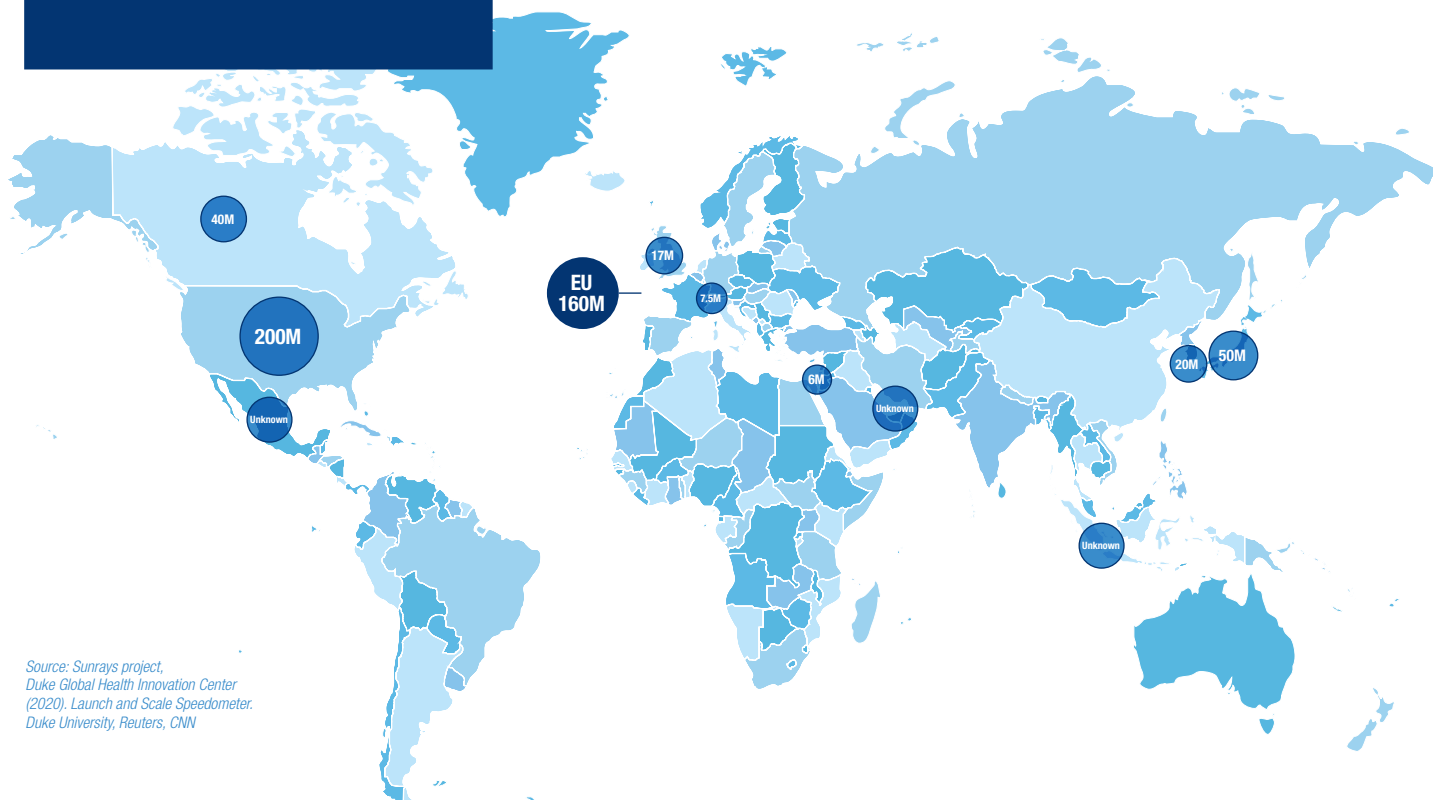


Source: Sunrays project,
Duke Global Health Innovation Center
(2020), Launch and Scale Speedometer,
Duke University, Reuters, CNN

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: • 6 months at -20°C • 30 days at +2°C to +8°C • 12 hours at +15°C to +25°C	 Production has started  Manufacturing sites: • Switzerland • USA  Production capacity of 500 million to 1 billion doses/year	 Phase: Approved  Approval status: 37 Countries → full list page 37  Clinical trials locations: • Canada • Switzerland • USA
Name: mRNA-1273		

 Transport requirements	Confirmed vaccine doses procured by country					
 Transport temperature +2°C to +8°C  Passive box (standard process)	CANADA	40M	MEXICO	Unknown	SOUTH KOREA	20M
	ISRAEL	6M	QATAR	Unknown	SWITZERLAND	7.5M
	JAPAN	50M	SINGAPORE	Unknown	UK	17M
					EU	160M

