GS1 Japan

The Global Language of Business

GS1 Japan Review

Special Edition

GS1 Standards in Healthcare

- The importance and Use of Global Standards and Digital Technology in the COVID-19 Pandemic Disaster -

(Excerpt from GS1 Japan Review, vol.4, 2021)

Preface

The World Health Organization (WHO) declared COVID-19 a global pandemic in March 2020, and, after a few years period, still it is not under control. Many precious lives have been lost, and many people are suffering from the aftermath. On the other hand, new vaccines have been developed and approved at an unprecedented rate, and several therapeutic drugs have become available for treatment. It is also true that digitisation and data linkage have advanced rapidly in various fields.

Under these circumstances, GS1 standards' identification codes and barcodes, already the world's fundamental standards, are re-acknowledged by industry and healthcare providers. In particular, there are high expectations for GS1 Standards to help enable traceability of COVID-19 vaccines supply to low- and middle-income countries/regions and remote areas, preventing introduction of counterfeit products. WHO and United Nations Children's Fund (UNICEF) are again emphasising the importance of individual identification and traceability control utilising barcode labelling.

In November 2021, GS1 Japan published a special issue in our Japanese journal "GS1 Japan Review" covered with a title "GS1 Standard Use in Healthcare–Importance and Application of Standards and Digital Use under the Pandemic", where 6 articles were kindly provided from many authors including GS1 Headquarters. We appreciate those contributing authors from around the world. Here in this issue, we decided to release those six articles also in an English version.

We hope this issue will be of help in gaining further understanding of GS1 standards and promoting digitalization at your sites.

2022
Koichi Uemura
Healthcare Lead, GS1 Japan

Contents

GS1 standards in the medical product supply chain

Why we need global standards in healthcare

Ulrike Kreysa*
Senior Vice President Healthcare, GS1 Global Office

Tania Snioch
Director Healthcare Operations, GS1 Global Office

An unprecedented healthcare challenge

There is no doubt that in the last 18 months, we have faced an unprecedented healthcare challenge – a global pandemic that has caused more than 4.6 million deaths, impacted so many families, left countless people with long term illness or disability, seen millions in hospital, and stretched national healthcare systems as well as their staff to their limits. With new COVID variants emerging and unequal access to vaccines and medical treatments across the globe, our new reality will continue for many months, if not years, to come.

However, from the challenges that the pandemic has produced, healthcare provider organisations, suppliers, wholesalers, distributors, and many organisations originally not working in the healthcare field have adapted, driven by the common need to continue delivering the best possible care to every patient. News articles discuss perfume manufacturers developing hand sanitiser, couture designers producing face masks, military assistance to small business to increase their PPE production capacity, automobile manufactures producing ventilators, and much more. At the same time, organisations working to supply and deliver healthcare continue to streamline their activities, to supply products more efficiently, track inventory, administer vaccines efficiently and deliver complex medical care.

Global standards play an important role

Amongst all these efforts, global standards have an important role to play. Whilst it may not be obvious, global standards are working right across the world to support the continued delivery of healthcare to patients not suffering from COVID but requiring medical care, to those most critically ill COVID patients, and to people requesting vaccinations.

The healthcare industry is regional yet global; fragmented yet cohesive, and heavily regulated. Therefore, the global healthcare supply chain, from manufacturer to patient, remains a complex web, interwoven with many actors and products crossing borders multiple times before reaching the patient. This supply chain complexity is necessary to ensure that products are available across the globe. However, to achieve efficiency, traceability and ultimately visibility of the healthcare supply chain, and to get the correct, authentic product to the right patient at the right time, interoperability is key. Interoperability relies on trading partners communicating in a common language, based on 'rules' all understand – and global standards define those rules.

Only widespread adoption of global standards across healthcare and across the world will enable significant, cost-effective interoperability at scale. Global standards that link stakeholders, from manufacturer to patient, have been shown to help the industry improve patient safety, efficiency, and effectiveness of healthcare product and care delivery. Such standards could support hospitals in reducing the number and severity of medication error. Also, product recalls both for medical devices and pharmaceuticals could be managed through a system of electronic records and communications, leveraging global standards. This operational efficiency leads to cost efficiency; for instance, clearer inventory visibility decreases the costs of managing and storing inventory. Global standards also help in reducing the prevalence of substandard and falsified medicines, a problem that affects the entire world, increasingly the low-middle income countries.

This trend of global healthcare standardisation was already in motion, but it has been accelerated due to COVID-19 pandemic, meaning healthcare organisations rely on a standardised, automated supply chain to

The article is basically the translation of its Japanese issue (GS1 Japan Review, Vol.4, 2021), and is slightly modified as needed for English readers.

*Ulrike Kreysa retired from the position of Senior Vice President Healthcare in April 2022, after initial publication of this article.

ensure a seamless medical product delivery around the globe.

The role of GS1 standards

GS1 is a not-for-profit, global standards body recognised as an NGO by the UN and a neutral platform that brings together all healthcare stakeholders. There is no competition regarding GS1 standards – the implementation of which will serve patient safety and improve the business and clinical processes of all healthcare-related organisations.

GS1 Healthcare, the healthcare initiative of GS1, is a neutral and open community that brings together all healthcare stakeholders to lead the successful development and implementation of GS1 global standards to improve patient safety, operational, and supply chain efficiency. For the last 17 years GS1 Healthcare has worked with regulators, ministries of health, hospitals, distributors and manufacturers and solution providers to ensure that GS1 standards meet requirements to improve supply chain operations, patient safety, medical outcomes and support the implementation regulatory requirements in healthcare.

Via use of globally unique numbers, our standards enable identification of key healthcare resources: products, locations, caregivers, care recipients, assets, etc. To ensure these numbers are accurately recorded in IT systems through machine-readable data capture – mostly scanning of barcodes with relevant additional data, e.g., batch number, expiry dates for medical products - GS1 standards define the rules for use of a set of applicable barcodes. To allow information sharing about the healthcare resources being identified, GS1's suite of standards encompasses standards for sharing product master data, event / traceability data, as well as business transactional data such as purchase orders and invoices.

The most simple way to visualise how GS1 standards apply across the supply chain is to refer to the GS1 Healthcare Digital Thread (**Figure 1**).[1)]

Through our current role as a member of the Joint Initiative Council, we collaborate with other important standards development organisations to enable the best standards-based outcomes for the healthcare sector world-wide.[2)] We all want to enable a digital health ecosystem where high-quality data is available to the right people, at the right place and at the right time for high-quality decisions and care.

GS1 standards around the world

GS1 standards are used in healthcare in more than 70 countries which have regulations, government

