DELIVERING NEXT LEVEL HEALTHCARE

WHITE PAPER

#WeCare

LOOKING BACK: ACCELERATING HEALTHCARE INNOVATION OVER THE YEARS

2000 BCE
ANCIENT ASSYRIANS CHEWED WILLOW LEAVES TO RELIEVE PAIN.

1847
HUNGARIAN PHYSICIAN IGNAZ SEMMELWEIS RECOMMENDED HANDWASHING WITH SOAP TO PREVENT THE TRANSMISSION OF DISEASE.

1899
SCIENTISTS AT GERMAN CHEMICAL COMPANY BAYER SYNTHESIZED ACETYLSALICYLIC ACID, THE ACTIVE INGREDIENT FOUND IN WILLOW, PATENTING IT AS ASPIRIN.

1920s
INSULIN FIRST USED FOR THE TREATMENT OF DIABETES.

1941
PENICILLIN, THE ORIGINAL ANTIBIOTIC, WAS GIVEN TO HUMAN PATIENTS FOR THE FIRST TIME.

1946
RESEARCHERS IN THE UK CONDUCTED THE FIRST RANDOMIZED CONTROLLED DRUG TRIAL.

1953
MOLECULAR BIOLOGISTS JAMES WATSON AND PHYSICIST FRANCIS CRICK DETERMINED THE STRUCTURE OF DNA, DRAWING KEY INSIGHTS FROM CRYSTALLOGRAPHIC IMAGES CREATED BY CHEMIST ROSALIND FRANKLIN.

1954
MASS INOCULATION AGAINST POLIO BEGAN, USING VACCINES BASED ON INACTIVATED VIRUS.

Early 1970s
COMPUTERIZED TOMOGRAPHY SYSTEMS ALLOWED DOCTORS TO CREATE DETAILED CROSS-SECTION IMAGES OF PATIENTS' BODIES USING MULTIPLE X-RAY BEAMS.

Late 1970s
MAGNETIC RESONANCE IMAGING (MRI) SCANNERS PROVIDED NEW INSIGHTS INTO THE COMPOSITION AND BEHAVIOR OF THE BODY'S INTERNAL STRUCTURES.

1990 - 2003
THE HUMAN GENOME PROJECT, A COLLABORATION INVOLVING THOUSANDS OF SCIENCES AND HUNDREDS OF INSTITUTIONS, SPENT 13 YEARS DECODING THE COMPLETE HUMAN DNA SEQUENCE.

1999
POLIO, WHICH HAD KILLED OR PARALYZED HALF A MILLION PEOPLE EVERY YEAR IN THE MID 20TH CENTURY, WAS ENDEMIC IN ONLY SIX COUNTRIES.

2020
WORLDWIDE PROGRAM DEVELOPED AND DELIVERS VACCINES AGAINST COVID19 IN LESS THAN TWO YEARS.

2020
EMMANUELLE CHARPENTIER AND JENNIFER DOUDNA RECEIVED A NOBEL PRIZE FOR THEIR DEVELOPMENT OF CRISPR/CAS9 GENOME EDITING TECHNOLOGY.

2021
RECORD TIME FOR SEQUENCING A COMPLETE HUMAN GENOME FELL TO FIVE HOURS.

2022
THE GLOBAL COUNT OF WILD POLIO CASES DROPPED BELOW TEN.

TO BE CONTINUED

CONTENTS

INTRODUCTION

The life sciences and healthcare industry is undergoing a period of transformation, driven by a combination of factors: continued development of advanced treatments and technology, unprecedented global events and their lasting implications, as well as broader societal trends and imperatives.

In this paper we explore transformation through the lens of key industry trends: the development of patient-centric healthcare models; the continued growth of biopharma and advanced therapies; digital technologies shaping the delivery of healthcare; new ecosystems forming across the industry; the imperative of sustainability; and how events of recent years are demanding a renewed focus on resilience.

These trends are driving the next generation of healthcare services and treatments, but also placing new demands on the logistics operations which enable their delivery. From expanded cold chain capabilities catering for temperatures down to -196°C, direct-to-X delivery models, and sustainable solutions to the development of completely new supply chain archetypes.

We'll also examine the emerging responses to recent challenges in the sector. They include persistent shortages of drugs and medical products, a wide-ranging reassessment of the way healthcare systems plan and prepare for future epidemics and pandemics, and increased pressure on the financial models that underpin regional, national and international health systems.

Each sub-sector within the industry is affected differently, from Consumer Healthcare to Pharmaceuticals, Clinical Trials to Medical Devices, and Public Sector organizations. Deep dives into each area are covered, culminating in identification of the critical supply chain factors which every logistics leader should consider and plan for now to be prepared for the future.

We believe that the coming years will see a transformation in this space, as next level healthcare drives the creation of next level healthcare supply chains.

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CHAPTER 1
AN INDUSTRY IN TRANSFORMATION

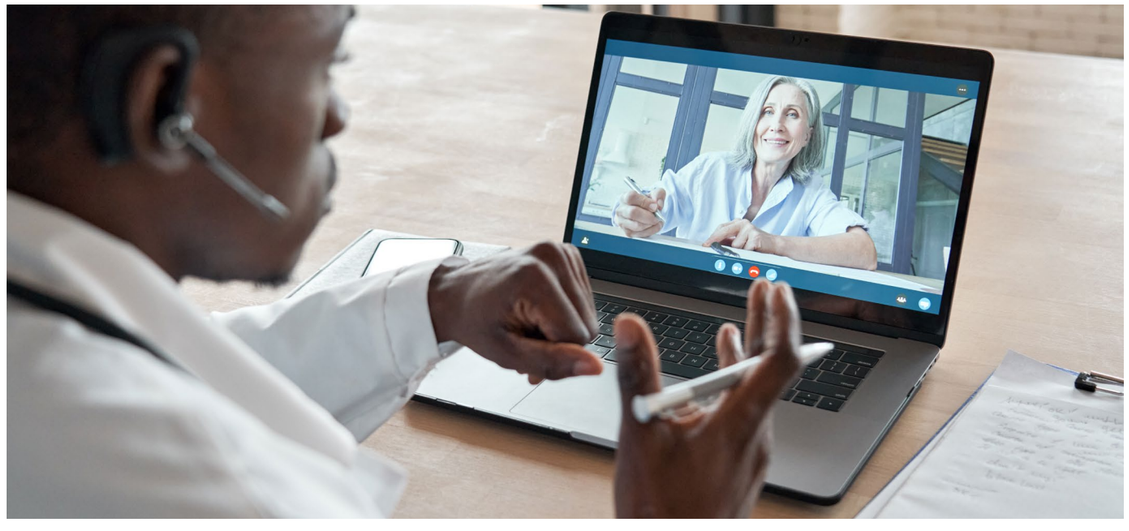
In April 2023, Vertex Pharmaceuticals and CRISPR Therapeutics requested approval from the US Food and Drug Administration for a novel treatment for sickle cell disease and transfusion-dependent beta thalassemia, two debilitating blood disorders.[1] The treatment, known as exa-cel, involves extracting stem cells from a patient's blood and modifying their DNA using gene-editing tools. The altered cells are infused back into the patient's body, where they boost the production of healthy red blood cells. If the regulators are satisfied with the submission, exa-cel will become the first commercial product to use CRISPR gene editing, a technology that has transformed scientists' ability to alter the basic building blocks of life.