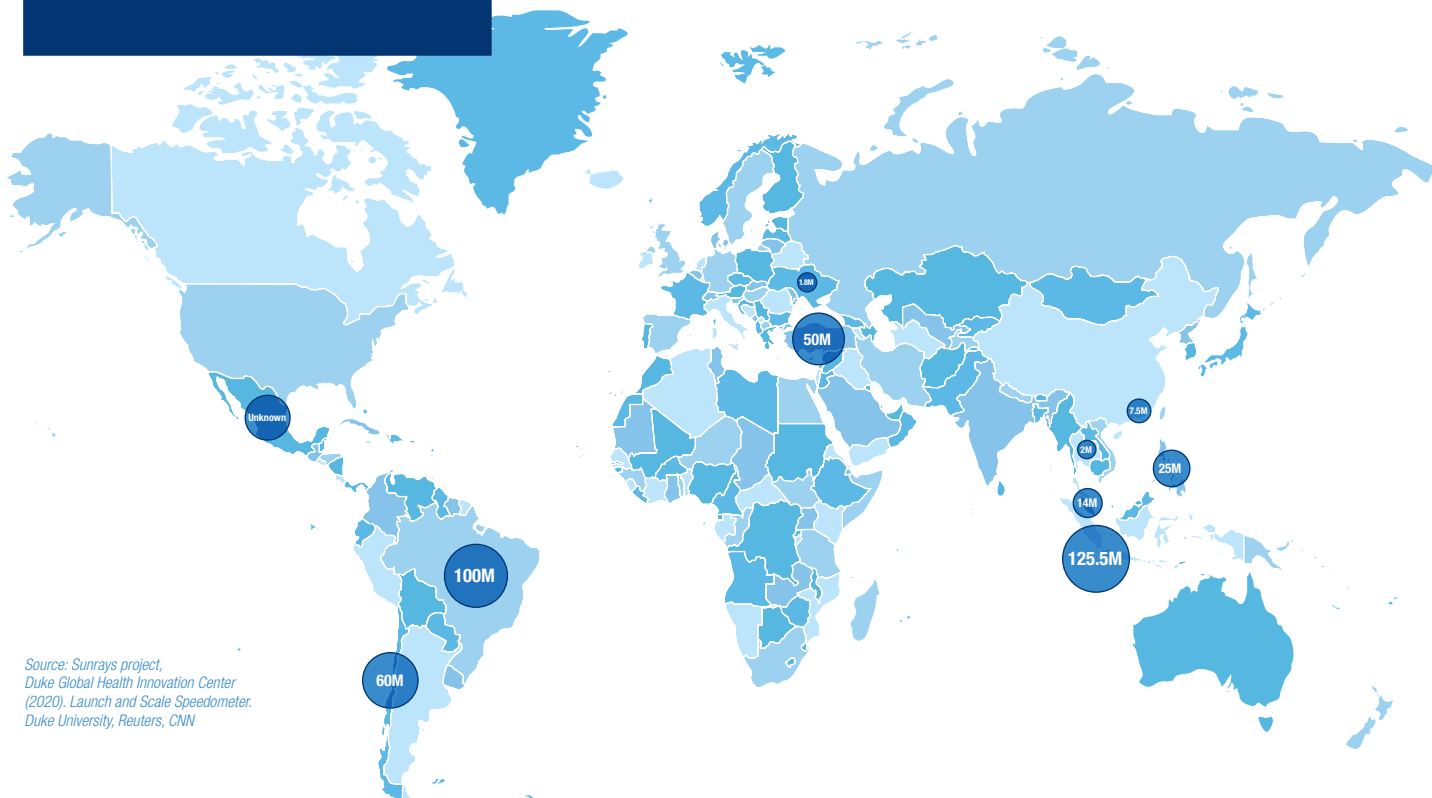


Source: Sunrays project,
Duke Global Health Innovation Center
(2020), Launch and Scale Speedometer,
Duke University, Reuters, CNN