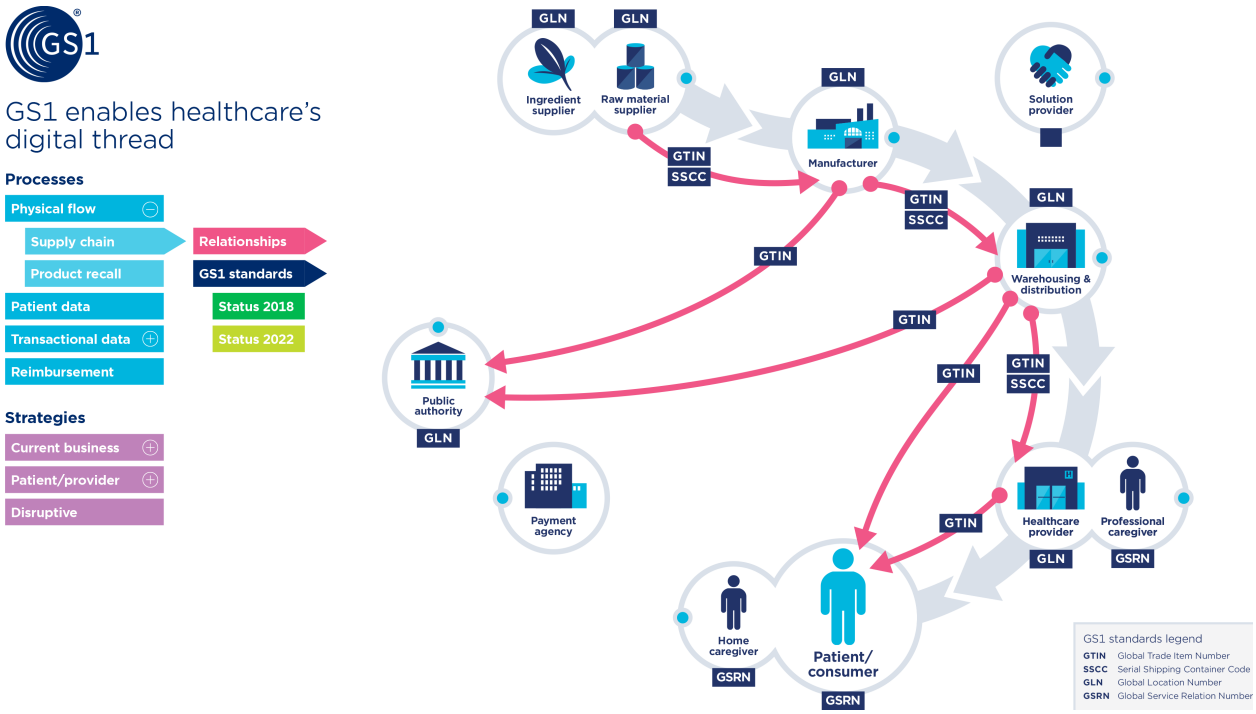


Figure 1 GS1 Healthcare Digital Thread

The digital thread is an interactive tool that represents the application of GS1 standards in healthcare. It details healthcare stakeholders and their interrelationships, and communicates how GS1 standards apply today and into the future. The figure above is one view of the Digital Thread that shows the product and data flow in the supply chain. For more detail, go to https://xchange.gs1.org/sites/hc/hdt

requirements or trading partner requirements. Regulations such as the European Falsified Medicines Directive, US Unique Medical Device Identification regulation, or Argentinean regulation for a 'traceability system for the control of pharmaceutical products from the manufacturer to the patient' are some notable examples. In addition, government bodies or trading partner requests are driving GS1 standards implementation, as seen with the English National Health Service Scan4Safety program, Gulf Cooperation Council Drug Barcoding Specifications, or the New Zealand 'Standard for identification and coding medical devices'.[3)]

In 2012, a report by McKinsey & Company called 'Strength in unity: The promise of global standards in healthcare', noted that 'adopting a single set of global standards will cost significantly less than two' (between 10-25% less cost to stakeholders), but even more importantly 'implementing global standards across the entire healthcare supply chain could save 22,000-43,000 lives and avert 0.7 million to 1.4 million patient disabilities'. It is these kinds of possible healthcare impacts that cause the ever increasing use of GS1 standards around the world.[4)]

Working with humanitarian organisations and development partners

Whilst for many years GS1 Healthcare has worked with stakeholders from all parts of the healthcare sector, in the last six years we have begun to collaborate with humanitarian organisations and development partners. The role of GS1 standards to help facilitate visibility, traceability and ultimately more consistent supply of authentic product to the countries these organisations support is crucial. This is even more so in the current pandemic where the healthcare products are needed by low- and middle-income countries to treat increasing numbers of COVID patients and vaccinate the populace to prevent infection.

The efforts started in 2015 when The World Health Organisation (WHO) issued the *Generic Preferred Product Profile for Vaccines* (PSPQ2) which recommends GS1 standard barcodes on all vaccines product packaging levels from the secondary package up the packaging hierarchy.[5)] Following publication of this document, a number of implementation pilots were undertaken including in Tanzania, Gambia, Nicaragua and Pakistan.

In August 2017, the Interagency Supply Chain Group (ISG), comprising the Bill and Melinda Gates Foundation, DFID, Global Affairs Canada, the Global Drug Facility, KfW, the Global Fund, Gavi, NORAD, UNDP, UNFPA, UNICEF, USAID, World Bank, WFP and WHO published a position paper about the adoption of GS1 standards. This paper was a commitment to the transition to and including of established, global data standards as part of their procurement requirements and support country uptake of these standards.[6)]

In 2019, the Global Standards Technical Implementation Guideline for Global Health Commodities, V2.1 was published. This document, authored by USAID, UNFPA, UNDP, Stop TB Partnership, and the Global Fund requests use of all components of the GS1 system: Identify, Capture and Share.[7)]

Following this recommendation, UNICEF and GAVI announced in 2019 that they required vaccines manufacturers to use GS1 standards and barcodes for their secondary packaging level.[8)] Starting the 1st of October 2019, for vaccine tenders backed by Gavi financing issued by UNICEF, it has been a requirement to have GS1 barcoding on the secondary packaging by latest 31st December, 2021.

These communications were not only addressing medical product manufactures, but also the regulators who play a vital role in driving this process by developing their requirements in a way that avoids and/or minimises localisation of global standards. Hence, the national regulatory requirements are shifting more and more toward global harmonisation.

In March 2021, WHO issued a *Policy Paper on Traceability of Medical Products* providing guidance to the 194 WHO Member States about policy and regulatory approaches to their traceability systems for pharmaceuticals.[9)] It includes an acknowledgement of the impact and benefits of global standards to enable traceability throughout the supply chain and interoperability across systems. Now, local regulations - whether existing ones or newly developed ones - are changing quickly to improve healthcare supply chains, leverage global standards and accommodate the current focus on pandemic.

The importance and significance of such steps were even clearer after the outbreak of the pandemic. The newly developed vaccines are nowadays the most precious commodity, and efficient track, trace and delivery helps the overall goal of increasing immunisation coverage. According to Deloitte's January 2021 white paper, *Building Trust in the COVID-19 Supply Chain* industry collaboration and transfer of technology (i.e., ultra-cold chains) while embracing global standards like GS1 would help in building vaccine confidence and eliminate vaccination hesitancy.[10)]

Falsified and substandard medicines

Initial efforts to address the different stakeholders aimed to improve product identification, labelling, and data exchange within the global healthcare supply chain. At the same time these activities sought to enable increased visibility along the supply chain to help in prevent falsification of vaccines and other medical products that are in high demand. According to the WHO, substandard and falsified medicines are major global health issue, but low- and middle-income countries carry the greatest burden with an estimated one in 10 medicines being falsified or substandard.[11)]

The medical product distribution systems in the developed world have a range of technologies in place to provide a reliable, safe, and secure distribution systems, including use of GS1 standards. Regulations such as the US Drug Supply Chain Security Act and the European Falsified Medicines Directive are two regulations driving implementation of such practices to secure the supply chain and therefore ensure authenticity of medicines. But this is not always the case in the LMIC countries where some governments haven't yet focused on regulations and distribution systems, or they are in very early stages in working in this area, so the risk of falsified medicines entering the market is extremely high.

It is important to note that traceability systems do not completely stop sinister, devious actors from falsifying products, but it does make it a lot easier to visualise the supply chain and detect where the product entered and how it entered, so that the leak can be closed. As noted earlier, use of GS1 standards are a foundation to an effective traceability system which is one key tool for preventing counterfeit medical products entering the supply chain.

