THE FUTURE OF LIFE SCIENCES AND HEALTHCARE LOGISTICS

A DHL perspective on key trends and technologies

June 2017
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From 2015 to 2019, global healthcare spending is expected to increase by 4.3% annually. Along with growth, the sector is going through significant transformation of its operating models and supply chains. These include three key developments:

First, there are significant pressures from governments and regulatory authorities to lower costs, and deliver more affordable and quality healthcare. From patient diagnosis to final delivery of products, the industry will need to adopt new commercial and service models across all touch-points in the value chain to be cost-competitive. This is forcing businesses to rationalize their portfolios and re-evaluate how they should play.

Second, consumer behavior has undergone rapid change. Consumers increasingly receive services through online channels and mobile applications, driving significant growth in areas such as tele-health and e-pharmacies. Better-informed patients also demand higher service levels.

Lastly, digitalization and related technology advancements are opening up new possibilities for life sciences & healthcare companies to enable different types of services and reduce costs.

These developments represent opportunities and threats for the life sciences & healthcare industry. The industry is currently ranked in the bottom 20th percentile of the Industry Digitization Index, even behind the public sector. Businesses which are able to reinvent themselves to meet the demands of the market will be the winners of tomorrow.

There is a sense of urgency to transform now; and supply chains play a crucial role in this transformation. In this report, we seek to answer:

1. Which trends and technologies can enable this transformation in the sector supply chains, and how?

2. What are the concrete solutions and opportunities for action?

This report serves as a guide to foster collaborative discussions and innovative projects with our customers and partners as we strive to be the provider of choice for delivering healthcare to the world.

Enjoy the read!

Scott Allison
President
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DHL Customer Solutions & Innovation

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1 https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/gx-lshc-2016-health-care-outlook.pdf
2 https://hbr.org/2016/04/a-chart-that-shows-which-industries-are-the-most-digital-and-why
1 INTRODUCTION

Picture the patient journey in the year 2027:

“Jane, a 40-year old working professional living in an urban city, has a lot to handle. Apart from a full-time job, Jane is also raising two children and caring for elderly parents. Jane is at risk for diabetes due to family history and needs regular monitoring.

She prefers to book her regular checks at a hospital that meets her desired level of service and price. She chose the hospital that offers booking appointments via a hospital app and virtual consultations, reducing her hospital trips. She receives a reminder one day before the appointment to test her blood sugar. Using a smart monitoring kit, Jane self-checks her blood sugar which updates the readings directly to the hospital. Her smart bracelet captures data on heart rate, blood pressure, sleep patterns, time of taking current medication, and other vital information. The bracelet also transmits the readings to the doctor’s monitoring system.

Based on patient’s data, the doctor recommends a 3-D printed medicine customized for her treatment and genetics. By scanning her prescription via the hospital app, Jane orders her medicines to be delivered directly to her house. She also receives a reminder on her app to book a home care session for her elderly parents. With Jane’s parents unable to leave the house, the professional healthcare provider visits the home to conduct a check-up. Knowing the patient’s history, the provider also brings the specific test kits and medication required for them. All at the convenience and safety of Jane’s home.”

Jane’s experience outlines the healthcare trends of self-care, remote monitoring and virtually-connected platforms. While this scenario seems visionary, examples that exist today suggest we are not so far away. Re-designed for home care, the Medtronic Hemodialysis machine enables dialysis care from home. Abbott’s smartphone-enabled cardiac monitor enables remote engagement with doctors.

Moving towards a patient-centric healthcare approach will require a transformation in sector supply chains. Supply chain managers must stay abreast with technologies and leverage them to support this transformation.
Derived from the Logistics Trend Radar, published by DHL, this report dives into six key trends and technologies that play the biggest role in transforming the Life Sciences & Healthcare (LSHC) supply chains. These are summarized below.

1. **Global healthcare analytics market is set to grow by 24% by 2020.** Advancing Data Analytics combined with real time view of operations will predict demand more accurately and optimize supply chains including storage, inventory, routing and risk planning. Linking real-time view of demand to supply enables optimization across the whole value chain, from manufacturing to consumption.