The history of modern medicine is a story of transformational ideas and radical innovations, backed by years or decades of grueling research by scientists, physicians and engineers. While some of the ideas that underpin today's treatments stretch back to antiquity, the basis of much medical science is surprisingly recent. Key ideas, such as the germ theory of disease, the significance of hygiene and the importance of data-driven decision-making, did not emerge until the late 19th Century.

The pace of progress has been accelerating relentlessly ever since. There's no clearer evidence of that than the response to the COVID 19 pandemic. In a matter of months, the industry successfully developed and tested novel vaccines, some based on completely new technologies, scaled up production, and delivered billions of doses to people around world. That effort represented a ten-fold increase in speed compared to conventional vaccine development programs.

New therapies are driving a big change in the way healthcare is provided to end users.

Other radically new therapeutic approaches are emerging in multiple areas. In the coming years, these are likely to significantly expand the options available to patients with previously hard-to-treat conditions. New therapies are also driving a big change in the way healthcare is provided to end users. The traditional approach, in which treatment was centralized in clinics and hospitals, will be augmented by new models that deliver care in a wider variety of settings. That shift has significant implications for patients, for providers and for the supply chains that underpin the industry.



CHAPTER 2
CHANGE DRIVERS

The key trends that are reshaping healthcare delivery

1. PATIENT-CENTRIC HEALTHCARE

Today's healthcare supply chains evolved in a world of standardized, mass-produced medicines and centralized treatment delivery. Now both the supply and demand sides of those supply chains are changing.

Upstream, the development of tailored and personalized treatment approaches calls for closer, more responsive links between pharmaceutical manufacturing and end users. Downstream, patients increasingly expect the same choice and convenience in healthcare that they already enjoy when procuring other products and services. "Healthcare consumerism" is changing the way people seek, choose and access treatments. In one recent survey, 90 percent of Generation Z consumers (people born between 1997 and 2010) said they research healthcare costs and options online before visiting a physician.

> *The concept of self-care and taking ownership of personal health has become very important to our consumers over the past three years. Sanofi is working to ensure our customers have access to the products and brand that support this approach."*
>
> **Steve Song, Head of Supply Chain, Consumer Healthcare, Sanofi**

Those changes create demand for new, patient-centric value chains in healthcare, capable of delivering drugs and medical devices to a much wider range of end-user settings. That can involve online ordering of medications and direct home delivery of drugs, medical devices and consumables. They are driving big changes in over-the-counter, consumer healthcare too, as established companies diversify their offerings and new entrants introduce more personalized healthcare products and services targeting specific consumer groups.

> *There is significant opportunity for supply chain and logistics operations to support and promote patient centric healthcare. For example, developing a deeper understanding of how patients want to engage with health services and receive treatments, what information they want access to and in which format, can drive insight to shape logistics services which underpin these elements."*
>
> **Trishna Bharadia, Patient Engagement Consultant & Advocate**

Direct models are also proving their value in other parts of the life sciences value chain. 89% of sponsors use technology to enable a decentralized model in at least one of their clinical trials. That model leads to much higher rates of retention than compared to studies that require participants to attend an out-of-home clinic.

Consumer trends create demand for new, patient-centric value chains in healthcare, capable of delivering drugs and medical devices to a much wider variety of end-user settings.

Direct to X supply chains

As pharma companies, device makers and healthcare providers explore new patient- and consumer-centric approaches, a wide range of different "direct to X" supply chain models are evolving. They include direct-from-manufacturer supply chains that supply hospitals and pharmacies more rapidly by bypassing established distribution channels, as well as different direct-to-patient supply chains that deliver products from pharmacies, hospitals, distributors or the manufacturer.

> *Traditionally the industry has operated on a business-to-business model. We are now experiencing a strong trend towards a patient centric service delivery model. As such, the supply chain needs to be segmented to fulfil differing requirements between these modes."*
>
> **Steen Morch, Head of Commercial Supply Chain, Novo Nordisk**

Biopharmaceutical products accounted for 33% of the global pharmaceutical market in 2020. This is set to reach 41% by 2028.

However they are set up, direct models need to offer the high levels of service, visibility and adaptability. That includes systems that offer a real time view of the status and expected arrival times of shipments and flexible delivery options that meet the varied needs of hospitals, patients and physicians. Upstream, pharma companies and medical devices makers face the challenge of operating their traditional supply chains alongside new direct models. That requires smart approaches to inventory management and places further emphasis on the development of "omnichannel" distribution facilities, capable of handling bulk orders from distributors, consolidating varied orders from physicians and pharmacies, and supplying single items to patients' homes.

Direct-to-patient logistics networks need careful management to ensure compliance with relevant regulations, tight control to prevent theft or product contamination, and high levels of delivery reliability. Regulations in some markets require a qualified pharmacist to sign-off the dispatch of prescription-only products, for example. Data privacy and security is also an extremely sensitive issue for organizations dealing with direct shipments to patients since order information may contain the contact details of individuals along with details of their medication.

2. ADVANCED THERAPIES

The first modern drugs were based on simple chemicals. A molecule of aspirin, for example, contains just 21 atoms. Today, cutting edge treatments are increasingly likely to be far more complex molecules, derived from biological sources. A molecule of insulin, the first widely used biopharmaceutical drug, is more than 30 times larger than aspirin. Monoclonal antibody treatments, such as anti-inflammatory drug adalimumab,[2] may be around 100 times larger.[3] Human cells, used in a growing range of therapeutic applications, are around a hundred trillion times larger than an aspirin molecule.