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

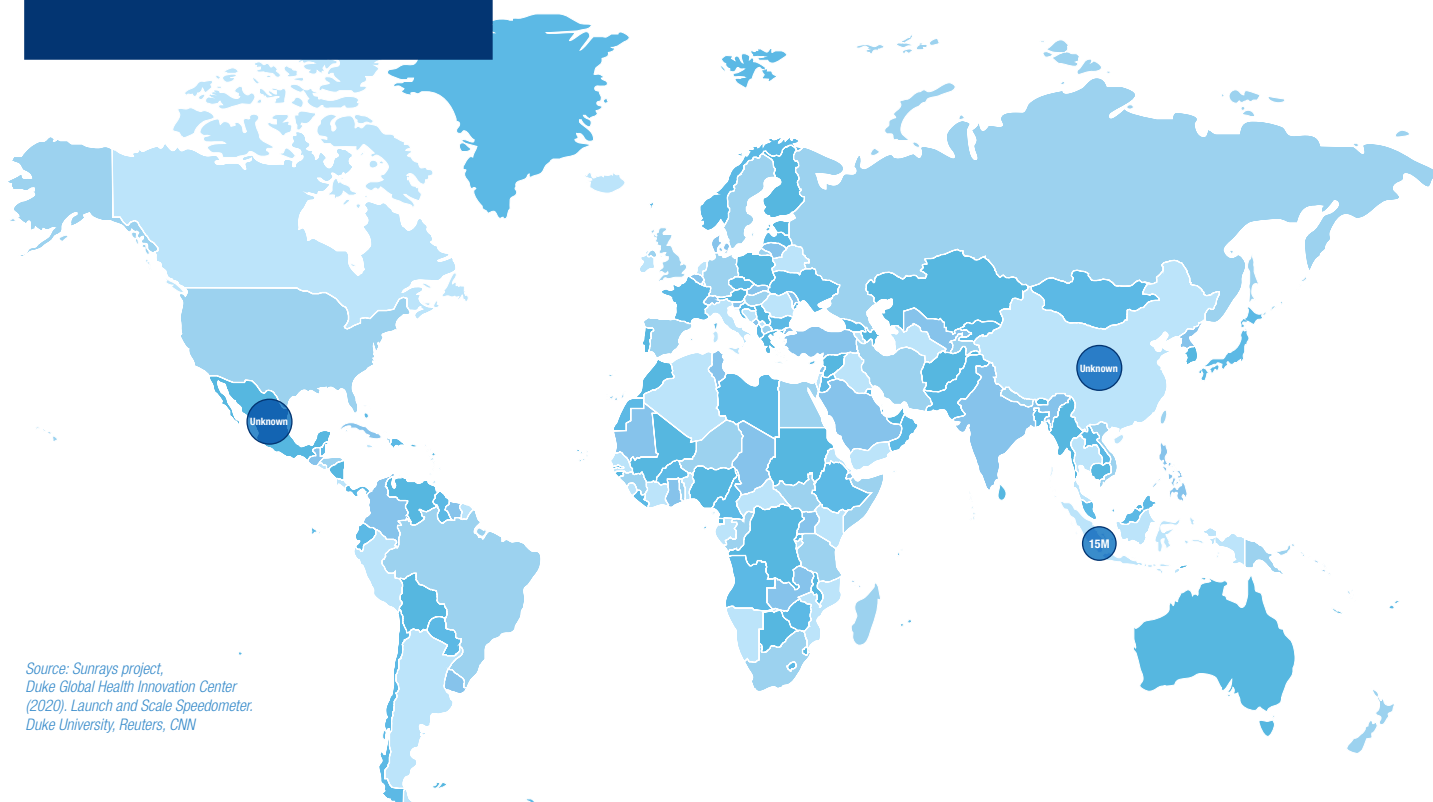
 Medical specs	 Manufacturing info	 Development status
 2 doses Intramuscular  Vaccine storage: Refrigerated (+2C° to +8C°)	 Production has started  Manufacturing sites: - China - Egypt (under negotiation) - Indonesia	 Phase: Approved  Approval status: 5 Countries Approved in Brazil, Chile, China, Indonesia, Turkey  Clinical trials locations: - Brazil - China - Indonesia
Name: CoronaVac		

 Transport requirements	Confirmed vaccine doses procured by country			
 Transport temperature +15°C to +25°C  Likely to be a passive box on +15°C (standard process)	BRAZIL 100M CHILE 60M HONG KONG 7.5M	INDONESIA 125.5M MALAYSIA 14M MEXICO UNKNOWN	PHILIPPINES 25M THAILAND 2M TURKEY 50M	UKRAINE 1.8M



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 has started beginning 2021  Manufacturing sites: • China  Production capacity of 100-200 million doses as of 2021	 Phase: Approved  Approval status: 1 Country China  Clinical trials locations: • Argentina • Chile • China • Mexico • Pakistan • Russia						
 Transport requirements  Transport temperature +2°C to +8°C  Likely to be a passive box.	Confirmed vaccine doses procured by country <table><tr><td>INDONESIA</td><td>15M</td></tr><tr><td>MALAYSIA</td><td>Unknown</td></tr><tr><td>MEXICO</td><td>Unknown</td></tr></table>		INDONESIA	15M	MALAYSIA	Unknown	MEXICO	Unknown
INDONESIA	15M							
MALAYSIA	Unknown							
MEXICO	Unknown							