2. **Internet of Things (IoT) devices for healthcare will grow 6 times to 646 million by 2020.** IoT-enabled tagging technologies allow tighter control of product inventories across supply chains, reducing waste while increasing service levels and availability. Stronger links between physical products and data will also aid the industry in its ongoing battle against theft and counterfeiting.

3. **Manufacturers are building up Healthcare On-Demand models in response to increasing online and home care channels.** The online pharmaceutical markets will grow to $128 billion by 2023. This will require solutions for direct-to-consumer deliveries and e-commerce fulfillment strategies to increase speed and flexibility in last-mile. LSHC manufacturers will go further downstream into hospitals to enable on-demand delivery of devices from medical parts to surgery kits.

4. **To meet increasing complexity and service requirements without adding excessive costs, LSHC supply chains will turn to Robotics and Automation.** Collaborative robots that work safely alongside humans and Autonomous Guided Vehicles (AGVs) can speed up simple operations. Unmanned Aerial Vehicles (UAVs) are available to serve remote areas and meet emergency delivery requirements.

5. **New ways of displaying and presenting information will make LSHC supply chain operations more accurate and efficient.** Augmented Reality enables increasing picking efficiency and reduces counterfeits in supply chains with latest advancements in visual cryptography.

6. **As treatments become increasingly personalized, new manufacturing technologies will enable medical devices and even drugs to be manufactured with Additive Manufacturing.** It will enable the switch to on-demand and small batch manufacturing reducing inventories and making supply chains more agile and responsive.

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2 DEEP DIVES ON KEY TRENDS

2.1 Advancing Data Analytics (Big Data)

The LSHC sector demands unerring precision to succeed. To make more informed decisions about the management of their operations, LSHC providers are increasingly turning to advanced analytics. The global healthcare analytics market will expand from USD$8.48 billion in 2015 to USD$23.8 billion in 2020, a growth of 23.9%. New tools will assist the sector to spot risks, better predict resources to support demand, and accurately forecast for optimal inventory. For new products, it means an increase in speed to market, with better user experience.

KEY DEVELOPMENTS & IMPLICATIONS

- **Real time and more accurate view of operations** allow LSHC providers to optimize resources with greater precision and reduce inventory costs and wastage. Four hospitals that make up the Assistance Publique-Hôpitaux de Paris are trialing platforms that predict admission rates based on past admission records to improve hospital bed management and logistics.

- **Supply chain optimization and risk management** can be further enhanced with better-quality and timely data. Predicting potential supply chain vulnerabilities before they disrupt operations strengthens risk management. With modern resilience solutions, such as DHL Resilience 360 (see Case Study pg. 7), LSHC manufacturers can mitigate disruptions in global supply chains with **near real-time incident alerts**.

Further solutions offering lane risk assessment, such as DHL Thermonet, help LSHC manufacturers identify risk scores and optimize their choice of lanes, packaging and other shipping parameters. The risk score is derived from granular-level data of past shipments such as carrier and route selection, cold chain packaging, temperature conditions and service levels (see further details in Spotlight on pg.9).

- **Predictive analytics to identify demand spikes** informs pharmaceutical manufacturers when to ramp up production, stocks and delivery resources ahead of time. Bayer AG uses big data from climate change and global weather trends to model hayfever occurrences in the US. With this data, production of its flagship anti-allergy drug, Claritin, is ramped up nine months ahead of a spike in allergies. Researchers at Harvard have used Google search data to predict influenza outbreaks based on the number of times people search for flu-related symptoms or treatments. Such data can help manufacturers scale up medicine production ahead of outbreaks and work with logistics partners to **increase speed to market** for new drugs or devices.

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The US-based Geisinger Health System’s Unified Data Architecture, a Big Data platform, tracks and correlates supply chain data to clinical information from its electronic medical records by surgery type and provider. Supplies ranging from the smallest of surgical sponges to thousand dollar medications or devices are tracked, along with waste in the operating rooms. This has led to **new lean supply chain initiatives, with powerful insights on supply use patterns and inventory optimization**. Linking real-time view of demand to supply enables optimization across the whole value chain, from manufacturing to consumption.