Biopharmaceutical products accounted for 33% of the global pharmaceutical market in 2020. More than 2,400 new biopharma products are currently undergoing clinical trials, and biopharma's market share is forecast to reach 41% by 2028. Cell and gene therapies are rapidly growing too, although from a smaller starting point. With an experimental product pipeline of more than 1,200 therapies in 2023 the market for Cell and Gene treatments is forecast to grow from around US $9.15 billion in 2023 to US $42.56 billion by 2030.[4]

The biopharma supply chain

Biopharmaceutical products tend to be delicate and expensive. They require careful handling at every stage in the supply chain, with tight temperature controls and rigorous tracking. The pharmaceutical industry already spends more than US $17 billion per year on cold chain logistics.

> *As personalized medicine becomes widely utilized for a broad range of difficult-to-treat diseases, pharmaceutical companies will be forced to rethink their existing manufacturing, distribution and supply lines. This includes developing new distribution models, cold chain and specialized dedicated logistics services to support new modalities."*
>
> **Nico Sacco, VP, Worldwide Planning, Customer Management and Deliver, Janssen Pharmaceutical**

As biopharma's share of the overall pharmaceutical market goes up, the demands placed upon supply chains will increase exponentially. Cold chains will need to reach further, and cope with a wide variety of different temperature requirements, from conventional refrigerated shipments at 3°C to ultracold frozen product supply chains at -70°C or, where cryogenic temperatures are required, as low as -196°C.

Managing complex supply chains in a regulatory compliant, cost-effective way will demand rigorous end-to-end control. That is both a technical and an organizational challenge. Advances in shipment tracking, enabled by Internet of Things (IoT) technologies such as smart sensors and wireless communication will allow shippers and customers to see the whereabouts of products in real time, and alert them to temperature excursions or other events that threaten their viability. Preventing such problems will call for disciplined execution, with well-trained operators, robust processes, highly controlled deviation management and fail safes at every step in the supply chain.

Larger, more complex cold chains will also create challenges around packaging. The need to control costs and reduce the environmental impact of packaging waste is likely to drive interest in innovative technologies and business models, including the wider use of returnable packaging systems and the development of new businesses dedicated to the management of closed-loop packaging supply chains that offer high levels of quality, availability and regulatory compliance.

Managing complex supply chains in a regulatory compliant, cost-effective way will demand rigorous end-to-end control. That's both a technical and an organizational challenge.

Cryogenic temperatures are required, as low as

-196°C.

Vaccines in focus

Global demand for vaccines more than doubled during the COVID-19 pandemic, as health systems rushed to deliver new vaccines to their populations. That called for the creation of extremely large-scale global supply chains, many using new delivery models that saw doses shipped directly from manufacturer to point of use.

Today, researchers are developing vaccines that work against new targets, such as cancers. Meanwhile, manufacturers, governments and healthcare providers are turning their attention of preparation for future outbreaks of communicable disease. Much of that work is focused on filling gaps in coverage exposed by the pandemic. They include the development of supply chains capable of delivering vaccines in high volumes to remote regions with poor infrastructure, and the development of regional manufacturing capacity to reduce reliance on a small number of global production locations.

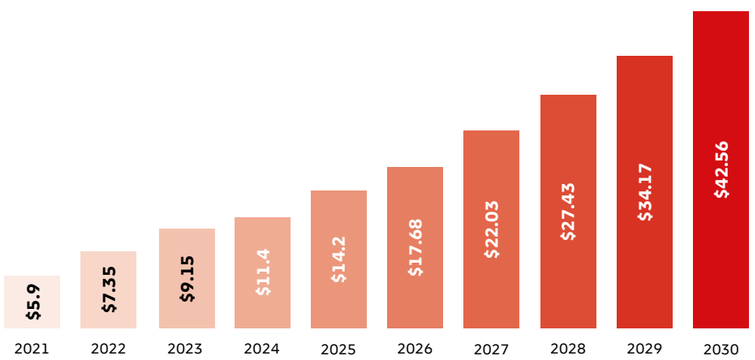
Cell and gene therapy supply chains

Cell and gene therapy products are complex, targeted products made in small batches. That drives up costs, and increases the critical importance of every shipment. Autologous cell therapies, where treatments are derived from an individual's own blood, require a tightly controlled two-way supply chain for each patient. The physical requirements of the supply chains used for these products are like those seen in biopharma, but the organizational requirements differ significantly.

> *Advanced therapies are a strategic growth area, but come with a significantly different set of characteristics and handling requirements. A key part of our supply chain strategy is to build capabilities which enable a highly tailored service to a smaller group of patients."*
>
> **Steen Morch, Head of Commercial Supply Chain, Novo Nordisk**

Demand for Cell and Gene therapies is volatile and unpredictable, but delivery must be fast, accurate and tightly controlled.

Cell and gene therapy market size, 2021 to 2030 (US $ billion)



Demand for these products is volatile and unpredictable, but delivery must be fast, accurate and tightly controlled. That requires highly responsive supply chain setups and logistics operating models, which may be global in scope. Ensuring personalized treatments reach the right patient every time creates rigorous chain-of-identity and chain-of-custody requirements. And because these treatments are still relatively rare in clinical settings, the final-mile service needs to be seamless, intuitive and designed around the needs of the patient and their physician.

3. DIGITAL HEALTHCARE

Digital technologies are driving advances across the healthcare value chain. They are accelerating drug discovery,[5] helping clinicians identify the best treatment options for their patients,[6] and even automating the distribution and dispensing of drugs using robots in healthcare settings.[7] Digital technology is a key enabler of new healthcare delivery paradigms too, from the development of technologies that allow the remote monitoring of patient condition or compliance with treatment regimes,[8] to the use of apps and videoconferencing tools for doctor-patient consultations. The fastest growing product category in consumer healthcare today is digital and wearable devices that allow owners to collect data about their own health.

> *Digitalization can be a key differentiator throughout the industry. Clinical Trial complexity is evolving and the amount of data that we can leverage consistently in the overall ecosystem to deliver patient benefit is growing."*
>
> **Markus Ofenloch, Head of Clinical Distribution, Roche**

These approaches have proved popular where they have been implemented, and surveys suggest that users have an appetite for further innovation. In one survey, 62% of patients said they would welcome the option of virtual reality (VR) services in healthcare, for example. The technology necessary to support highly digitized healthcare delivery has become more sophisticated and more accessible too. The market for health and wellness focused wearable devices has already passed 320 million units per year, for example. And the evolution of advanced analytics and artificial intelligence (AI) technologies helps healthcare providers draw valuable insights from high volumes of data.

