Cell and Gene Therapy:
Supply Chain Challenges and Solutions

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Because they include live cells, shipments of autologous medications require unique packaging, temperature, and tracking approaches – as well as tight collaboration among supply chain stakeholders.

Imagine a temperature-controlled shipment of pharmaceuticals is supposed to have arrived at Los Angeles International Airport but, for some reason, could not be located. In recent years, supply chain hiccups have been the rule rather than the exception, so supply chain managers would probably not get bent too far out of shape over such a development. They might go to a Plan B, which could involve arranging for a replacement shipment — to arrive a few hours or a few days later than originally planned. That result would have been less than optimal for the shipper and receiver of the goods, but such is life in today's supply chain.

These considerations get thrown out the window when it comes to shipments of cell and gene therapies. Why? In the case of these autologous medications — which use a patient's own tissues to manufacture treatments to be reintroduced into the patient — there often is not a second chance to get the shipment right. Cells are harvested from a patient and sent to a remote laboratory to be cultured over a period of weeks before being sent back to the patient's healthcare providers. A lost shipment would require that process to start over again — and the patient may not have the luxury of time. In other words, it could be a matter of life and death.

The deployment of cell and gene therapies to treat cancer, genetic diseases, infectious diseases and other maladies has been growing at a healthy rate in recent years. Contributing to this growth have been cost reductions made possible by the development of more affordable refrigeration and packaging technologies — including reusable packaging solutions — which prevent temperature excursions and maintain the super-low temperatures required for such shipments. Versatile sensors and foolproof data technologies for tracking and tracing individual shipments — to make sure that precious cargo is where it is supposed to be at all times, without exception — are also required for the success of the cell and gene supply chain, as is close collaboration among supply chain stakeholders. Continued technology innovations are expected to reduce the costs of administering cell and gene therapies even further, spurring continued growth in the years to come.

Cell and gene shipments include living cells, and shipments often traverse long distances to make the round trip to the laboratory and back to the patient. Those conditions suggest one set of challenges faced by logistics services providers when it comes to managing these shipments. Many of these cargoes require cryogenic temperatures of hundreds of degrees below zero to maintain their integrity. Reliable technologies that are able to maintain those temperatures are necessary to make that happen.

"If the transportation process is going to take longer than the lifespan of the cells," explains Alex Guillen, a life sciences and pharmaceuticals expert at Tive, a logistics and supply chain visibility technology company, "you need to maintain cryogenic temperatures. That's very difficult, very expensive, and very hard to manage."

"The personalized nature of the therapies, and the fact that they're 'living drugs' much of the time, means that the requirements for handling shipments are a lot more precise in terms of time, temperature, shock and other variables," adds Christopher Good, director of cell and gene therapy logistics at Biocair, a life-sciences logistics company. "You need tight control of the supply chain, from pre-production to post-production."

The extreme cold requirements often necessary for cell and gene therapies mark one of the differences between those and ordinary pharmaceutical shipments. Liquid nitrogen is one of the common agents used to maintain the extremely low temperatures required.

The process of harvesting tissue from the patient — often in the form of white blood cells — usually takes several hours. As soon as that process is completed, the logistics operators handling the shipment must be ready to move it. Since the length of the initial procedure can vary, flexibility is required.

Once the cells are prepared, the logistics specialist arranges for shipment of the product from the clinical site directly to the manufacturing site, making sure that the packaging and temperature controls are in order. "As soon as they take the cells from the patient, they're going to start deteriorating," says Michael De Beuckelaer, Biocair's sales lead for Belgium. "So we have to observe stringent timing for the transportation from the clinic to the manufacturing facility, typically 18 hours or less." Depending upon the procedure and the therapy involved, and the location of the patient and the laboratory, the sample could be transported across continents and oceans.