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KEY OPPORTUNITIES

- Real-time view of operations and analytics tools improve demand accuracy, leading to less resource waste or unmet demand.
- Crowdsourced data can contribute valuable near real-time insight into any demand spikes or contingencies that can disrupt movement or quality of shipments.

KEY CHALLENGES

- Privacy and security concerns can slow down implementation of analytics tools that rely on sensitive patient medical records.
- Shortage of trained analytics resources may slow development of such tools.
- The sheer volume of Big Data often can be overwhelming to develop meaningful operational insights for the sector.

CASE STUDY: ENHANCING VISIBILITY AND RESILIENCY IN GLOBAL SUPPLY CHAINS

A global biopharmaceutical company focused on developing and delivering specialty products to treat devastating and rare diseases realized the importance of building resilience in its supply chains. Disruptions along its supply chain were not only high-risk for the company but potentially life-threatening for its patients.

With DHL Resilience360\(^1\), the company acquired end-to-end visibility of its complex drug supply chain, from manufacturing to distribution. Along with this came the advantage of not only anticipating, but assessing and responding to risks for shipments in transit. As a result, the company reduced manual effort in risk monitoring while increasing its ability to respond to risks in real time. It also leveraged the tool to support business partner compliance audits and gap analysis.

Source: DHL

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\(^1\) https://resilience360.com/?WT_mc_id=DHL_RESILIENCE_360_OFFBAN_002
2.2 Increasing Visibility through Connectivity (Internet of Things)

More than 646 million Internet of Things (IoT) enabled devices for healthcare are expected to be operational by 2020, or 6 times the number operating in 2015. The growing use of wearables and smart kits allows gathering of granular-data on patient health, which enables improvements in clinical trials, virtual treatments, and adherence monitoring. IoT will also be the key enabler for data-driven transformation of LSHC supply chains.

KEY DEVELOPMENTS & IMPLICATIONS

- IoT-enabled tagging of assets allows supply chains to obtain greater real-time visibility and control. In Denmark, Aarhus University Hospital uses RFID tags to track everything from wheelchairs to medicines. As they move around the hospital, RFID readers track asset flow creating a real-time view accessible via mobile devices and computers. With such insights, hospitals are able to effectively channel resources to retrieving moving assets. In the long-term, it allows hospitals to redesign their process flow. For medicines, better insights allow more effective management of their inventory. A smart warehouse of the future will track all inventory, equipment and people, utilizing sensors and tags to monitor movement and temperature. Companies such as DHL are piloting these concepts to further optimize warehouse operations. In one such DHL pilot lasting a month, fork-lifts and scanners were tagged to create a heat map that highlighted idle times, queuing times, and areas of congestion.

As a result, the site optimized operations flow, asset utilization and reduced net time travelled per worker by 18%. In another use case, temperature and condition monitoring solutions, such as DHL Thermonet, enable tagging of medical products and devices with sensors during transportation and storage to ensure compliance and quality (see Spotlight on pg. 9).

- Sensors are used to enforce compliance and counterfeit checks. Johnson & Johnson has begun to shift production of Prezista, an HIV medication, from large batch manufacturing to continuous manufacturing. The pharmaceutical giant has installed sensors along its production line that test and sample the drug at each stage of manufacturing, removing the need to frequently stop the process for bulk testing. Pfizer uses RFID tags to efficiently monitor for counterfeit drugs and maintain the integrity of its flagship Viagra products. Each tag contains a microchip that stores a unique serial code, known as an Electronic Product Code, which pharmacists and drug distributors can retrieve with a special reader and verify its authenticity. The explosion of IoT devices will further enhance Product serialization of pharmaceuticals which has become a legal requirement across the globe.

- Auto-replenishment will introduce new channels of order and fulfillment. Innovations such as IoT-enabled pillboxes and bottles are fast emerging as effective tools for adherence monitoring and auto-replenishment. With increasing home care, such tools help remind patients when to take their medication, and order replenishments through a push button on the device.