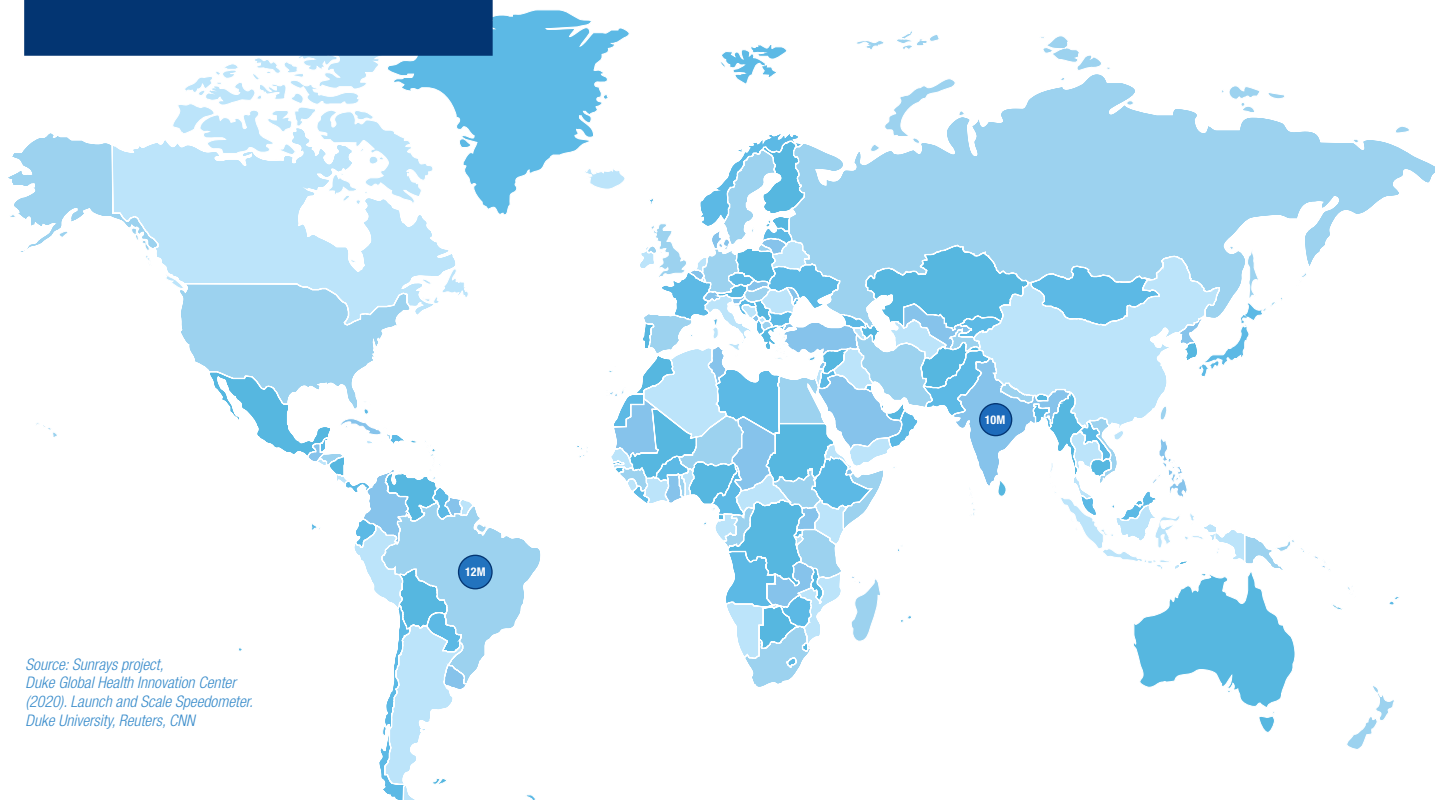
Bharat Biotech International Limited is an Indian biotechnology company headquartered in Hyderabad.