Sadly, the COVID-19 pandemic has led to a global surge in reported falsified medical products including protective equipment, such as surgical masks, hand sanitisers, gloves, and diagnostic tests. More recently – and even more worryingly – fake drugs for COVID-19 treatment and vaccines have widely been reported for sale. On March 2021, even before the approval of the authentic vaccines anywhere in the world, the Interpol announced that it has dismantled a network of fake COVID-19 vaccines in South Africa and China, adding that this operation is just a fraction of the COVID-19 related criminality.[12)]

The implementation of global standards for identification, barcoding and data exchange allows securing and closely monitoring the chain of distribution of COVID-19 vaccines to ensure every vaccine administered through the legitimate supply chain is genuinely of high quality, safe and efficacious.[13)]

Application of GS1 standards in the context of COVID

Existing national or regional traceability systems based on GS1 standards can and are being leveraged in the context of COVID-19. Turkey is a notable example of where an existing traceability system has been expanded to encompass COVID-19 vaccines. Since 2011, Turkey has implemented full traceability of medicines from the manufacturer to the pharmacy, with the use of GS1 barcodes, and data shared via a central Ministry of Health database. Like other medicines, the COVID-19 vaccines carry a GTIN, expiry date, batch number and serial number, but also have additional necessary information relating to dosage calculation.[14)]

There is also an opportunity for countries / regions yet to initiate traceability to use the need for COVID-19 related product traceability as their first step. These initial projects can then be expanded later for other medical products. We have seen this in both Nigeria and also Ethiopia.[15)]

In some cases, the implementation of traceability for COVID-19 vaccines has surpassed that already in place for regulated medicines. In these cases, the traceability using GS1 barcodes is to the vial of vaccine which is a more granular level than the secondary medicines pack. Currently, medicines traceability regulations such as the European Falsified Medicines Directive and the US. Drug Supply Chain Security Act require traceability at the medicine secondary package.[2)]

A great example of COVID-19 vaccine traceability is seen in Ireland where the Republic of Ireland's Health Service Executive (HSE) adopted a traceability solution based on GS1 standards. The solution now used in nearly all 43 Irish Centralised Vaccination Clinics (CVC) is called TrackVax and is provided by GS1 Ireland. The system works based on barcode scanning, where a barcode scan of each vaccine vial captures data, including the batch number of the vaccine and the time at which a vial must be discarded. Before introduction of the GS1 barcode-based system, vaccine tracking and reconciliation was managed manually, with handwritten information on the vials. This was time consuming, but also was seen as a possible safety risk. Now the Irish HSE's National Immunisation Office has visibility of vaccine usage data across the CVCs including accurate stock levels. With this information, the safety of COVID-19 vaccines is assured and waste is prevented.[14)]

Japan – providing access to electronic leaflets

As discussed later in this journal, for many years Japan has been leveraging GS1 standards in building medical product identification into their healthcare systems.

Due to COVID-19, also here the digitalisation process has been accelerated. Japan decided to abolish the use of paper leaflets for medical products and started to use the GS1 barcode marked on the product to access medical product e-leaflets in August 2021. The goal is to increase the visibility of this information about pharmaceutical products in the Japanese market.

Before the enforcement of this regulation, every secondary package of pharmaceuticals had paper leaflets for healthcare providers. The information in those leaflets was registered in a national database held by the Pharmaceutical Medical Devices Agency (PMDA). This framework required constant revising of the paper leaflets which created a synchronisation challenge because the information contained in the paper leaflets may not be up to date when they are received by healthcare providers. Also, the use of paper was wasteful and not in line with Japan's eco-friendly and green vision.

Now, the latest information can be accessed by scanning the barcode on the product package, which is linked to the national database of the PMDA. All packages, including primary packages, are barcoded in Japan, and that makes it possible to access the database from ampules, vials or any other package.

In the context of COVID-19, Japan currently has three different types of vaccines. All of their packages have been assigned GTINs despite those are urgently approved, and one of those vaccines already has a GS1 barcode printed on vials, which could be scanned to view e-leaflets in the database.

These different applications pave the way to work on more comprehensive digital verification of the right vaccine for the right person, capturing of administration information to compile information on national usage, adverse events and recalls.

This is an innovative approach to help ensure patient safety through access to up-to-date digital information, whilst ensuring that there is only one barcode on the product for healthcare providers and their supply chain partners to leverage – preventing any risk of misidentification.

Please remember: Ultimately, GS1 standards contribute to patient safety

The healthcare landscape across the world is ever changing, as the current pandemic has highlighted, however one key thing remains the same – the patient rights. The mantra of all healthcare provider staff is to ensure that the right product is provided to the right patient at the right time by the right route of administration and by an authorised caregiver. One of the ways to ensure patient safety is to have a visible and traceable supply chain – so the product is in the healthcare facility available for the patients when they need it, and there is surety that the product is authentic. To do this, the healthcare sector can leverage the use of globally unique identifiers and barcodes, coupled with information exchange, to allow the caregiver, at the time of medical product administration, to rely on IT system-based decision support to ensure that the correct medical product is being used.

We must all remember that each one of us will one day be a patient, and that safer, more efficient care starts with a simple (barcode) scan.

References

1) GS1 Healthcare, *GS1 Healthcare Digital Thread, 2018*, https://www.gs1.org/sites/default/files/18gsgl0203_d16_hc_digital_thread_interactive_pdf.pdf

2) Joint Initiative Council, http://www.jointinitiativecouncil.org/

3) GS1 Healthcare, *GS1 Healthcare Public Policy Database,* https://www.gs1.org/industries/healthcare/public-policy-database

4) McKinsey & Company, *Strength in unity: The promise of global standards in healthcare, 2012,* https://www.gs1.org/sites/default/files/docs/healthcare/executive_summary_mckinsey_white_paper_-_strength_in_unity.pdf

5) World Health Organisation, *Assessing the (Revision 2014) programmatic suitability of vaccine candidates for WHO prequalification, 2015,* https://www.who.int/publications/i/item/WHO-IVB-14.10

6) The Interagency Supply Chain Group - ISG, *Visibility for Health Systems: Adoption of Global Data Standards (GS1), 2017,* https://www.healthdatacollaborative.org/fileadmin/uploads/hdc/Documents/Working_Groups/ISG_Position_Paper_GS1_August_2017.pdf

7) USAID et al., *Global Standards Technical Implementation Guideline for Global Health Commodities.* USAID Global Health Supply Chain Program, 2019, https://www.ghsupplychain.org/sites/default/files/2019-07/20190327%20GSTIG%20V2.1_FINAL.pdf

8) GAVI, *GAVI announcement: vaccine manufacturer GS1 compliance,* UNICEF Supply Division, 2019, https://www.unicef.org/supply/stories/gavi-

announcement-vaccine-manufacturer-gs1-compliance

9) World Health Organisation, *Policy paper on traceability of medical products,* WHO Publications, 2021, https://www.who.int/publications/i/item/policy-paper-on-traceability-of-medical-products

10) Deloitte, *Securing trust in the global COVID-19 supply chain,* Deloitte White Paper, 2021 https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/gx-lshc-future-of-trust.pdf

11) WHO, *Substandard and falsified medical products, 2018,* https://www.who.int/news-room/fact-sheets/detail/substandard-and-falsified-medical-products

12) INTERPOL, *Fake COVID vaccine distribution network dismantled after, INTERPOL alert.* INTERPOL Publications, 2021, https://www.interpol.int/News-and-Events/News/2021/Fake-COVID-vaccine-distribution-network-dismantled-after-INTERPOL-alert

13) Fight The Fakes Alliance, *Updated statement regarding COVID-19 and falsified medical products – Fight the Fakes, 2021,* https://fightthefakes.org/updated-statement-regarding-covid-19-and-falsified-medical-products/

14) GS1 Healthcare, 2nd *Executive Dialogue,* https://www.gs1.org/docs/healthcare/ExecDia-2/GS1%20Executive%20Dialogue_EN_sub.mp4

15) GS1 Healthcare, 2nd *GS1 Healthcare Online Summit, 2021,* https://www.gs1.org/industries/healthcare/online-summit-2nd

Creating a secure and optimised supply chain in COVID-19 pandemic

Importance of standards utilisation in global logistics under a pandemic

Mike Meakin
Vice President, Global Quality Regulatory & Compliance,
DHL Supply Chain, UK

Introduction

Pandemics are defined as an epidemic phase of an infectious disease that spreads across large geographical regions. They are well-documented since the 14th century with perhaps the most fatal pandemic known as 'The Plague' which killed an estimated 75-200 million people. Hence, pandemics are not new and have struck about three times every century since the 16th century.