Figure 3: Smart Warehouse – IoT Pilot; Source: DHL

15 http://www.mobihealthnews.com/20795/slideshow-8-pillboxes-that-connect-to-your-phone/page/0/5
Wearables will be used for prevention and safety to reduce accidents, increase accuracy, and avoid costly mistakes in operations. Logistics companies are already piloting such applications. As an example, DHL is piloting an application to detect driver drowsiness. Through wearables, detection sensors monitor bio-rhythms, blood pressure changes, and other vital statistics to gauge early signs of drowsiness. Based on this information, critical alerts can be sent to the driver via a smartphone. The pilot found drowsiness patterns (peak risk period: before mealtimes) as well as driving patterns that can inform decisions to improve road safety. A similar pilot is underway for forklift drivers and operators in a DHL warehouse to improve safety.

KEY OPPORTUNITIES

- IoT will improve visibility and control of product inventories across supply chains, reducing loss and waste.
- New product serialization and identification technologies allow greater control of quality and compliance in supply chains.
- Application of wearables within the warehouse will improve operations safety.

KEY CHALLENGES

- IoT devices lack common industry standards. Its full potential can only be realized in a seamless ecosystem of connected IoT devices.
- Cybersecurity concerns also limit leveraging IoT’s full potential. Perceived user acceptance of wearables can be low or limited by privacy laws in some countries.
- IoT hardware needs to be further ruggedized for large deployments, especially in logistics operations.

SPOTLIGHT: DHL THERMONET

DHL Thermonet, an air freight product, employs Smart Sensor RFID technology that tracks the ambient temperature of each shipment while in transit. The data is transmitted to an online portal called LifeTrack. It is supported by a global network of more than 100 Certified Life Sciences stations, providing monitoring, intervention, and storage services that meet the international medical community’s Good Distribution Practices standards. Enabled by the data collected via DHL Smart Sensor, Thermonet has gone a step further to offer a risk intelligence engine, providing a lane risk assessment score on the profile of each shipment’s lane, packaging, and carrier.

Source: DHL

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16 http://www.mobihealthnews.com/8605/mobile-health-2020-verizon-google-glowcap
17 http://www.dhl.com/content/dam/downloads/g0/logistics/brochures/dhl_air_thermonet_flyer_february2017.pdf
2.3 Healthcare On-Demand (On-Demand Delivery)

Manufacturers are building up direct delivery models in response to increasing online and home care channels. The online pharmaceutical markets will grow to $128 billion by 2023.\textsuperscript{18} Services will be pushed from hospital or clinics, to a home care environment to increase customer convenience and reduce cost of care. Mobile healthcare professionals provide treatment at patient home or close to home. Treatment kits will be delivered to the healthcare professional prior to the home visit or delivered to the home directly. These changes require new direct delivery models by manufacturers.

\textbf{KEY DEVELOPMENTS & IMPLICATIONS}

- Increasing online pharmacies orders and platforms that offer healthcare products/services on-demand will require adoption of e-commerce strategies. Chinese e-commerce giants such as Alibaba and JD.com are investing heavily in China's $1.1 billion online pharmacy market.\textsuperscript{19} Services such as UberHEALTH in US, offering on-demand delivery of flu vaccinations, provide convenient and affordable healthcare platforms. In India, where 25% of drugs are believed to be counterfeit, online pharmacy startups provide quality-assured medicines to customers where registered pharmacies may not be easily accessible. Pluss, takes orders through WhatsApp as well as websites and telephone calls, while others like BookMEDS offer compelling value propositions such as free delivery within four hours of order.\textsuperscript{20} These changes will drive growth in direct distribution channels. Specialized services are required for direct-to-consumer deliveries, such as tracking, temperature monitoring, and packaging solutions. More e-commerce logistics fulfillment strategies will come into play to meet the need for speed and flexibility in last mile (see Case Study on pg. 11). Omni-channel integration of different ordering and fulfillment channels will also be required in the long term.

- On-demand delivery models will be utilized by hospitals for time-critical deliveries of all items, ranging from medical parts to surgical kits, cost-effectively. Instead of maintaining large inventories on-site, medical device manufacturers can work with logistics partners to utilize logistics consolidation centers to supply products/parts based on near-future demand.\textsuperscript{22} Some manufacturers have already begun to adopt these models. One of the world's largest standalone medical technology companies worked with DHL to build an on-demand supply chain in the UK that can deliver high-value medical implantable devices and critical care products directly to wards and operating theatres within hours of an order. This is possible by leveraging the service’s logistics networks which are densely populated and located closer to hospitals/clinics (compared to regional warehouses). This model can be successfully replicated throughout the healthcare industry to improve levels of patient care, providing an unrivalled ability to respond to urgent medical demand (see Figure 6).