 Medical specs	 Manufacturing info	 Development status
 2 doses Intramuscular  Vaccine storage: • Refrigerated (+2C° to +8C°) Vaccine shelf life: • 6 months at +2C° to +8C°	 Production has started beginning of 2021  Manufacturing sites: • India • Brazil  Production capacity of 100-200 million doses as of 2021	 Phase: Approved  Approval status: 1 Country India  Clinical trials locations: • India
Name: Covaxin		

 Transport requirements
 Transport temperature +2°C to +8°C
 Likely to be a passive box (standard process)

Confirmed vaccine doses procured by country

BRAZIL	12M
INDIA	10M



Serum Institute of India is an Indian biotechnology and pharmaceuticals company. It is located in the city of Pune, India

 Medical specs	 Manufacturing info	 Development status
 2 doses Intramuscular  Vaccine storage: • Refrigeration (+2°C to +8°C) Vaccine shelf life: • 6 months at +2°C to +8°C Name: Covishield	 Production has started beginning of 2021  Manufacturing sites: • India  Production capacity of 100-200 million doses as of 2021	 Phase: Approved  Approval status: 1 Country India  Clinical trials locations: • India

 Transport requirements
 Transport temperature +2°C to +8°C  Likely to be a passive box (standard process)

Confirmed vaccine doses procured by country

INDIA	11M
COVAX	200M



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



FACT SHEET

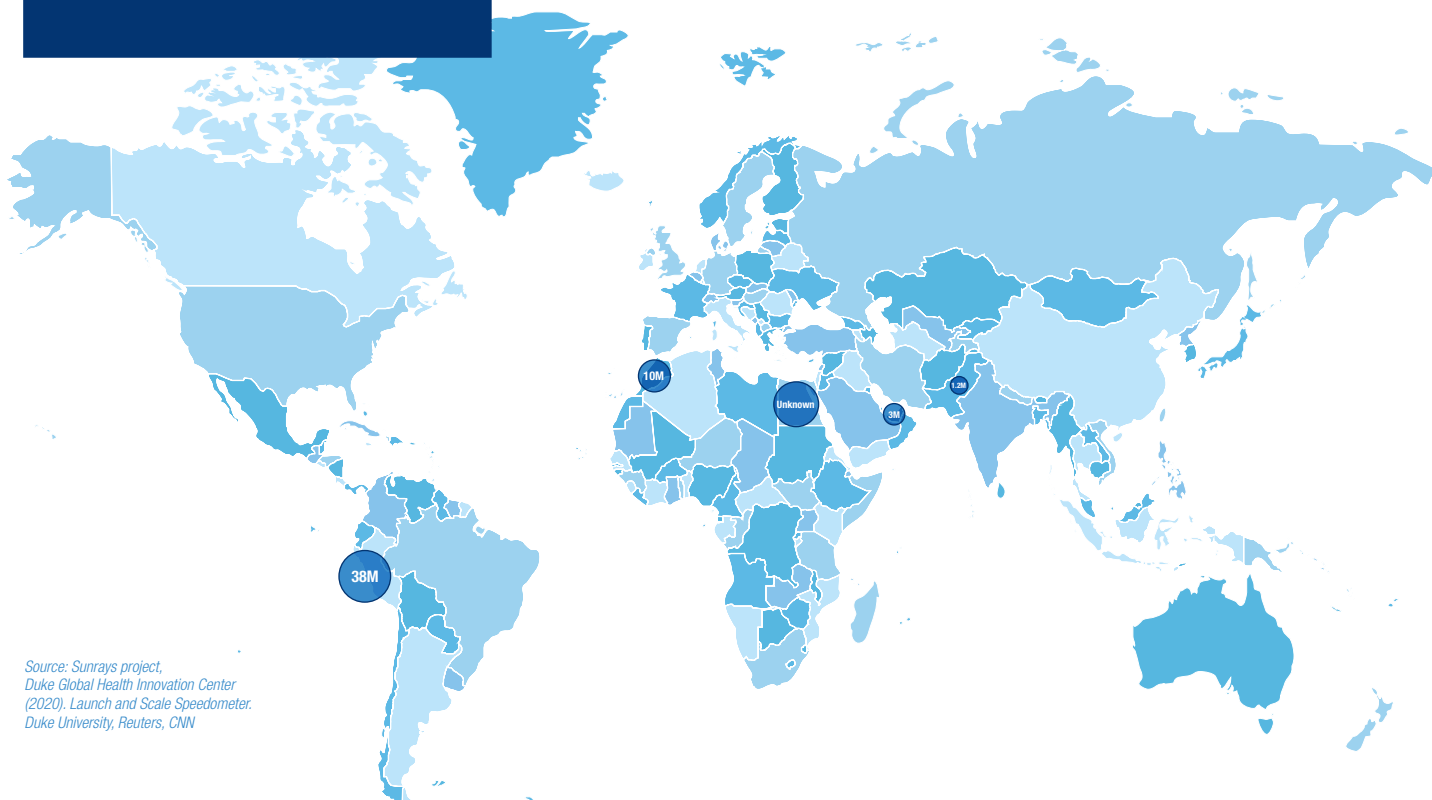
Sinopharm Group Co., Ltd. is a Chinese pharmaceutical company
Headquarters Sinopharm Plaza, Shanghai, China