Digital technology is a key enabler of new healthcare delivery paradigms, from remote patient monitoring to apps and videoconferencing for doctor-patient consultations.

320 million

The market for heath and wellness focused wearable devices has already passed 320 units per year.

62%

of patients would welcome VR healthcare services as an alternative to traditional healthcare.

Digitizing the supply chain

Digitalization is reshaping healthcare supply chains too, with multiple opportunities for participants to improve the quality, security, agility and cost-effectiveness of their supply networks with new technology and advanced digital tools. Smart, connected sensors track the location and condition of shipments. Asset tracking technologies allow drug and device suppliers to monitor the status of consignment stocks at hospitals or even in patient's homes, paving the way for seamless, automated replenishment. Blockchain technologies can support information exchange and supply chain coordination in complex, multi-stakeholder networks. Blockchains can also be used to verify compliance and stop counterfeit products entering the supply chain. And smart analytics technologies, including digital twins, can be used to optimize material flows and inventory disposition, helping supply chain participants to reduce waste and maintain availability without excess cost.

> *There are huge opportunities to be unlocked through digitalization of the supply chain. End-to-end visibility will help us to precisely identify when and where demand is created, in turn driving efficient operational processes from order to shipment, fulfilling a specific demand request."*
>
> **Ashok Theyver, Global Head of Medical Device Supply Chain, Abbott**

Today, supply chain and healthcare digitization initiatives are usually designed and implemented independently. Bringing those two sides of the digital equation together could pave the way for a further step change in efficiency, speed and convenience. Examples of such an approach might include AI systems that take the current availability of specific medications into account when making recommendations for doctors, or which automatically create and order and reserve stock ready for dispatch when the supervising physician signs off the prescription. In hospital settings, dispensing robots could generate replenishment orders automatically based on real time data on demand for drugs and devices on the ward.

The key barrier to end-to-end digitalization of healthcare supply chains is not the availability of the suitable technologies, but data integration, access control and governance within a single analytics ecosystem.

The key barrier to such end-to-end digitalization of healthcare supply chains is not the availability of the suitable technologies. The required data already exists in the value chain, but today it is distributed across multiple different systems with limited interconnections. Integrating this data into a common platform would allow value chain participants to derive new insights and automate activities to much greater extent than currently possible. Such integration would require rigorous management of security, patient privacy and governance issues.

> *Janssen Supply Chain recognizes that digitalization is essential to ensuring a stable, "intelligent" supply chain amidst mounting external challenges. Janssen's Planning team, in collaboration with Information Technology (IT), has built an integrated global planning system that enables better planning decisions, based on enhanced demand visibility and improved reaction times, which leads to more agile responsiveness to market and patients' needs."*
>
> **Nico Sacco, VP, Worldwide Planning, Customer Management and Deliver, Janssen Pharmaceutical**

4. NEW ECOSYSTEMS

Advances in science and technology are driving shifts in the structure of the global healthcare industry. To address unmet clinical needs, or to bring new therapies to market quickly and scale, life sciences companies are collaborating with new partners or working together in new ways. Recent examples of new collaborations between healthcare players and technology companies have created novel digital offerings and services.

The COVID vaccine programs are seen by some in the industry as a template for a new way of working in healthcare, in which close collaboration between research organizations, pharma companies and regulators allows the development, testing and approval cycle for new therapies to be accelerated by as much as tenfold.

Many factors which supported a compressed timeline for COVID vaccine development were unique to the pandemic and are unlikely to be successfully replicated at scale across ongoing and future trials e.g., 24/7 lab operations and availability of government funding. Others, such as redesigning internal decision making and optimizing operational processes hold greater potential to shorten trial timelines. However, it remains to be seen whether the innovative approaches pioneered during the crisis will result in faster product cycles in other areas of healthcare, or whether the industry will revert to pre-pandemic methods.

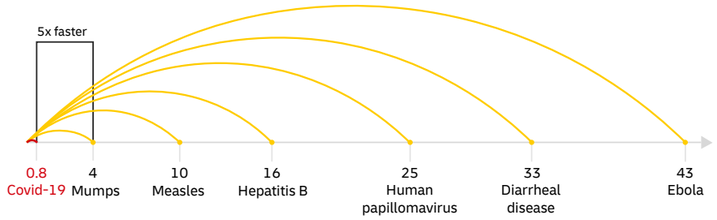
Supply chain at the center

These new collaborations allow the healthcare sector to innovate at scale, by drawing upon expertise of multiple organizations to create new product offerings and service solutions. And for many of tomorrow's healthcare innovations, advanced supply chain and logistics capabilities will be a key piece of the puzzle.

> *The pandemic paved the way for how we can work together in the future: government entities, regulatory agencies, supply chain providers etc. Processes were streamlined and barriers removed in an unprecedented way to enable the movement of our respirators between countries."*
>
> **Rob Varner, VP Americas Distribution & Logistics, Medtronic**

Advances in science and technology are driving shifts in the structure of the global healthcare industry.

Vaccination Innovation
Time from infectious agent infection to vaccine approval in US, yrs



Covid 19 vaccination had received emergency use approval, whereas the other vaccines had received biologics licence application approval in the stated time. [9]

Development cycles for the COVID vaccines accelerated by

10 times

The success of advanced therapies, patient-centric delivery models and digital health services depends upon the effective orchestration of multiple stakeholders, with carefully coordinated flows of products and information between individuals and organizations. Other industries that depend upon the flawless execution of complex supply chains, such as the automobility sector, increasingly rely on specialist partners to manage those flows. Automotive manufacturers, for example, often use Lead logistics Partner (LLP) models in which a specialist supply chain player is responsible for the coordination of flows from suppliers to the point of use. Many large healthcare providers also rely on external logistics organizations to handle the critical flows of medicines and devices through the whole supply chain.

Supply chain collaboration between healthcare players has plenty of potential benefits too. As other sectors have shown, adopting common standards and flows can improve the cost effectiveness of returnable packaging schemes and container pooling solutions, reducing costs and environmental impact. Where multiple healthcare players service the same customers, load sharing in trucks and other transport assets can improve utilization, allowing higher service levels, reducing transport-related emissions and cutting costs. Sharing supply chain infrastructure such as warehouses can help companies reach critical mass faster, simplifying entry into new regions.