Logistics is known as the art of moving, handling and transporting people and equipment. The Cambridge Dictionary defines logistics as, "*the careful organisation of a complicated military, business or other activity so that it happens in a successful way.*" Logistics as a function is not new as the Ancient Greek and Romans had Military Officers called "Logistikas" who provided supply and distribution of materials to Roman Legions.

Today logistics are far more complex and have a larger focus on the flow of materials and information from its origin to its point of use to meet the needs of consumers, patients and medical practitioners. The world is now operating in the 4th Industrial Revolution with the Internet of Things (IoT). Digitalisation Logistics has become more about Just in Time (JIT), smarter and more agile which requires automation and synchronisation data to work effectively. This can only work with the use of efficient and effective global standards including data carriers, such as barcodes, and standards for communicating that are interoperable. In this article much of the work and case studies I refer are based on the experience with DHL and its divisions handling COVID-19 vaccines and distributing various COVID-19 diagnostic test kits and distributing specialised medicines including antibodies to treat patients suffering with the Severe Acute Respiratory Syndrome – Associated Coronavirus -2 (SARS-COV-2).

In the last century the world experienced 3 pandemics starting with Spanish Flu in 1918 that resulted in at least 50 million deaths with around a third of the world's population at that time c500 million becoming infected. The next major Pandemic nearly 40 years later "Asian Flu" in 1957 which killed around a million people and 8 years later "Hong Kong Flu" with another million deaths.

On the 11th of February 2020, SARS-Cov-2 was given the name by International Committee on Taxonomy of Viruses (ICTV) and on the same day the WHO announced the name of the new disease 'COVID-19'. A month later the WHO declared a pandemic on the 11th of March 2020, when the world had reported 118,000 cases in 114 countries and 4,291 people had sadly died. Eighteen months later, at the time of writing, the WHO Coronavirus Dashboard had reported nearly 217 million confirmed cases with four and a half million deaths. The world has been on a twisting and turning rollercoaster journey since the date the pandemic was declared which we are all still in the middle of.

Another development by many of the world's leading diagnostics and medical device manufacturers was producing test kits that could give rapid results. At the start of the pandemic, testing was limited to taking samples from patients and getting these processed in local laboratories. Whilst warehouses would hold test kits of influenza at the beginning of the pandemic, there was not an abundance of test kits. Testing created new logistical challenges in quickly moving test kits through supply chains for quick diagnosis. Reflecting on the past 12 months, it is astounding to see how many supplies of new test kits have been developed for Polymerase Chain Reaction (PCR) that require laboratory analysis, Lateral Flow Tests (LFT) that can be done quickly within the home in 15 minutes but are less accurate and Antibody tests which can tell if a person has immunity.

Moreover, the logistics required to support COVID-19 test kits has been a challenge. In the first three weeks of April 2020, DHL Global Forwarding shipped more than 1.3 million COVID-19 test kits from South Korea

The article is basically the translation of its Japanese issue (GS1 Japan Review, Vol.4, 2021), and is slightly modified as needed for English readers.

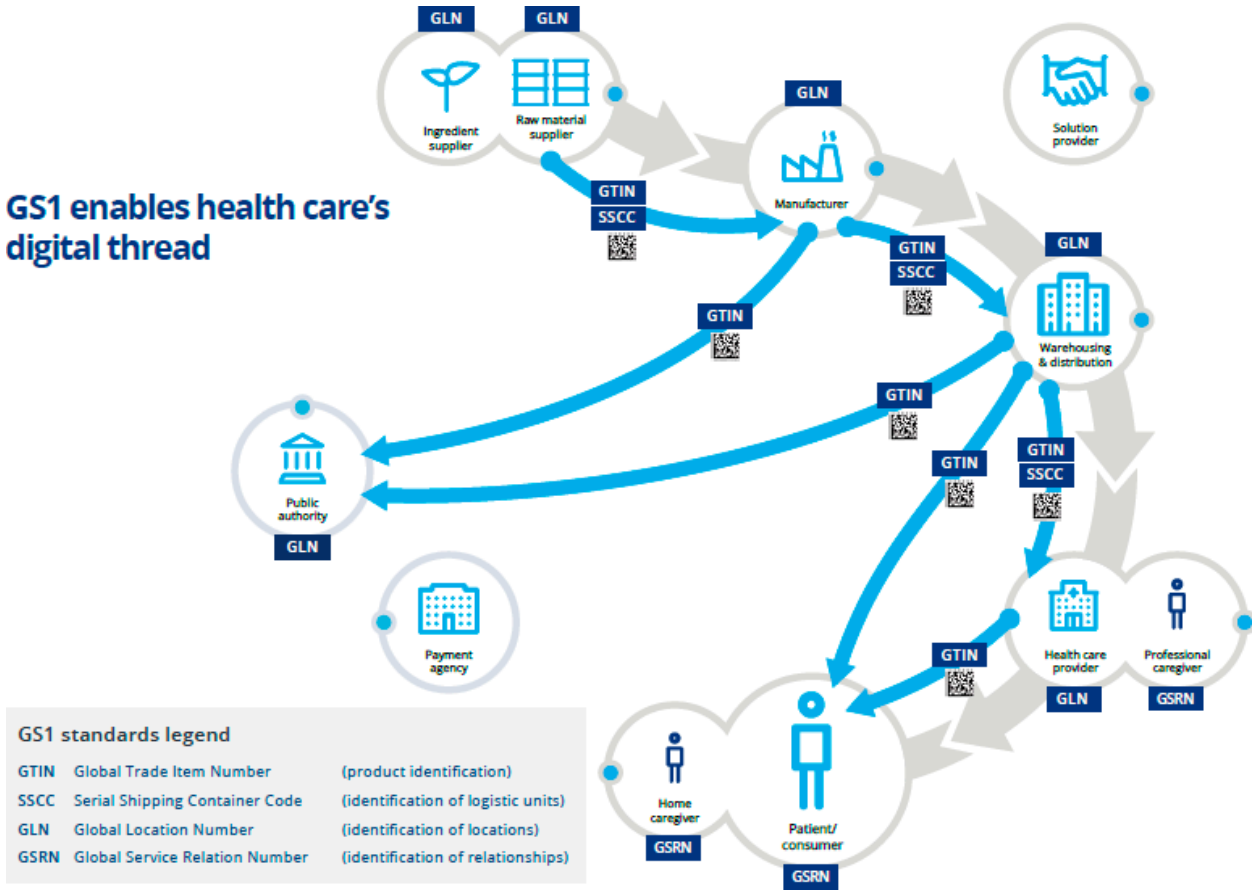


Figure 1 GS1 Healthcare Digital Thread

to Brazil, Ecuador, India, Lithuania, Poland and Russia. Thereafter DHL ISO 13485 certificated sites have been assembling kits on behalf of both manufacturers and Governments.

The supply of COVID-19 vaccines form a major part of this article, there are other healthcare products that have created challenge for global logistics. Whilst stocks of medical devices, including face masks, eye shields, gowns and gloves, were vital in protecting healthcare workers and preventing the spread of infections in healthcare settings, there was also the need to supply and transport diagnostic test kits and new medications and treatments. Fortunately, many of these did use global GS1 standards, principally Global Trade Item Number (GTIN) and Serial Shipping Container Codes (SSCC) established via recent international legislation, as seen in the figure below of the GS1 Healthcare Digital Thread (**Figure 1**), however, newer therapies threw up new challenges.

Whilst this article focuses on those standards seen within the digital thread, it is important to note there are a plethora of standards a logistics provider must comply with and the need to increase digitalisation. Many of these additional standards focus on temperature and traceability including International Air Transport Association (IATA) and Technology Asset Protection Association (TAPA) security standards to reduce losses in supply chains. To be permitted to store and distribute within the Healthcare field, global logistics companies must comply with over 40 different Good Distribution Practices) and GMPs (Good Manufacturing Practices), which are legal requirements enforced by drug regulators (GDPs), other guidelines and standards including ISO 13485 for fabricating test kits for manufacturers and Government bodies.

