

Optimizing Vaccine Cold Chains and Logistics with RFID

More than half of all vaccine doses are unusable due to mishandling in storage and transit. How can Identiv's RFID-based technology reduce vaccine waste?

According to the World Health Organization (WHO), [more than 50% of vaccines lose their efficacy](#) globally every year due to the lack of proper temp control, logistics, or shipment related issues. While COVID-19 spotlights the need to keep vaccines cold, pharmaceutical temperature control — typically referred to as the vaccine cold chain — has been a well-recognized challenge in the healthcare world for many years. [Every vaccine distributed in the last few decades](#) has required some form of temperature regulation. While temperature and distribution challenges are familiar, they have been exaggerated in the COVID-19 vaccine rollout, as many of these novel mRNA vaccines require extreme temperature regulation.

In addition to temperature challenges, these vaccines are being distributed at an unprecedented pace and scale through a complex, global process. Throughout 2020, supply chain management has been a central focus across many industries. Proactive logistics management is critical to ensure timely and successful delivery of this vaccination campaign. Radio-frequency identification (RFID) tags and monitoring enabled by wireless networks enforce accountability and provide timely, relevant data to make key decisions. Smart packaging tracks shipping progress and reduces damage in transit. Identiv has tried-and-true technology and methodology to monitor temperature, logistics, and shipment quality of each dose from initial production through the last mile of delivery.

Regulating Temperature Control

Meeting the cold chain storage requirements is mission critical to a successful roll out. The speed and scale of the COVID-19 vaccine deployment is made even more challenging by the need to store some vaccinations at ultra-low temperatures (ULT) beyond the normal cold storage range for vaccines.

Systems need to be in place to transport vaccines in temperatures as low as -80C, requiring organizations to find solutions to ramp up ULT cold chain capacity to safely store and deliver vaccines. For context, most vaccines need to be stored [between 2C and 8C](#). The lowest recorded temp on Earth is -89C, and for most of the year Antarctica is [above -60C](#). *Vaccine temperature requirements vary slightly by manufacturer:*

- **[Pfizer's vaccine](#) requires most storage from -70C to -10C, and the [CDC recommends](#) shipping this in an**



ultra-cold freezer that reaches -80C.

- **[Moderna's vaccine](#) requires storage from -25C to -15C, more on par with your typical household or medical freezer.**
- **Other vaccine candidates (like [Astrazeneca](#), [Novavax](#), and [J&J](#)) require anywhere from -20C to 8C.**

Many COVID-19 vaccines are an entirely new vaccine type, called mRNA vaccines. These mRNA vaccines are [highly sensitive](#) and very fragile by nature. If not kept within specific temperature ranges, they are unusable as their components will chemically unravel. However, mRNA vaccines have numerous potential benefits for COVID-19 vaccination, like quick development and dramatically increased effectiveness, which make this additional complexity very worthwhile. These benefits might make [mRNA vaccines useful for many other diseases](#) or future pandemics, too.

For existing cold chain monitoring, [the WHO and UNICEF](#) encourage the use of temperature monitoring devices. To meet performance requirements that COVID-19 mRNA vaccines demand, these devices need increasingly rigorous accuracy and interconnectivity. Smart sensors can relay temperature readings via secure Internet of Things (IoT) for end-to-end monitoring at every step in the process to ensure vaccine safety and potency. These sensors generate alerts when a shipment is nearing the edge of acceptable temperature ranges, enabling status tracking and quickly identifying which doses need manual adjustment. Early intervention is critical to fix any temperature issues before the shipment becomes unusable. For near-real time intervention,