Tighter regulatory regimes are also ramping up demand for specialist logistics expertise in healthcare ecosystems. In Europe, the 2021 Medical Device Directive, for example, set new expectations for the compliant handling of medical devices in the supply chain.

5. SUSTAINABLE SOLUTIONS

Like every other industry, the healthcare sector is looking for ways to cut its carbon emissions and reduce the impact of its activities on global ecosystems. This is even more pressing for the healthcare industry which accounts for 4-5% of global CO2 emissions,[10] more that many other high-emission sectors. Progress is being made; by 2021, 75% of pharmaceutical companies had achieved reductions in their Scope 1 and Scope 2 emissions that were in line with efforts to meet the Paris Agreement goal of limiting global warming to 1.5°C.

However, there is still much more to be done. Pharmaceuticals and Chemicals are the largest contributor to scope 3 emissions for the provision of national health services, accounting for 18%, whilst Medical Devices and Supplies are the second highest contributor with 7%. With emissions of 1,664 tons of carbon dioxide per million US dollars of revenue, the pharma sector is more carbon-intensive than the global automotive sector. [11]

The healthcare sector also generates large quantities of material waste. The World Health Organization estimates that the global healthcare sector generates 300 million tons of plastic waste every year, with half of that coming from single use equipment and packaging.

With 1,664 tons per million US dollars of revenue, the pharma sector is more carbon-intensive than the global automotive sector.

The challenge of sustainable supply chains

Reducing waste and cutting emissions will be a key priority for the sector in the coming years, and supply chains will play a central role in that effort. This represents new ground for healthcare players, which have traditionally prioritized availability, safety and regulatory compliance in their supply chains.

> *With a goal to be carbon neutral by 2045, sustainability is one of our core strategic pillars in global operations and supply chain at Medtronic. We are working across many different areas to make this possible, from running facilities with solar power to buying energy credits and using more electric vehicles."*
>
> **Rob Varner, VP Americas Distribution & Logistics, Medtronic**

Bringing sustainability into the mix will add an extra layer of complexity for stakeholders, but supply chains and logistics processes also present a largely untapped opportunity to make significant reductions in the carbon footprint and wider environmental impact of the healthcare sector. Those opportunities will come from multiple sources, including carbon neutral warehousing and alternative transportation fuels, returnable packaging technologies, and optimized inventory and delivery models that ensure high levels of availability while minimizing waste.

> *Sanofi works closely with customers and suppliers to optimize transport modes and routes. However, the challenge of sustainability is far broader and requires a different mindset to drive different choices for the future; we can work collaboratively within the industry to drive accelerated progress."*
>
> **Steve Song, Head of Supply Chain, Consumer Healthcare, Sanofi**

The global healthcare sector generates 300 million tons of plastic waste every year.

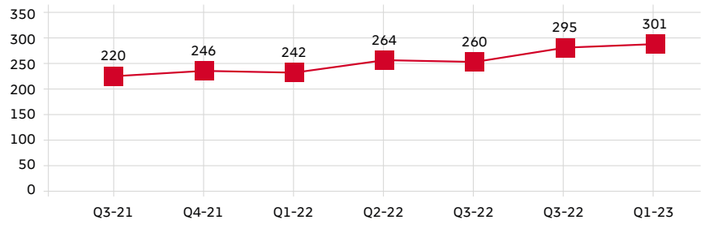
Reducing waste and cutting emissions will be a key priority in the coming years, and supply chains will play a central role in that effort.

6. THE RACE FOR RESILIENCE

Over the past three years, the world's healthcare supply chains have been subjected to unprecedented stress. The Coronavirus pandemic was the first big shock, driving significant spike in demand for the products needed to provide care and protect patients and citizens from the risk of infection.

As the immediate effects of the crisis receded, the sector has struggled to return to business-as-usual. Health systems around the world have faced shortages of drugs and equipment, including widely used antibiotics, painkillers, insulin, and implantable cardiac devices.[12]

US national drug shortages by quarter



These supply disruptions have multiple causes. As societies opened after pandemic-era restrictions, for example, increased social mixing drove a spike in non-Covid respiratory infections. Concerns about potential shortages encouraged stockpiling of medicines by users, exacerbating supply problems. Healthcare products have been caught up in wider global supply chain turmoil too. The surge in demand for physical goods as economies reopened caused demand to exceed supply in multiple areas, from logistics capacity to energy, basic raw materials and workers. And the resulting cost inflation presented significant challenges for some healthcare players. Generic drug manufacturers, for example, may be locked into long-term contracts with key customers that stop them passing on higher input costs. On the other side of the equation, steep increases in the cost of drugs and devices not covered by long term supply contracts is placing further strain on the finances of national health systems.

The great supply chain rethink?

The challenges of the pandemic and its aftermath are encouraging the healthcare sector to take a fresh look at the way supply chains are structured. Providers in some regions are frustrated that access to critical products during the pandemic was affected by their inability to compete with richer countries for limited supplies. And even the most well-funded healthcare systems have found themselves exposed to supply problems caused by issues in highly centralized, global supply chains.

In parallel with similar discussions in other sectors, these issues are encouraging governments to explore the possibility of national or regional supply chain localization for critical healthcare products. This could involve a reversal of recent trends in the sector, with processing capacity for raw materials, active pharmaceutical ingredient (API) production, and the formulation and packaging of finished products all taking place closer to end-use markets.

The surge in demand for physical goods as economies reopened caused demand to exceed supply in multiple areas, from logistics capacity to energy, basic raw materials and workers.

The challenges of the pandemic and its aftermath are encouraging the healthcare sector to take a fresh look at the way supply chains are structured.

> *"Geo-political factors are informing our strategy and driving a higher level of geographical focus. Distribution networks and manufacturing sites will be centered on geographical clusters with a closer proximity to all markets."*
>
> **Steen Morch, Head of Commercial Supply Chain, Novo Nordisk**

SUPPLY CHAIN IMPLICATIONS BY SECTOR

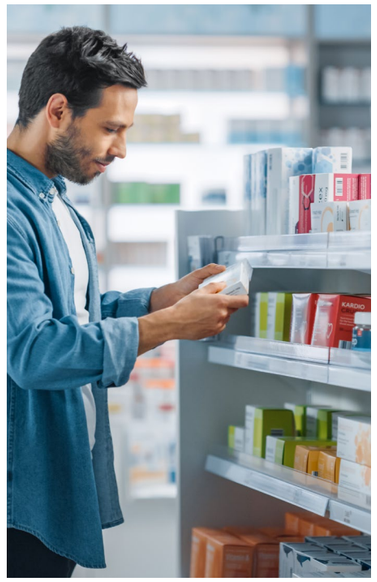
Different parts of the life sciences and healthcare industry will be affected in different ways by these big ongoing trends. Let's take a sector-by-sector view.