Accordingly, the optimised supply chains handled and delivered many known essential medicines and medical supplies which were urgently required. At the start of the pandemic, this did highlight and expose how supply chains have become more globalised from more local and national production. When the shortage of Personal Protective Equipment (PPE) hit the world in the spring of 2020, nations had to rely on their Air Forces to fly in essential medical supplies because inventories were concentrated on a few global hubs.

Background

Many countries around the globe have already experienced at least three waves with differing variants and lockdowns. It is amazing looking back over the past 18 months, since the official announcement of the pandemic, that COVID-19 vaccines were being administered in people within nine months - starting with 90 year old Margaret Keenan at University Hospital, Coventry in the UK on the 8th of December 2020. With Influenza pandemics, the plan was to take an approach of layered defense with a pre-pandemic vaccine and the use of antivirals and antibiotic medicines whist a specific pandemic vaccine was developed - which would be expected to take longer than six months to produce. Therefore, bringing out a pandemic vaccine for COVID-19, a novel disease, was remarkable as many would have thought that a vaccine would not be available until well into 2021 at the earliest.

In 2005, the WHO published its Global Influenza Preparedness Plan. That same year, other countries produced their equivalent plans.[1-3] Many corporations, at the same time, were also producing their own Pandemic Influenza Preparedness Plans (PIPPs), including my own company Deutsche Post – DHL in June 2007. Whilst we all know the COVID-19 virus is not Influenza, much of the planning for global logistics is germane.

On the 1st of March 2005, the UK Health Secretary John Reid and UK's Chief Medical Officer announced a protection plan that triggered the ordering of known antiviral medicines, Tamiflu (Oseltamivir) and Relenza (Zanamivir), together with other essential medicines such as antibiotics, medical devices and associated PPE (face masks and gloves). They then became stockpiled for a pandemic in many strategic warehouses with some of the products being deployed in the 2009 'Swine Flu Pandemic', the first pandemic of the 21st century.

2005 was the year GS1 created its Healthcare User Groups (HUGs) and started to develop and optimise global standards for medical devices and pharmaceuticals, including vaccines. Consequently during the time at which much of the Influenza Pandemic stocks came into national supply chains the deployment of global healthcare standards was still in its infancy.

Roll forward 15 years to the second half of 2020, it was great to discuss with the GS1 Healthcare Leadership team meetings that global standards were seen as vital to ensure we all learned from lessons in the past around being able to handle recalls, avoid adulterated and counterfeit medical products entering the supply chain.

It is amazing how all DHL Life Science & Healthcare (LSH) facilities continued to operate globally. No DHL LSH operation closed even in the epicentres. I recall how our initial plans for the pandemic envisaged large groups of workers not being able to turn up to work so we had prepared to move our resources to meet demand which did work well. This was helped where some industry sectors such as aviation and automotive whose warehouse and drivers were being impacted by national lockdowns the people were trained and redeployed as essential workers as part of Business Continuity Management (BCM) plans.

As countries came through their respective lockdowns, DHL were able to review their BCM Emergency Preparedness Plans. I recall initially where our operations are certified to ISO22301 and they looked at issues with driver and staff shortages. On Friday the 13th of November 2020 (a superstitious day in western culture), we did have a day where we had around 200 drivers off sick or self-isolating in the Milan area, but our plans were resilient in ensuring our service continued to plan.

A lot of people issues were managed by the company following the guidance of working in facilities like social distancing, wearing appropriate PPE and having additional hygiene resources in place. Operations undertook measures to have office staff operate from home and those on sites were split into A & B workforces.

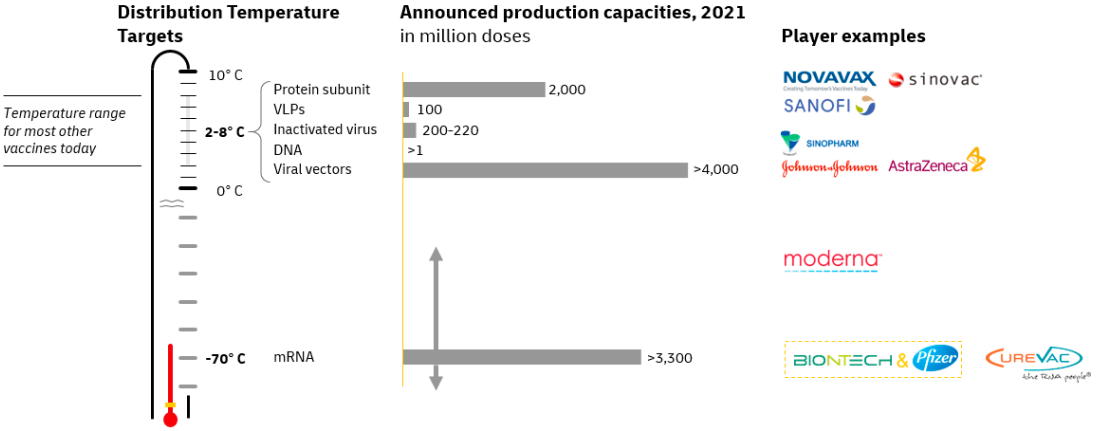
DHL campus operations, which would have multi warehouses in a close proximity, had similar rules where people would avoid moving and mixing between these facilities.

Planning and preparing – Delivering pandemic resilience

During the summer of 2020, it became clear from most manufactuers that their vaccines would have to be stored and handled at Ultra Low Temperatures (ULT). From expert interviews[4] from several vaccine manufacturers conducted last year the picture emerging by August 2020 was that the mRNA vaccines would require storage at -70°C whilst most of the Viral Vector vaccines, like the Oxford-AstraZeneca COVID-19 vaccine, would need 2-8°C storage and distribution capabilities (**Figure 2**).

Further reseach from sources like the World Bank and McKinsey, DHL[4] recognised the world would require approximately 10 billion vaccines for a global population of 7.8 billion people. Therefore, to immunise about 70% of the world's population to achieve herd immunity based on an average of 1.8 doses per person, there was a huge logistical task building to get the most

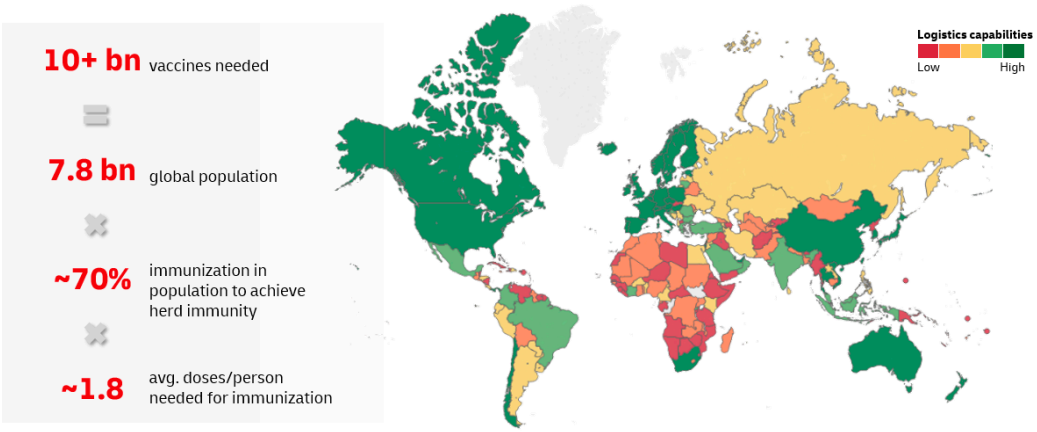
Shortened development cycle of vaccines to meet ambitious schedules can require distribution at deep-frozen temperatures for a potentially sizeable volume share