 Medical specs	 Manufacturing info	 Development status
 2 doses Intramuscular  Vaccine storage: • Refrigerated (+2C° to +8C°) Vaccine shelf life: • 6 months at +2°C to +8°C	 Production has started beginning of 2021  Manufacturing sites: • China  Production capacity of 1 Billion doses as of 2021	 Phase: Approved  Approval status: 8 Countryrs Approved in Bahrain, China, Egypt, Iraq, Jordan, Pakistan, Seychelles, United Arab Emirates  Clinical trials locations: • Bahrain • Egypt • Jordan • UAE • Argentina • Peru • China
Name: BBIBP-CorV		

 Transport requirements
 Transport temperature +2°C to +8°C  Likely to be a passive box (standard process)

Confirmed vaccine doses procured by country

EGYPT	Unknown	PAKISTAN	1.2M	UNITED ARAB EMIRATES	3M
MOROCCO	10M	PERU	38M		



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



FACT SHEET

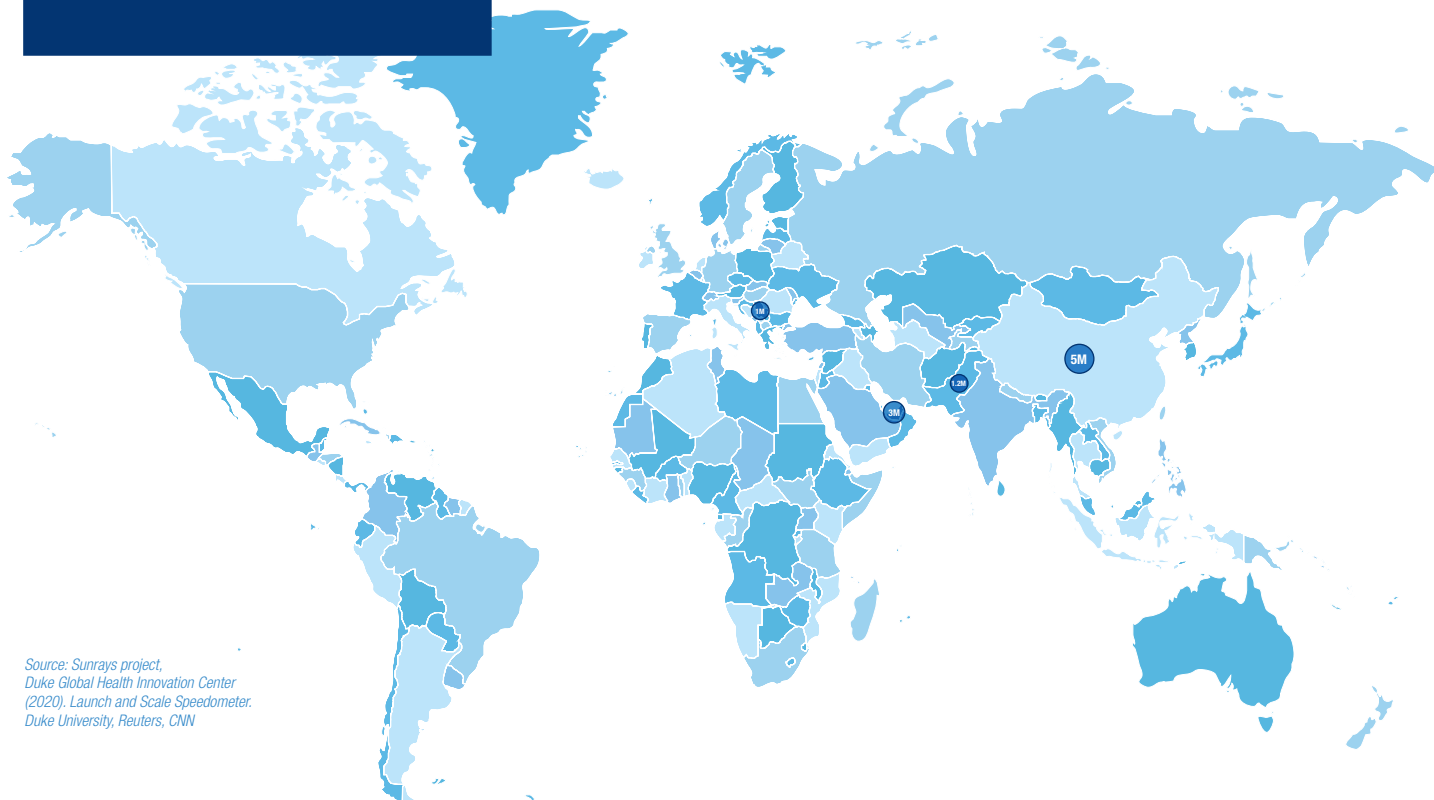
Sinopharm Group Co., Ltd. is a Chinese pharmaceutical company
Headquarters Sinopharm Plaza, Shanghai, China