MEDICAL DEVICES

- The medical devices sector is extremely diverse, covering a broad range of product categories from bandages and syringes to surgical robots and multi-million-dollar imaging systems.
- Healthcare consumerism is driving patient centricity with increasing focus on E-Commerce, contactless treatments and direct delivery models. Digitalization is a key driver for new treatments and diagnostic techniques.
- Tighter regulatory frameworks and global harmonization of standards are driving demand for improved visibility and distribution control, including additional regulation around temperature controlled shipments.
- As a key industry challenge, inventory optimization and obsolescence management is critical to control costs in the face of more cooling economic conditions and ongoing pressure on public health financing.
- Cost and sustainability concerns are further increasing the pressure on device makers to operate efficiently whilst maintaining product availability in a timely and compliant way. This extends to ensuring the operational readiness of large capital equipment through availability of aftermarket service parts and returns processes for asset recovery and supporting sustainability.

CONSUMER HEALTHCARE

- Pharmaceutical companies are creating standalone consumer divisions to drive a more differentiated market approach, which includes a segmentation of supply chains and distribution channels to serve the specific needs of consumer healthcare.
- As consumers take a more active role in decisions related to their health and wellbeing, demand for over the counter (OTC) products is increasing. These products, which include items previously only available via prescription, require secure, seamless and cost-effective supply chains.
- Consumers also expect more choice, including access to products via multiple channels and the availability of digital alternatives to conventional pharmacies. Consumer healthcare players usually rely on channel partners and online platforms to serve these channels. As their importance grows, product makers face the challenge of managing service and delivery experience over which they have only limited control.
- Wearables and tracking devices enable consumers to own and track their health, medication intake, exercise, and wellness. Full transparency and rigorous protection in the supply chain will be essential to the delivery of a good user experience and ensure consumer trust.



PHARMACEUTICALS

- New therapeutic approaches, combined with an increase in direct deliveries to patients, will require new supply chain models and greater segmentation of channels for different customer groups.
- The greater instability of biopharma products will require increased use of cold chain logistics services. End-to-end real time condition monitoring will be needed to ensure product integrity.
- Cost pressure in healthcare systems will drive an increased focus on inventory, flow and usage of pharmaceuticals to optimize allocation and reduce obsolescence.
- Sensors, analytics and collaboration tools will have a significant impact across all stages in the delivery of healthcare – from R&D, through the manufacturing, storage and distribution of products, to diagnostics and monitoring.

CLINICAL TRIALS

- The global clinical research market is undergoing a major transformation. The shift away from traditional trials to direct-to-patient clinical trials requires logistic links to multiple locations, coordinating pick-up and delivery over long distances within extremely tight timeframes.
- Identifying and recruiting suitable trial participants is becoming more challenging too, as researchers develop treatments for rarer conditions, and adapt their trial designs to test new products against more diverse patient populations. That is creating a need for truly global supply chains that can provide full loop services across all temperature ranges, even in countries with less developed healthcare and logistics infrastructure.

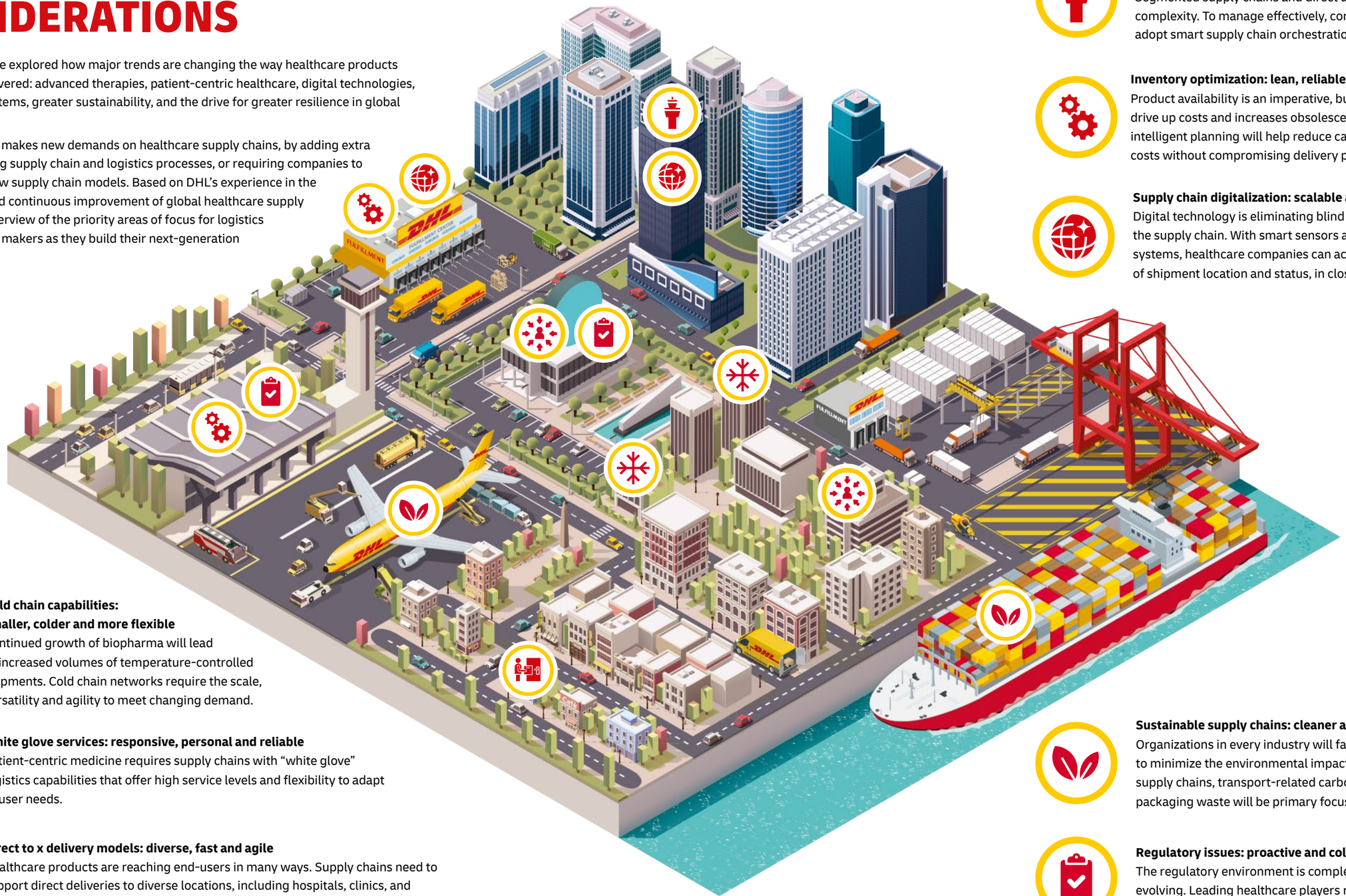
GOVERNMENTS AND NON-GOVERNMENTAL ORGANIZATIONS