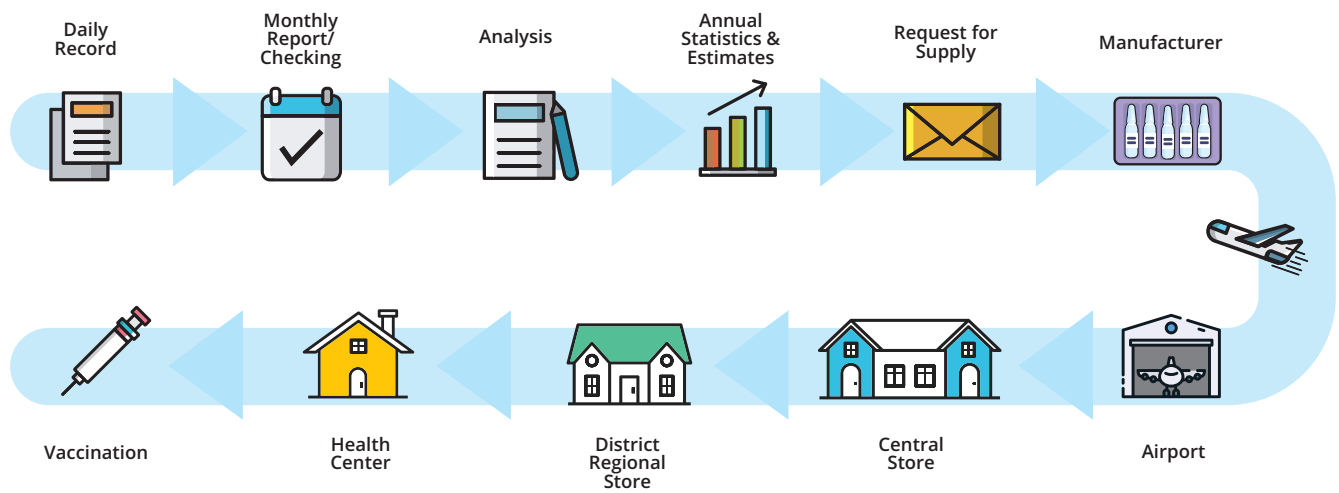


Figure 1. Logistics supporting typical vaccine manufacture, storage, distribution, and patient delivery. Source: [WHO](#)

automated temperature regulation can account for weather or environmental changes that arise during storage and transit. [Identiv's proven smart sensors](#) that track and store temperature readings are a [perfect fit for the vaccine cold chain](#).

Streamlining Logistics

While the development and testing of vaccines has been spotlighted in recent news, there are additional challenges to a vaccine rollout, including manufacturing, storing, shipping, and distributing. Vaccines are manufactured in various locations, shipped globally to distribution centers, and are eventually provided as individual doses for patients all over the world. These logistics are incredibly complicated, and nearly as important as the creation of a safe vaccine itself — Pfizer cut their initial delivery estimates [by 50%](#) due to supply chain challenges. For a typical vaccine campaign, supply chain logistics might look like Figure 1 above.

Supply chain complexity increases exponentially with the COVID-19 vaccine roll out. Various countries and regulating bodies are competing for highly limited vaccine supply with variable production rates. To make things even more complicated, the last-mile problem, which already poses massive challenges in a standard vaccine campaign, is even more troublesome at pandemic scale.

Identiv's expertise with RFID tagging is a natural fit to streamline supply chain operations. RFID tracking enables large-scale logistics optimizations, ensuring the right doses are in the right places at the right time. The last-mile problem is so severe that [the WHO recommends](#) a single person per vaccination facility manages all logistics; RFID tracking reduces

the end-to-end overhead, improving accountability and reliability even for delivery of each dose. RFID labels, including passive RFID tags, makes it easy for handlers to determine the contents, source, and destination of each shipment, reducing errors in the distribution and shipping process. Further, handlers have an immediate record of how to quickly correct for any errors, improving quality and efficiency. Identiv has proven experience in applying RFID expertise to optimize logistics as demonstrated in one of [our case studies](#).

Protecting Shipments

It is relatively easier to keep vaccines stable in storage, but meeting environmental requirements in transit is even more challenging. During transit, packages face temperature fluctuation, vibrational shock, impact, and jostling due to the carrier's movement. Packaging solutions that affect drug efficacy, durability, and shelf life must be used on both [primary and secondary packaging structures](#) to retain as many usable doses as possible.

Smart tracking systems can be built into both primary and secondary packaging to manage and record activity in real time from manufacturer to patient. Smart tags can stick right on a crate, and they provide an instant RFID-connected package that enables remote tracking and monitoring. These RFID tags are low cost and low overhead with minimal infrastructure changes. Between each checkpoint, status and condition is continuously monitored. RFID tags work in tandem with special temperature-sensitive monitoring devices to provide comprehensive status updates.

Beyond the complexities of regular operation, RFID tags can help with detection of theft, fraud, and damage during shipment:

- **Theft:** Current geographic location and location history can be used to ensure that there were no unauthorized interventions or movements.
- **Fraud:** Identiv's technology partnership with [collectiD](#) has proven success with preventing counterfeiting. Additionally, [emerging research](#) has successfully applied blockchain and RFID to prevent tampering and counterfeiting of other pharmaceuticals.
- **Damage:** Implementing shock monitoring can detect mishandling and reduce shipment damage. When cargo is clearly indicated it is being monitored, this encourages cargo handlers to be more careful, [decreasing likelihood of damage](#) during transit.

Conclusion

Proactive logistics management is integral to the critical supply chain efforts that enable the delivery of the COVID-19 vaccines. RFID tags and monitoring, enabled by Wi-Fi, cell networks, Bluetooth, and other wireless networks, track accountability at each step and provide continuous monitoring to make informed decisions. Smart packaging with temperature control, anti-tampering, and location tracking is mission critical in efficient vaccine delivery. While these technologies are immediately relevant for near-term with the COVID-19 vaccine campaign, as mRNA vaccines continue to prove their worth, optimized, secure ULT systems will become increasingly in demand. COVID-19 has forced exponential growth of these systems. Manufacturers, distributors, government leaders, NGOs, and the healthcare community will have an opportunity to troubleshoot methodologies and identify best practices to better prepare for the next pandemic.

Identiv's RFID-based technology solutions go beyond vaccine cold chain monitoring and logistics. Contact us today at +1 888.809.8880 or transponder_sales@identiv.com to learn how we can work together to verify identities and security in the IoT.