Source: Press search, company statements, expert interviews, DHL, McKinsey – last updated on the 13th of August 2020

Figure 2 Distribution of vaccines at deep-frozen temperature

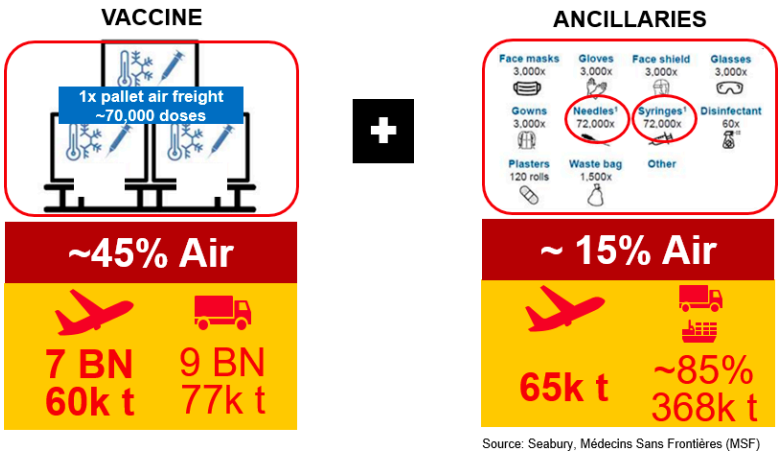
10bn+ COVID vaccines need to be distributed to countries with vastly varying climates and logistical capabilities



Source: World Bank; DHL; McKinsey

Figure 3 Distribution of COVID-19 vaccines and global climate

ANCILLARIES - Vaccine ancillaries may contribute more to airfreight than vaccines, growing challenges in Diagnostics



Source: Seabury, Médecins Sans Frontières (MSF)

Figure 4 COVID-19 vaccines and ancillaries

of the world vaccinated. Furthermore as seen from the coloured world map (**Figure 3**), there were some countries where logistics capabilities were limited to be able to distribute vaccines at low temperatures.

From further analysis and reports from the media Bloomberg [5] and other sources, DHL were aware that to fly vaccines around the world airlines faced a 'Mission of the Century.'

Administering the vaccine requires a variety of accessories to be in place at the moment the vaccine arrives as a result the airfreight demand on ancillaries was seen as exceeding the one for vaccines. There is an estimate factor x3 on weight in terms of Ancillaries versus Vaccines. With a wide range of suppliers in China, India, across Europe and the USA, DHL could see, whilst not all transportation would be done by air, 15% shipments by air was a greater volume than the vaccines (**Figure 4**).

With information DHL captured on a weekly basis as the Deloitte Analysis showed on the 25th of November 2020, many High Income Countries (HICs) had already contracted millions of doses from several manufacturers before the vaccines had been approved for emergency use by drug regulators like the FDA, EMEA or UK's MHRA (**Table 1**).

The Advance Market Commitments by country income initially showed logitistics companies were likely to be servicing HICs, shown in orange in **Figure 5**. Manufacturers of mRNA vaccines that have been stored in Ultra-Low Temperature (ULT) freezers, did advise in late 2020 they could be stored in a fridge at a hospital or vaccination centre for five days at 2-8°C or in qualified 'passive' thermal shippers (temperature controlled packaging), in which the doses are kept in dry ice for 15 days. This key information then helped DHL design its various archetype logistics models.

Evaluating the vaccines demand towards the end of 2020 based on AstraZeneca, Moderna and Pfizer it was clear the mRNA ULT frozen vaccines were being required by HICs with the majority required in Continental Europe (**Figure 6**).

Regarding ULT temperature distribution, as identified in the Deloitte, 'Securing trust in the global COVID-19 supply chain.[6], quoted DHL as having ULT operations in mainly 25 high income countries across the globe. ULT freezers in DHL were primarily used for distribution of biologics and orphan drugs for rare diseases and clinical trials medicines that are handled in low volumes (**Photo. 1**).

Moreover freight forwarders, who were shipping bulk products, were being asked for solutions to be able to maintain ultra low temperatures. So, as part of DHL's planning and preparation, it needed to evaluate and look to innovate 'active' and 'passive' solutions that

Table 1 Vaccine manufacturers and number of doses contracted by country or group

	Vaccine Manufacturers & Doses Contracted*								
Country / Group	Pfizer/ BioNTech	Moderna	JNJ	AstraZeneca	Sanofi / GSK	Novavax / Takeda	CureVac	Valneva	Sinovac
USA	100M (initial purchase w/ opp to buy add'l 500M)	100M (initial purchase w/ opp to buy add'l 400M)	100M	300M	100M	100M	n/a	n/a	n/a
European Union (EU)	200M (initial purchase w/ opp to buy add'l 100M)	160M	200M (initial purchase w/ opp to buy add'l 200M)	400M	300M	n/a	225M (initial purchase w/ opp to buy add'l 180M)	n/a	n/a
Japan	120M	50M	n/a	120M	n/a	250M	n/a	n/a	n/a
United Kingdom	40M	5M		100M	60M	60M	n/a	60M (initial purchase w/ opp to buy add'l 130M)	n/a
Latin America (excluding Brazil)	n/a	n/a	n/a	250M	n/a	n/a	n/a	n/a	n/a
Brazil	n/a	n/a	n/a	100M	n/a	n/a	n/a	n/a	120M
Canada	20M	56M	38M	n/a	72M	76M	n/a	n/a	n/a
Australia	10M	n/a	n/a	33.8M	n/a	40M	n/a	n/a	n/a
Indonesia	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	40M

*Data as of November 25, 2020
Source: Deloitte Analysis

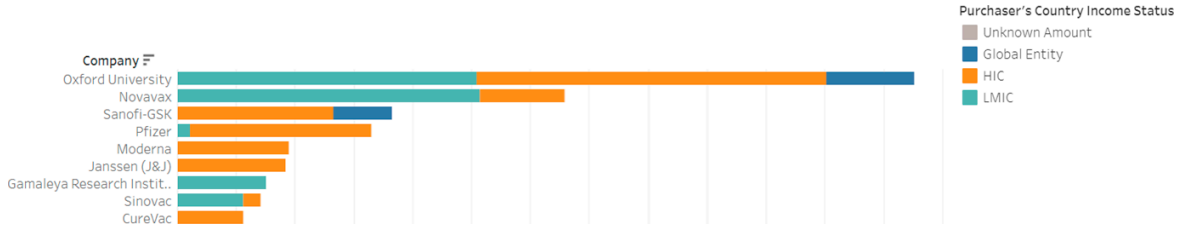


Figure 5 Advance Market Commitments by Vaccine and Country income

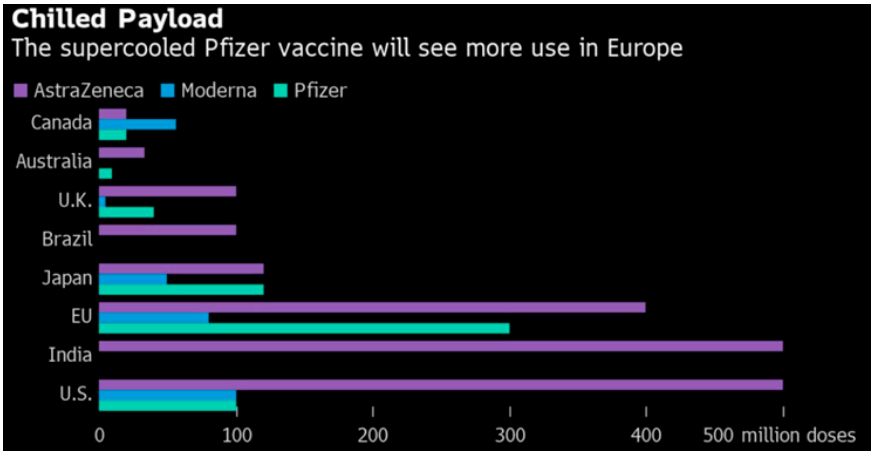


Figure 6 Estimating vaccine demand

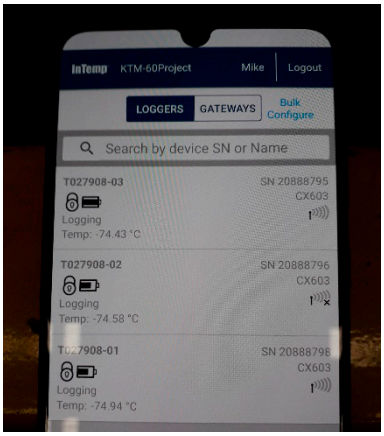


Photo. 1 ULT freezers in DHL

could meet the demands of operating at -70°C. Deep frozen operations at -25°C are common throughout DHL with many countries having drive-in and walk-in chambers around the globe where staff can work with warm protective clothing, operating at -70°C is different. Batteries in many temperature monitoring devices struggled at these very temperatures so other devices needed to be sourced as part of the solution.