- The rising cost of healthcare provision is a challenge for governments around the world. This is creating significant demand for supply chain solutions that enable a high level of care to be delivered at a lower cost. Key levers include the use of digital tools to support diagnoses and patient management and digitally enabled supply chains to maximize the availability and utilization of drugs and devices while minimizing waste.
- COVID19 demonstrated the broad effects a global infectious disease can have and the importance of investment in pandemic preparedness, including supply chains and distribution models.
- Access to medication is a fundamental component of the right to health. The equitable distribution of vaccines and essential treatments requires a global logistics network to reach low and middle-income countries.
- Providing humanitarian logistics requires best in class supply chain expertise to ensure compliant and cost effective storage and distribution of goods. Best in class humanitarian initiatives require a close collaboration between NGOs, governments, healthcare providers and logistics companies.

CHAPTER 3
KEY SUPPLY CHAIN CONSIDERATIONS

In the last chapter, we explored how major trends are changing the way healthcare products and services are delivered: advanced therapies, patient-centric healthcare, digital technologies, new industry ecosystems, greater sustainability, and the drive for greater resilience in global healthcare systems.

Each of those trends makes new demands on healthcare supply chains, by adding extra complexity to existing supply chain and logistics processes, or requiring companies to adopt completely new supply chain models. Based on DHL's experience in the design, execution and continuous improvement of global healthcare supply chains, here's our overview of the priority areas of focus for logistics leaders and decision makers as they build their next-generation supply chains.



Supply chain orchestration: segmented, coordinated and optimized
Segmented supply chains and direct delivery adds complexity. To manage effectively, companies will need to adopt smart supply chain orchestration approaches.

Inventory optimization: lean, reliable and digitally visible
Product availability is an imperative, but big inventory buffers drive up costs and increases obsolescence risk. Visibility and intelligent planning will help reduce capital and operating costs without compromising delivery performance.

Supply chain digitalization: scalable and accessible
Digital technology is eliminating blind spots throughout the supply chain. With smart sensors and connected systems, healthcare companies can achieve better visibility of shipment location and status, in close to real time.

Cold chain capabilities: smaller, colder and more flexible
Continued growth of biopharma will lead to increased volumes of temperature-controlled shipments. Cold chain networks require the scale, versatility and agility to meet changing demand.

White glove services: responsive, personal and reliable
Patient-centric medicine requires supply chains with "white glove" logistics capabilities that offer high service levels and flexibility to adapt to user needs.

Direct to x delivery models: diverse, fast and agile
Healthcare products are reaching end-users in many ways. Supply chains need to support direct deliveries to diverse locations, including hospitals, clinics, and consumers' homes.

Sustainable supply chains: cleaner and greener
Organizations in every industry will face greater pressure to minimize the environmental impact. For healthcare supply chains, transport-related carbon emissions and packaging waste will be primary focus areas.

Regulatory issues: proactive and collaborative
The regulatory environment is complex and constantly evolving. Leading healthcare players recognize a proactive approach can deliver multiple benefits.

KEY SUPPLY CHAIN CONSIDERATIONS CONTINUED

COLD CHAIN CAPABILITIES:
Smaller, colder and more flexible

The continued growth of biopharmaceutical treatments will lead to increased volumes of temperature-controlled shipments. Logistics decision makers will need to ensure that their cold chain networks have the scale, versatility and agility to meet changing demand.

- Cold chains may need to cope with a wider range of temperatures, including ultra-cold shipments, and to handle smaller consignments for high-value and personalized treatments with volatile demand characteristics.
- Points across the network must be equipped to deliver advanced cold chain services, including dry icing, re-icing or shipper pre-conditioning. Logistics assets will need to be upgraded to include more advanced condition monitoring and tracking technologies, and specialized packaging solutions such as liquid nitrogen shippers.
- Networks will have to develop in alignment with the evolving needs of the biopharma industry, expanding their scope, accessing new markets and offering a wider range of final-mile solutions in established territories.

WHITE GLOVE SERVICES:
Responsive, personal and reliable

Patient-centric medicine requires supply chains that can deliver the right product at the right time, directly to the hands of patients or care providers. That calls for “white glove” logistics capabilities that offer high service levels and the flexibility to adapt to the needs of users.

- Logistics systems must be able to respond immediately and deliver swiftly when demand is volatile and unpredictable. They must be designed to manage the compliant, end-to-end transport of small, personalized shipments, including direct pickup-from manufacturing laboratories and delivery to hospitals and other care settings.
- Logistics personnel must be trained and equipped to manage additional technical requirements, such as the preconditioning of packaging. And they must be prepared for interaction with clinical professionals in busy healthcare settings.
- The supply chain must be able to achieve and maintain the highest service levels at scale to accommodate growth in personalized therapies.

DIRECT TO X DELIVERY MODELS:
Diverse, fast and agile

As healthcare delivery models and user preferences evolve, products are reaching their end-users in many ways. Supply chains will need to accommodate those differences, offering direct deliveries to diverse locations, including hospitals, clinics, pharmacies, and consumers' homes.