- Demand for point-of-care diagnostic kits or remote monitoring devices is expected to grow with increasing inclination towards home care. This will require different supply chain models for spare parts and consumables. Kits such as the Roche Accu-Check Connect Meter, which sends a patient's blood sugar levels to their doctors for real-time remote management of diabetes, are increasingly popular.\textsuperscript{23} LSHC firms can expect final mile delivery models of such kits to include end-to-end options (for delivery of spare parts for high-value kits; including returns) as well as subscription-based delivery models (for regular consumables and prescriptions). The sector will see further growth in dedicated express shipment services, such as DHL Medical Express, allowing time-critical shipments of patient bio-samples, and diagnostic kits. It also offers specialized packaging solutions for sensitive deliveries, temperature control, and 24/7 tracking.

\begin{figure}
\centering
\includegraphics[width=0.5\textwidth]{figure5.png}
\caption{Platform for healthcare, UberHEALTH\textsuperscript{21}}
\end{figure}

\textsuperscript{18} http://www.prnewswire.com/news-releases/epharmacy-market-to-reach-us128-billion-by-2023-transparency-market-research-560938861.html
\textsuperscript{20} https://www.techinasia.com/4-indian-startups-business-medical-delivery-space
\textsuperscript{21} https://www.uber.com/blog/boston/bringing-house-calls-back-with-uberhealth
\textsuperscript{22} http://software-monetization.tmcnet.com/articles/426139-how-medical-manufacturers-benefit-from-on-demand-trend.htm
\textsuperscript{23} http://www.medgadget.com/2015/12/why-its-such-a-big-deal-that-mainstream-glucose-meters-are-going-wireless.html
Deep Dives in Key Trends 11

**Figure 6:** Medical Device Final Mile; Source: DHL

**KEY OPPORTUNITIES**

- Healthcare on-demand will allow manufacturers to sell directly to consumers, giving them increased visibility in the sales channel, while the patients benefit from increased convenience.
- On-demand medical devices and parts delivery to hospitals, leveraging consolidation centers, will create value for manufacturers and hospitals.
- Growing field of point-of-care and remote monitoring kits will require innovative delivery models from logistics providers.

**KEY CHALLENGES**

- Online channels and platforms will require stringent compliance and credibility checks, with constant pressures to be cost-competitive.
- Direct distribution channels need to address possible liability issues in case of misuse of drugs or devices sent for home use.

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24 https://diatribe.org/accu-chek-connect-calculating-bolus-smartphone-style

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**CASE STUDY: DELIVERING BEAUTY DIRECT TO CONSUMER**

The beauty product manufacturer had ample experience selling its premium skincare products via a direct selling model. Its decision to embark on a global e-commerce growth strategy required a major shift in the supply chain structure. Stretched to meet growing demands through a legacy supply chain structure, the company partnered with DHL for end-to-end logistics solutions, including fulfillment services and direct-to-consumer deliveries.

To support the strategy, it migrated from a single US distribution center to a global network of five fulfillment centers (across US, Asia, and Australia); integrated with DHL’s eCommerce parcel delivery network. With this the company was able to increase shipments to about 1.3 million orders for 3.1 million products within a year. They were also able to offer far shorter delivery times than before; and enhanced customer experience with greater visibility of when their products will arrive. Aside from achieving competitive delivery options, the decentralized network of fulfillment centers also extended the reach of its products into high growth markets like Hong Kong and Australia.

Source: DHL
2.4 Automating for Speed and Accuracy (Robotics and Automation)

To meet increasing complexity and service requirements without adding excessive costs, LSHC supply chains will inevitably turn to automation. Today’s automation technology presents opportunities to help operations improve productivity without breaking the bank.