In terms of 'passive' solutions DHL had experience. The tried and tested KT400D-60 performs well at between minus -80°C to -60°C for >120 hrs in hot conditions. It is an ideal solution in shipping to countries in the orange/brown hot coloured georphapical areas. As a result, DHL did investigate what could be achieved if we qualified the equipment using deep frozen vehicles and drive in deep frozen storage units at below -20°C to extend the ULT capabilities with dry ice. In conjunction with Tower Cold Chain solutions, using 250 kg of dry ice per unit, which holds 2 full euro pallet size of product, we could plan a re-ice in <10 mins and recover back to >-70°C in about 15 mins. The product could be stored at this temperature for 9-10 days. It also proved to DHL and Tower Cold Chain it was possible to fly from any continent where the fight and transit times exceeded 20 hours we found innovative solutions on shipping products.

The need for a storage solution for vaccines in ULT freezers was the way to maintain COVID-19 vaccines at temperatures at -70°C. However, there were numerous challenges with setting up this type of solution for high volume products. This meant the inbound and outbound process for handling shippers was planned and practised like a "Formula 1 racing team pit stop". The doors of the freezers, once opened, take up to 25 - 30 minutes to return to -70°C, so planning the use of ULT freezer farms is challenging.

There were other logistical problems in that it was difficult to secure supplies of ULT freezers from the main global producers. The ULT freezers had to be qualified and validated before use. The ULT freezers had to be redesigned from handling '2 inch' (50.8 mm) draw samples to having a new shelf design whereby vials in vaccines were stored and distributed in 'pizza' type boxes with hundreds of vials contained in the secondary packs.

The other challenge for DHL was who the customers were. In some cases, DHL dealt with the actual vaccine

Photo. 2 ULT freezer farms established in Northern Europe

manufacturer but, in many cases, DHL dealt directly with government agencies - known as 'Public Sector' in DHL – we would be involved in storing the vaccines on behalf of Government agencies so DHL managed the vaccines at -70 °C before being shipped to vaccination centres.

This resulted in where DHL set up ULT freezers, the operations were having to qualify their equipment so it could handle any of the mRNA vaccines. DHL quickly found by the beginning of 2021 we were handling and distributing all types of COVID-19 vaccines so the business was able to impart its knowledge and experience to other countries increasing capability and capacity. ULT freezer farms established in Northern Europe were able to advise their Australian colleagues of the settings shortly after (**Photo. 2**).

DHL COVID-19 global logistics

DHL's global COVID-19 logistics supply chain[7)] is well summarised by the graphic in **Figure 7**.

DHL supply chain also undertook several COVID-19 logistics solutions around the world as listed below:

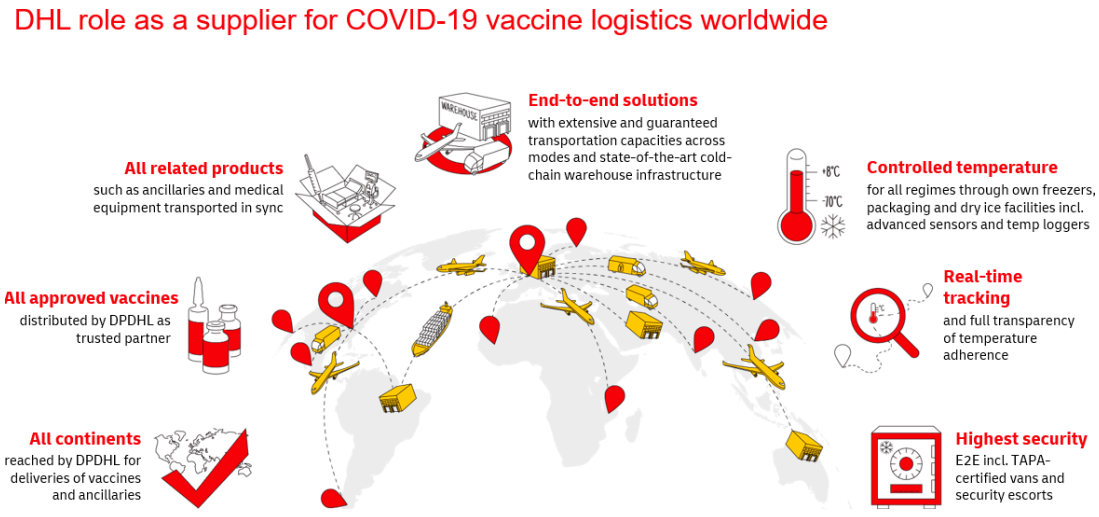


Figure 7 DHL role as a supplier for COVID-19 vaccine logistics worldwide

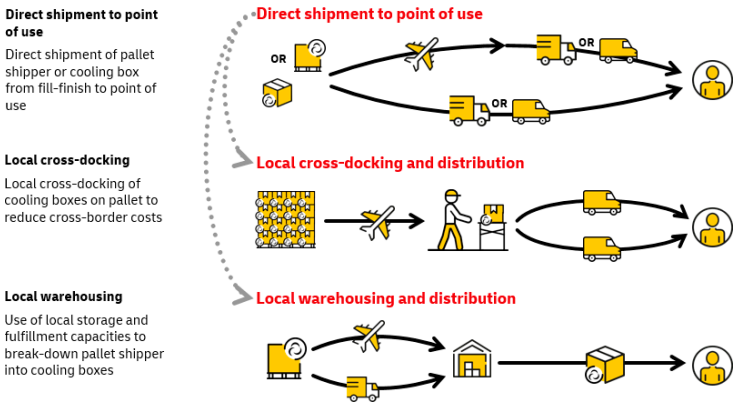


Figure 8 Three supply chain archetypes

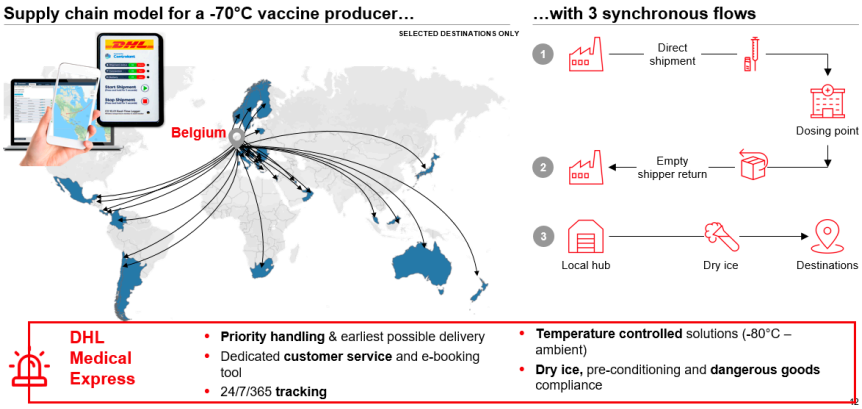


Figure 9 DHL case study direct shipments of COVID-19 vaccines to >25 countries

- A Phase III clinical trial of COVID-19 viral vector vaccines in Japan at ultra-low temperatures
- Set up of new emergency hospitals and testing centres
- Formation of off-site hospital consolidation centres
- Transportation of infected COVID-19 patients to and from hospitals in ambulances
- Establishment of COVID-19 test kit facilities
- Procurement and storage and distribution of PPE
- Supporting in the build of ventilator equipment
- Control towers and call centres coordinating country supplies of vaccines and ancillaries
- Postponement manufacturing and serialisation of COVID-19 mRNA vaccines

A number of the foregoing logistics solutions involved the use of global standards, in particular the building of diagnostic test kits and the late stage customisation and serialisation solutions, required DHL to apply 2D data matrix barcodes and GTINs to COVID-19 test kits.