 Medical specs	 Manufacturing info	 Development status
 2 doses Intramuscular  Vaccine storage: - Refrigerated (+2C° to +8C°) Vaccine shelf life: 6 months at +2°C to +8°C	 Production has started beginning of 2021  Manufacturing sites: China  Production capacity of 1 Billion doses as of 2021	 Phase: Approved  Approval status: 3 Countrys China, United Arab Emirates, Serbia  Clinical trials locations: - China - Peru - UAE - Morocco
Name: Inactivated		

 Transport requirements
 Transport temperature +2°C to +8°C  Likely to be a passive box (standard process)

Confirmed vaccine doses procured by country

CHINA	5M	UNITED ARAB EMIRATES	3M
PAKISTAN	1.2M		
SERBIA	1M		



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

Air pharma logistics company directory



Brussels Airport

As one of the most important airports located in the heart of Europe, Brussels Airport is the ideal gateway to Belgium, Europe and the rest of the world. Brussels Airport links the European capital with 236 passenger and cargo destinations worldwide that are served by 74 different airlines. BRUcargo, the dedicated cargo area at the airport, is world leading and innovative when it comes to the transportation of pharmaceutical goods. Brussels Airport is recognized as a preferred European pharma gateway. Alongside all the ongoing capacity expansions and infrastructure investments, we manage to keep all our customers close to our heart.

www.brusselsairport.be/en/cargo



Changi Airport Group

Singapore is a leading Asian biomedical sciences hub and home to regional operations of global pharmaceutical manufacturers. Supporting this industry, Changi Airport, together with our air cargo community, has since established the largest IATA CEIV Pharma certified community in Asia Pacific. Spanning more than 9,000sqm of temperature-controlled facilities, coupled with state-of-the-art cold chain handling equipment, the Changi air cargo hub boasts an annual cold chain handling capacity upwards of 375,000 tonnes, providing pharmaceutical manufacturers with a piece of mind to transport their pharmaceutical shipments with the highest standards. Changi Airport is also a strategic member of Pharma.Aero.

www.changiairport.com



Cold Jet

Cold Jet produces systems for the production, metering, dosing, and packaging of dry ice for food transportation and cold chain management, as well as vaccine and pharmaceutical distribution. We also provide environmental cleaning, surface preparation, and parts finishing systems to global manufacturing industries that utilize particles of dry ice as a blasting medium. Cold Jet is headquartered in Loveland, Ohio, with international operations in Europe, Asia, Canada and Mexico. For more information, visit www.coldjet.com, call 1-800-337-9423 or +1-513-831-3211 (International), or email vaccine@coldjet.com.

www.coldjet.com



Edmonton International Airport (EIA)

Edmonton International Airport (EIA) is Canada's fifth-busiest airport by passenger traffic, the largest major airport by land mass and is one of Canada's essential airports due to its advanced logistics infrastructure and strategic geographical location. EIA is open 24/7, offers unrestricted slots and is close to major rail & highway transportation links to get products anywhere in the world, fast and safely. All facilities operate within a Foreign Trade Zone, which reduces trade barriers & enhances access to key international markets. EIA was first in Canada and the most northern airport in the world to achieve IATA CEIV Pharma community certification and offers certified multi-temperature cargo facilities.

www.flyeia.com/cargo



Etihad Cargo

Etihad Cargo is the cargo and logistics arm of the Etihad Aviation Group. Since its establishment in 2004, Etihad Cargo has grown rapidly to become one of the leading air cargo carriers in the world, offering customers a range of cargo products and services to five major continents. Our hub in Abu Dhabi is strategically located at the centre of the worlds' busiest trade lanes, providing an integral link between Asia, Europe, North America, Australia and Africa.

In addition to general cargo, Etihad Cargo offers a wide range of specialty products including market leading PharmaLife and FreshForward holding IATA's stringent Center of Excellence for Independent Validators certifications for both Pharmaceutical Logistics as well as Perishables Logistics. Etihad Cargo currently operates across more than 1,050 IATA CEIV Pharma/GDP certified trade lands which ensure the integrity of products during transportation.