Once the product arrives at the manufacturing facility, it is genetically modified for use in the patient's individualized therapy — and then multiplied many times over so that millions of cells are available for infusion back into the patient. When that procedure is completed, usually in a matter of weeks, the logistics experts step in to arrange for the shipment of those living cells back to the clinic for infusion into the patient.

"It's a manufacturing process that starts and ends with the patient," says De Beuckelaer. "Logistics is at the heart of the process because the quality of the cells that are delivered into the manufacturing facility will have a big impact on the quality of the product and the ability to deliver potentially life-saving treatment to the patient."

"The biggest hurdle is not the therapy itself, but the supply chain," adds Guillen. "Patients may be deprived of therapies if they cannot get to them on time and with full integrity. There is no room for error."

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All of these considerations require the utmost of cooperation — at every stage of the supply chain. The industry has benefited in that regard from the experience of having had to cope with supply chain dislocations brought on by the COVID-19 pandemic. "One of the consequences of COVID has been this high level of collaboration," says Guillen. "Companies have partnered on developing packaging, cold solutions, and monitoring capabilities that are more robust, proven and validated."

The latest tracking and monitoring technologies being brought to bear in the cell and gene therapy supply chain are designed to provide even greater shipment visibility and to better pinpoint estimated times of arrival (ETAs). "For example," says Guillen, "with the use of geolocation technology, you can track and report on shipments with accuracy. Geofencing technology reports on deviations from the expected route."

The need to maintain shipments at super-low temperatures requires sensors that are able to withstand those temperature ranges. The latest sensors that have been introduced to the marketplace — which can be placed internal to the packaging, an innovation for cryogenic cargoes — can now accommodate the full range of temperatures required for cell and gene therapy shipments.

The sensors monitor the temperature of cargo at every step of the supply chain — as well as conditions, such as battery life and package openings — and communicate that information to a data platform via 5G wireless technology. "If a temperature excursion is at risk of occurring," says De Beuckelaer, "the system notifies the users so that contingency plans can be implemented, which ensures the cold chain is not compromised."

That could mean meeting the shipment at the destination airport as soon as it arrives, and taking steps to ensure that the shipment is not compromised. When a shipment arrives at its destination, the system automatically reports that event to the end user, who is then in a position to present documents for the expeditious release of the shipment.

With the control tower features included in the latest data platforms, "logistics specialists can log in and have visibility to the exact location of the product and its temperature at any point — and can check to see that all conditions are being properly maintained," says Good. "All this is done in real time as the cargo is traveling around the supply chain. The end result is that we have the data to prove that the product was kept at the correct temperatures and conditions throughout transit."

This same data is also used to analyze supply chain performance and to plan for future shipments. "Data analysis can identify which carriers and which packaging solutions are performing the best," says Guillen. "Carrier performance data is used to optimize specific traffic lanes. Supply chain issues can be addressed and problems mitigated by understanding how shipments were handled at different sites and by addressing root causes."

There are also important patient privacy concerns when it comes to the handling of data, as the shipment will include intimate health, genetic, and other personal details. "That's another reason why a sophisticated data platform is required," says Guillen. "Access to the data at the various supply chain stages must be on a need-to-know basis. The information needs to be managed properly."

The administration of cell and gene therapies has grown in recent years, thanks to technology and supply chain cost reductions, and further reductions are expected to spur continued growth. "Therapies that used to cost a million dollars, now can cost as low as one hundred thousand," says Guillen. "As the costs of the therapies go down, they can be made available to more and more patients." That means that the number of cell and gene therapy shipments traversing supply chains and transportation systems will be increasing from the thousands to the hundreds of thousands in the not-too-distant future. "The supply chain requirements for these shipments are going to be escalating," says Guillen, "and the technology has to be there at scale."

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"We're only at the beginning right now," Guillen adds, "and we will know a lot more about how we're progressing in a year's time. But it's certain that the sector will be accelerating, and the supply chain cooperation that we've developed over the last few years will be instrumental to its future success."

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