KEY DEVELOPMENTS & IMPLICATIONS

- **Collaborative robots or “co-bots”,** which work safely alongside people, **support zero-defect logistics processes and enable higher productivity in logistics operations.** While already used in manufacturing, their use is only now being piloted in logistics. Since 2016, DHL has successfully tested different co-bots for their ability to perform an array of tasks from assembly, picking to packaging.\(^{25}\) Being interactive, safe, highly adaptable, and cost effective, co-bots will assist warehouse operations by performing simple repetitive tasks such as co-packing and labeling. (see Case Study on pg. 13). Given special requirements for sterilized environments and cold conditions, robots are an especially attractive option for the LSHC sector.

- **Enabling healthcare access in remote areas remains a key challenge for the sector.** **Unmanned Aerial Vehicles (UAVs)** can **speed up and lower the cost of delivering medicines** without compromising their quality, particularly to remote or hard-to-reach areas. In 2016, DHL successfully tested its Parcelcopter 3.0 and became the first parcel service provider to offer drone deliveries as a service. Tested in the alpine region of Bavaria, urgently-needed medicines were transported by the drone. It covered an eight kilometer journey within eight minutes, which by car may take up to 30 minutes in winter.\(^{26}\)

- **Autonomously Guided Vehicles (AGVs)** can significantly speed up operations, while at the same time minimize risks of error. In Singapore, Ng Teng Fong General Hospital employs AGVs that transport meals throughout the hospital three times a day.\(^{27}\) Aethon, a US-based robotics manufacturer, developed a robot called TUG for transporting and delivering medications, lab samples, and other hospital supplies on-demand from pharmacies to nurses.\(^{28}\) Such robots come with guidance and navigation systems that help them to negotiate narrow corridors and complex layouts of hospitals with a high degree of precision. In another pilot for a medical devices operation in a DHL facility, the site team is exploring picking efficiency improvements by deploying autonomous picking assistance robots that are integrated with the warehouse management system (WMS). The robots navigate to the next station on their own and guide the warehouse worker on the items required to be put in its tray. Their efficiency in performing those tasks promises future deployments.

KEY OPPORTUNITIES

- Co-bots, UAVs, and AGVs will increase the efficiency of warehouse and distribution processes both in speed and accuracy.
- Automating simple and repetitive activities allows for a more productive use of human resources.

KEY CHALLENGES

- Logistics is a relatively new space for collaborative robotics. It will require investments from both LSHC and logistics industries to shape the use of these robots in the sector.
- Regulation and compliance need to evolve to enable further deployment of automation alongside humans.

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\(^{27}\) [http://www.yoursingapore.com/micelen/bulletin-board/design-for-future-care/design-for-future-care.html](http://www.yoursingapore.com/micelen/bulletin-board/design-for-future-care/design-for-future-care.html)

CASE STUDY: LABELING ROBOTS AS LIFESavers

Accurate labeling and quality checks of medicines are critical to ensuring the wellbeing of patients. A biopharmaceuticals leader in the Netherlands was experiencing growing demand for one of its new drugs for treatment of an uncommon chronic illness. The company needed to speed up and scale up quality-assurance processes for the drug, including packaging and printing critical information on the injectors used to deliver the drug.

To do so, the DHL site team “hired” a new helper for its production line: ABB’s “YuMi” robot. Instead of printing each injector pen manually, DHL warehouse associates place it on a tray; YuMi then picks up the pen with one of its two robotic arms, passes it by the printer head, and sends the printer the necessary information to be printed. After the pen is printed, YuMi holds it in front of a camera, automatically comparing the actual print to the original input to the printer and discarding it if they fail to match.

Each YuMi robot can process up to 6 pens per minute with a single robotic arm—significantly more than even the most adroit of human workers. The system also minimizes the maintenance downtime required by the company: each YuMi robot only requires servicing after 20,000 hours (more than 2 years) of operation. The robots have allowed the company to ramp up production without worrying about bottlenecks at the labeling stage, ensuring a stable and scalable flow of the drug in response to global demand.

Source: DHL

2.5 Increasing Efficiency with Augmented Reality

Data needs to be accessible to be useful. New ways of displaying and presenting information will make supply chain operations more accurate and efficient. By layering digital information on top of physical items, Augmented Reality (AR) is guiding numerous actions across patient care and hospital operations. It will further enable LSHC supply chains to increase efficiency and reduce counterfeits.