Contact person: @Fabrice Pierre Augustin Panza – Manager, Cool Chain Solutions, Etihad Cargo. FPanza@etihad.ae

For more info please visit

www.etihadcargo.com

flexport.

Flexport

Flexport is the modern freight forwarder. Companies use Flexport to move freight, clear customs, and make smarter decisions about their supply chain - all on one digital platform powered by a unique combination of technology, logistics infrastructure and expertise. Today Flexport connects almost 10,000 clients and suppliers across 116 countries, including established global brands as well as emerging innovators. Flexport offers a full range of services, including ocean, air, truck and rail freight, drayage and cartage, warehousing, customs and trade advisory, financing, and insurance.

www.flexport.com



Hong Kong Air Cargo Terminal Limited (Hactl)

Hactl is the leading air cargo terminal operator in Hong Kong. Its SuperTerminal 1 base is the world's largest multi-level air cargo terminal, with a capacity of 3.5 million tonnes per annum. Since 1976, Hactl has made a major contribution to the development of Hong Kong International Airport to become the world's top air cargo hub, and has led the world in handling automation and innovation. Hactl has strong pharma credentials: it was the first handler in Hong Kong to attain WHO GDP and IATA CEIV Pharma. Its dedicated pharma facilities and fast-track processes from airside to truck are second to none.

www.hactl.com



Hong Kong International Airport

Strategically located at the heart of Asia, Hong Kong International Airport (HKIA) is well placed to be the preferred gateway for transshipping vaccines to both Asia-Pacific and global destinations efficiently. As an IATA CEIV Pharma Partner Airport, HKIA cargo community is fully geared up to provide proficient and seamless cold-chain handling for temperature-sensitive vaccines at globally assured standards. Apart from impeccable handling quality, HKIA offers the largest fleet of cool dollies in Asia and two sets of pioneering apron shelters to mitigate temperature excursion on apron. HKIA stands ready to play a part in worldwide delivery of vaccines.

Email: pharmacargo@hkgairport.com

www.hongkongairport.com/en/the-airport/air-cargo



Miami International Airport (MIA)

Miami International Airport (MIA) is the

leading international freight airport in the Americas and one of the world's top global cargo gateways. As the world's largest Latin American/Caribbean gateway, MIA handles over 79% of all the air imports and 77% of exports between the US and the region. MIA serves as the hemispheric hub for distribution of perishable products and is a prominent partner in the global pharma industry. MIA also serves as a major trans-shipment point between the Americas, Europe and Asia. Total international air cargo trade accounted for \$57.3 billion in 2019.

www.miami-airport.com



Neutral Air Partner

Neutral Air Partner is the premier global network of leading air cargo architects and aviation specialists, dedicated to providing innovative air cargo solutions to the global supply chain as well as the logistics & aviation community.

NAP aims to inject a greater degree of advanced air cargo expertise into the logistics industry, revive specialization, and to drive airfreight and express buying power across the air cargo supply chain. The group is positioned amongst the world's largest air freight and express services providers, counting over 250 like-minded experts from 150 countries.

www.neutralairpartner.com



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SATS is present in over 60 locations and 13 countries across Asia Pacific, the UK and Middle East.

SATS has been listed on the Singapore Exchange since May 2000.

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www.sats.com.sg



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Offering service to 127 countries and being the fastest-growing air cargo brand around the world, Turkish Cargo has been carrying out the air cargo transportation operations of Turkish Airlines, the "rising star" of Turkey, since 1933.

Operating with the fleet of Turkish Airlines, our flag-carrier main brand, including 365 aircraft (passenger aircraft and freighters), Turkish Cargo provides air cargo service to more than 300 international destinations including 95 direct cargo destinations. Having the world's largest cargo freighter network and passenger plane network, Turkish Cargo aims to be one of the world's five largest air cargo brands by 2023.

www.turkishcargo.com.tr

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



Approval status: 54 Countries

Approved in the Argentina, Austria, Bahrain, Belgium, Bulgaria, Canada, Chile, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Ecuador, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Iraq, Ireland, Israel, Italy, Jordan, Kuwait, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Mexico, Mongolia, Netherlands, Norway, Oman, Panama, Philippines, Poland, Portugal, Qatar, Republic of Serbia, Romania, Saudi Arabia, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States (date 22 JAN 2021)



Approval status: 37 Countries

Approved in Austria, Belgium, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Mongolia, Netherlands, Norway, Poland, Portugal, Romania, Seychelles, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States

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