- Pharmaceutical companies, medical device makers and consumer healthcare manufacturers will need access to logistics networks that can serve diverse end-user groups, while maintaining high standards of quality and delivery performance.
- Supply chains must integrate seamlessly into the end-to-end patient experience (e.g., online doctor consultation and prescription receipt, online pharmacy, direct delivery).
- Supply chain segmentation is required to serve customers through multiple channels and support direct patient deliveries.
- To protect their reputations, companies will need to ensure that customers' supply chain interactions and delivery experience are always in line with brand values.

SUPPLY CHAIN ORCHESTRATION:
Segmented, coordinated and optimized

The growth of personalized supply chains and direct delivery models adds significant complexity to healthcare supply chains. To cope with that complexity without compromising operational efficiency and reliability, companies will need to adopt smart supply chain orchestration approaches.

- Supply chain segmentation strategies enable different processes, material flows and service levels for different customer and product groups.
- Once segmented, processes must be designed to manage coordination across these supply chain elements, incorporating multiple service partners and organizations (e.g., clinical professionals, biopharma companies, manufacturing facility scientists, logistics service providers).
- After coordinated operations are bedded in, holistic optimization initiatives drive out waste and improve service levels.
- Advanced digital tools support multiple dimensions across the end to end supply chain: strategy and design for optimal network setup and configuration, forecasting and planning to ensure the right resources and assets are in place and direct management for optimized operational execution transport or shared supply chain infrastructure.

INVENTORY OPTIMIZATION:
Lean, reliable and digitally visible

High availability is a healthcare supply chain imperative, but relying on big inventory buffers drive up supply chain costs and exposes companies to the risk of excessive obsolescence. With smarter planning and execution, healthcare companies can reduce the capital and operating costs of their supply networks, without compromising delivery performance. Key levers include:

- Continuous improvement of demand forecasting and production planning capabilities, with the incorporation of new sources of data and new analytical techniques.
- Dynamic adaptation of inventory targets in response to changes in demand, or shifts in production and logistics processes.
- Visibility and control of last mile distributed inventory in combination with automated and fast replacement cycles to reduce stock levels, increase accuracy and speed of invoicing while ensuring product availability.
- Establishing platforms and processes with healthcare providers to enable digital visibility of demand signals and provide data-led insights to drive informed optimization decisions.

SUPPLY CHAIN DIGITALIZATION:
Scalable and accessible

Digital technology is rapidly eliminating the blind spots that make supply chains hard to manage. With smart sensors and connected systems, healthcare companies can achieve visibility of the location and status of every shipment, in close to real time. For many players, the emerging challenge is learning how to use all that data to optimize supply chain performance. That requires:

- A robust data platform strategy, with appropriate governance and access control to ensure that data can be used widely across the organization, with compromising security, confidentially or compliance.
- Organizational structures, systems and processes, to derive maximum value from digital data. That might include a digital supply control to manage supply chain execution, or logistics engineering teams that use data on product flows and delivery performance to optimize supply chain design.
- A technology portfolio approach that balances standardization and flexibility. Using common technologies wherever possible provides benefits of scale and simplicity, but companies should ensure their systems are ready to accommodate future innovations, or the requirements of specific use-cases.

SUSTAINABLE SUPPLY CHAINS:
Cleaner and greener

In the coming years, organizations in every industry will face greater pressure to minimize the environmental impact of their operations. For healthcare supply chains, transport-related carbon emissions and packaging waste are likely to be areas of focus. Companies have significant opportunities to make improvements in several key areas.

- Optimizing existing supply chains to reduce carbon emissions, for example by reducing miles driven, maximizing the utilization of transportation assets or switching to lower emission transport modes.
- Adopting new and emerging low carbon technologies, such as highly fuel efficient vehicles, electric mobility solutions or the use of sustainable fuels for air and sea transport.
- The increased use of returnable, reusable and repairable packaging solutions, and the optimization of product designs for multiple uses, repair and end-of-life recycling.
- Logistics and supply chain leaders can take advantage of opportunities for cross-supply chain collaboration with other healthcare players, such as shared reusable packing solutions, shared transport or shared supply chain infrastructure.

REGULATORY ISSUES:
Proactive and collaborative

The healthcare regulatory environment is complex and constantly evolving. That can leave companies on the back foot, constantly struggling to ensure compliance in their supply chains. Leading healthcare players now recognize that a more proactive approach can deliver multiple benefits. That might include:

- Preemptively identifying and acquiring the supply chain capabilities need to comply with upcoming changes in regulations.
- Continually adapting process to take advantage of increased regulatory alignment between regions.
- Exploring opportunities to work with regulators to accelerate product development or streamline supply chain operations.

CHAPTER 4
TAKING THE NEXT STEP

In this report, we have looked at the way healthcare is changing, driven by technological advances and the evolving demands of patients, providers, regulators and governments. We have shown how these changes will require the sector to rethink its supply chains, and we have outlined the key supply chain and logistics capabilities that will underpin the delivery of next generation healthcare systems.

These major trends will affect companies in different ways, and the demands placed upon every supply chain will be unique. The key to supply chain excellence lies in defining a clear vision of your organization's emerging priorities. By understanding how your supply needs to operate tomorrow, you can identify the capabilities that will be required to make that happen. Then it's time to take stock. Does your organization already have access to all the capabilities its next generation supply chains will need? Which capability gaps are most critical?

With a clear endpoint in mind, and an understanding of what is needed to get there, it is time to act. Define the high priority initiatives for your supply chain, identify partners with skills, technologies and experience to help you get there, and take the first bold steps on your next generation supply chain journey.

Want to discuss your next step? Then reach out to us
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ABOUT DHL LIFE SCIENCES & HEALTHCARE

DHL Life Sciences & Healthcare (LSH) provides high quality, compliant logistics services to the world's leading pharmaceutical, medical device and health companies. We operate a truly global logistics network with more than 170 Good Distribution Practice (GDP) qualified warehouses and more than 20 Good Manufacturing Practice (GMP) certified sites. Our workforce includes more than 9,000 trained and certified Life Science & Healthcare specialists.

Our Air Thermonet temperature-controlled distribution network includes more than 120 stations around the world, and our Ocean Thermonet network has more than 60. We operate sensor-monitored packaging and dry ice facilities in over 170 countries.

Our European Cold Chain road freight network serves more than 30 countries, with GDP-certified cross-dock facilities for fast, efficient and fully compliant road distribution operations. Our clinical trials network of 25 depots provides specialized logistics support to operations in 80 countries and counting.

DHL's World Medical Express serves >180 countries and supports a growing network of cold chain capabilities and services.

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