KEY DEVELOPMENTS & IMPLICATIONS

- **Vision Picking** is the use of AR glasses to give visual guidance on items to be picked. This can significantly improve productivity and picking efficiency in warehouse operations (see Case Study on pg. 14). Pharmacies and hospitals can use AR to guide their staff to the right drug prescriptions or equipment amongst fully-stacked shelves and near-identical products.

- **Enhanced security through visual cryptography** with AR technology may one day form the backbone of safety processes for medical shipments. Strengthening anti-counterfeiting measures continues to be a key focus for the sector supply chains. In addition to IoT, AR will be a key technology enabling security checks. The World Health Organization (WHO) estimates that over 920 types of medical products have been counterfeited and placed in public circulation, and over 100,000 deaths occur yearly due to counterfeit drugs. Researchers at the University of North Carolina are testing an approach, whereby half of a visual cryptography image is printed on a surface, while the other half is projected in an AR headset. When the two halves align, they reveal a final image containing vital security information—something only the wearer of the headset can see. Such processes may complement existing counterfeit checks in supply chains, helping to further reduce safety risks posed by counterfeit medicines.

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28 [http://www.07.abb.com/api/ir/getimage/36fb710b-54e0-4e53-8388-aedicde53ce56/1](http://www.07.abb.com/api/ir/getimage/36fb710b-54e0-4e53-8388-aedicde53ce56/1)
29 [https://blog.catavolt.com/2015/12/3-ways-augmented-reality-is-changing-the-pharmaceutical-industry/](https://blog.catavolt.com/2015/12/3-ways-augmented-reality-is-changing-the-pharmaceutical-industry/)
KEY OPPORTUNITIES

- Providing visual instructions, AR allows for increased efficiency, and simpler training of operations staff.
- Through new ways of layering information, AR will further strengthen security and compliance checks of medical goods.

KEY CHALLENGES

- AR displays are in early adoption phase. The technology still needs work in quality of interface with other systems, speed, wearability & robustness of the hardware and battery life.
- Cybersecurity concerns also apply to AR headsets and devices.

CASE STUDY: FINDING YOUR WAY WITH AUGMENTED REALITY

Picking accuracy is a crucial metric for pharmaceutical warehouses, which are subjected to strict regulation laws to prevent error in delivery of controlled substances. Vision picking has shown to improve productivity and picking efficiency in warehouse operations. DHL recently piloted Vision Picking in partnership with wearable computing solutions experts, Ubimax. Through their Vuzix glasses, users received visual instructions on items to pick per order. By scanning the QR or barcodes per physical item, they received a visual display on how to place items in the pick trolley and complete the order. Bringing automation with the AR glasses, the handling staff were able to achieve a hands-free approach for order picking and eliminate errors common with pen and paper checklists.

Integrated with the WMS, DHL has now conducted number of such pilots across its global operations. Results across all pilots show an increase in picking efficiency in range of 10-25%. This technology will see its way to becoming a common warehouse solution.

Source: DHL

2.6 Leveraging Additive Manufacturing

As treatments become increasingly personalized, leveraging new manufacturing technologies will enable medical devices and even drugs to be printed with Additive Manufacturing. The first 3D printed pill, Spritam, received FDA approval in 2016.35 A recent survey shows that over the course of 2 years, the relevance of 3D printing has doubled amongst life sciences supply chain executives.36 It will enable the switch to on-demand and small batch manufacturing, reducing inventories and make supply chains more agile and responsive.

KEY DEVELOPMENTS & IMPLICATIONS

- **On-demand manufacturing will support delivery of customized medications and products cost-effectively,** and reduce high levels of expenditure on maintaining fully-stocked inventories.37 Hospitals will be able to get small medical devices, spare parts printed on-demand, thus reducing operation costs and wastage. Further, hospital inventories can be reduced by limiting, or even eliminating, the need to maintain a surplus of these items and parts (see Spotlight below). This will see greater numbers of small-volume aftermarket deliveries on a more frequent basis, rather than large batches of parts or devices.

- **Small batch size** printing may replace large batches of finished shipments when supplying medical products to hospitals and other healthcare providers. Printing of smaller-scale drug batches can be achieved onsite at hospitals or regional centers, reducing costs and risks of expired stock.

KEY CHALLENGES

- To address added complexity to the value chain, manufacturers will rely on new models to supply raw materials onsite to hospitals/distributed manufacturing locations.
- With the current speed of 3D printing, it will be primarily used for higher-value items like devices and organs.
- Certification, including liability, of these products or devices is in the process of development.

KEY OPPORTUNITIES

- With on-demand printing, issues of expiry of stock and wastage due to surplus inventory are minimized.
- On-demand manufacturing improves services level with items being printed closer to the end delivery point.

**SPOTLIGHT: 3D PRINTING FACTORY**

China’s first 3D printing factory for medical products is currently under construction in the city of Chongqing and is slated to begin operations in 2017.38 The factory is producing printed human body part molds for surgeries and artificial limbs, and ensuring swift delivery through its distribution centers. The factory is developed in collaboration with private firm Hkable Biological 3D (China) Ltd, biotechnology firm Jintai, and the Fengdu County Government.

**Source:** 3ders.org

2.7 THE FUTURE OF LIFE SCIENCES AND HEALTHCARE LOGISTICS

So far, this section outlined the different use cases in the six key trends and technologies that supply chain managers can leverage to transform LSHC supply chains. Bringing all these together, Figure 10 outlines how LSHC logistics will look in the future.

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37 http://www.modernhealthcare.com/article/20160507/MAGAZINE/305079980
38 http://www.3ders.org/articles/20160722-chinas-first-medical-3d-printing-factory-to-open-in-six-months.html
THE FUTURE OF LIFE SCIENCES AND HEALTHCARE LOGISTICS

- UAVs speed up and lower the cost of delivering medicines particularly to remote or hard-to-reach areas.
- Autonomous Guided Vehicles (AGVs) transport supplies on-demand to patients across the hospital.
- Online drug orders and diagnostic kits are delivered directly to home.
- Collaborative robots perform value-added tasks with greater accuracy, speed at lower costs.
- Serialization tags printed on boxes in warehouses.
- On-demand delivery of supplies and spare parts to hospitals from a logistics center that consolidates manufacturers’ consignment stocks, reduces inventory costs.
- Augmented reality is used to perform counterfeit checks.
- 3D printing of medicines, prosthetics, and other medical devices makes supply chains far more agile and responsive.
- Augmented visual displays on physical items increase picking productivity.
- Internet of Things enabled tagging technologies create real-time visibility and improve flow and safety in warehouses.

Figure 10: The Future of Life Sciences and Healthcare Logistics; Source: DHL
As patients and consumers, we can relate to the needs of Jane introduced in the beginning of the report. The six key trends and technologies highlighted in the report hold the key to meeting Jane’s needs and desired service levels via cost effective, agile and highly responsive supply chains. We are only just beginning to understand the magnitude of change that lies ahead for the sector. The good news is that many aspects highlighted in Jane’s journey are in focus of innovation and research projects today across the LSHC sector.

Over the next few years, we will see significant growth in leveraging enhanced connectivity and data analytics in the sector supply chains that will improve the flow of information and goods.

As a result, supply chains will be better optimized, resilient and compliant. Capturing the growth in home care and online platforms with direct distribution channels will help manufacturers improve accessibility and convenience for patients. However, this could also drive up costs in last mile distribution.

Automation through technologies like robotics, 3D printing, and Augmented Reality will enhance speed and efficiency of operations to meet increasing demand for fast and direct-to-consumer deliveries. Partnering with innovative solution providers for agility, cost effectiveness and innovative last mile delivery models will be the key. Working with the right partners in supply chain, this sector can accelerate its transformation journey.

Despite the current technical and regulatory barriers as well as concerns on privacy and patient data security, successful examples of deployment and pilots are emerging. Clear benefits with regards to improved efficiency, service levels, visibility and control shall overcome the cost of dedicating resources to address these concerns. Businesses that embrace this transformation will be far more successful than those who watch from the sidelines.

It is clear that logistics providers will have a key role to play in this transformation. At DHL, we continue to navigate this innovation journey of delivering the future of healthcare to the world.
RECOMMENDED READING

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