DHL, at global level, saw three supply chain archetypes being developed as highlighted in **Figure 8**. Some countries built on their existing vaccines distribution models, i.e. via traditional wholesalers, however, it quickly became clear many governments set up new supply chains often involving the military to control supplies of COVID-19 vaccines.

1. Direct shipment to point of use

2. Local cross dock

3. Local warehousing – Distribution centres

Consideration for the choice of logistics archetype would depend on the following criteria

- Supply assurance and in-country stock levels
- Lead-time to deliver vaccines, diagnostic test kits
- Availability of infrastructure
- Availability of packaging
- Temperature requirements
- The local warehousing could be more bespoke and use further traceability standards

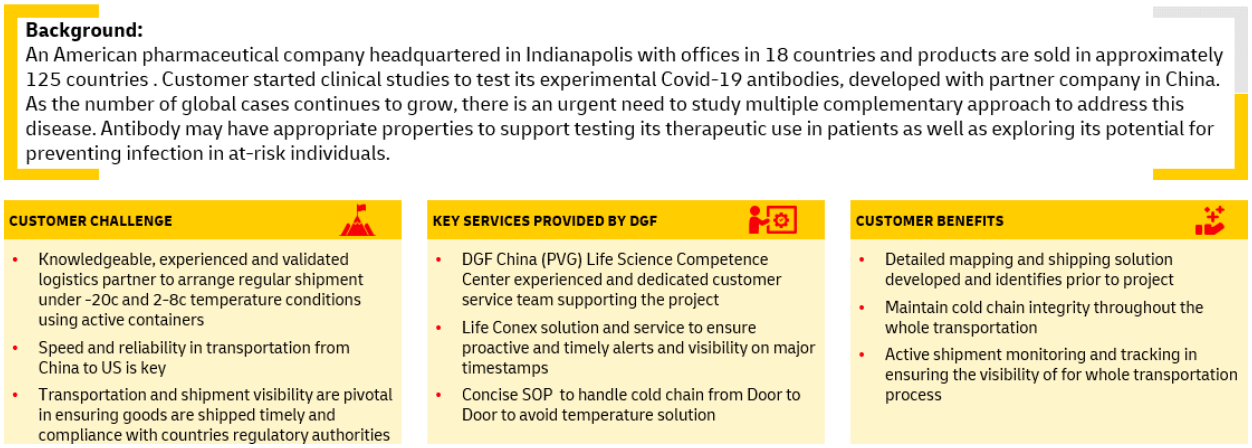


Figure 10 China-Case study (Air Export of Covid-19 antibodies)

- ULT did pose some challenges to Public Sector distribution and traceability, e.g. full track and trace

The 'Direct shipment to point of use' archetype is seen and discussed in the below case study where vaccines were distributed from Belgium to over 25 countries for one of the initial COVID-19 vaccine manufacturers. New local warehousing and distribution centres supported by -70°C ULT freezer farms.

DHL COVID-19 case studies

This article will discuss some global logistics solutions:

1. Direct shipments from a manufacturer's factory in Belgium to over 25 countries globally
2. COVID-19 Vaccines Global Access (COVAX) COVID-19 vaccines shipped direct to over 100 countries from the Netherlands (**Figure 9**)
3. Air export of COVID-19 antibodies from the USA to China
4. Local warehousing of COVID-19 vaccines into Northern European vaccination centres
5. Assembly of serialised diagnostic test kits that tracked a patient with the Brazilian variant

Direct global shipments from Belgium

Whilst much of the track and trace of the vaccines from Belgium was done via Air WayBills (AWB) and the use of 'cargo tracking devices' (temperature loggers) in accordance with IATA[8,9], similar project was launched between GS1 Hong Kong and DHL Germany to look at the traceability of COVID-19 vaccines manufactured in Germany and shipped direct to Hong Kong to demonstrate the use of global standards.

Direct COVAX shipments

Another variation of the 'Direct shipment to point of use' archetype logistic model has been to set up a warehouse to handle viral vector vaccines for the COVAX ACT-Accelerator based in the Netherlands. The vaccines are flown direct from Schiphol Airport, Amsterdam to over 100 countries across the globe. This saw vaccines being flown in from South Korea where the first batches were manufactured in early 2021 and being then flown back into Asian countries such as Mongolia and the Philippines.

COVAX, founded in April 2020, is a worldwide initiative by Global Alliance for Vaccines and Immunization (GAVI). By July 165 Countries, 60% of the human population, had joined COVAX. Therefore, it was satisfying for DHL to be part of this initiative that within a year of this global initiative COVAX COVID-19 vaccines were being distributed to low income countries within weeks of vaccines being distributed to high income countries.

Air export of COVID-19 antibodies from the USA to China

As COVID-19 vaccine studies were going through their respective clinical trial phases, DHL also found as part of its normal distribution of biologic medicines and pharmaceuticals there was a requirement to distribute for leading biological manufacturers to distribute their specialist medicines to treat COVID-19 patients. Before the COVID-19 vaccines became available during 2021, DHL was also being asked to ship COVID-19 antibodies as illustrated in another case study described in **Figure 10**.

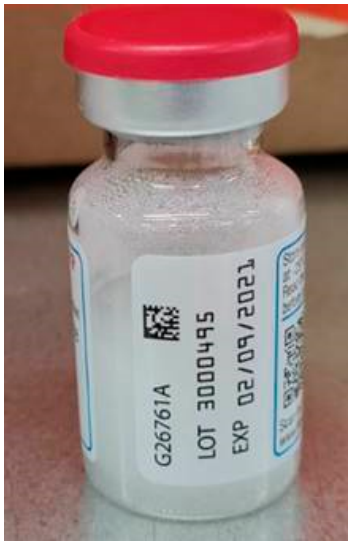


Photo. 3 QR code link to expiration date is printed on the very right side of the vial in the photo.

Local warehousing of COVID-19 vaccines into Northern European vaccination centres

One of the first COVID-19 vaccine distribution solutions that the DHL local warehousing logistics archetype involved a strategic DHL ULT freezer farm located in the Netherlands that held other country regions' COVID-19 vaccines. The COVID-19 vaccines were shipped into the facility by the Military and then DHL arranged using its supply chain to deliver direct to vaccination centres.

During one shipment staff in the facility staff discovered during their outbound process checks that lot number and expiry dates were not printed on some secondary packs containing mRNA COVID-19 vaccine vials. Due to this the team put the whole batch was placed in quarantine as this became treated as a suspected counterfeit or adulterated product.

Recorded events of countries having identified counterfeit vaccines is not so rare, there had been 16 reported cases around the world of counterfeit Rabies, Meningitis, Cholera vaccines since 2015 and during 2020 fake COVID-19 vaccines had been identified in Russia and Ecuador.[10)]

DHL staff performed a 100% check on the full shipment and found no further deviations. To further enable their investigation, DHL staffs were requested by manufacturer to open the quarantine packs and to check the vials. They did find the correct lot number and expiry date, 02/09/2021, on the vials as seen in **Photo. 3**. And it was also noted both a 2D datamatrix and a QR code are printed on the vial. It was interesting to find the QR code which was linked to the expiry date at the latest information. I have also seen the QR code use case on a viral vector COVID-19 vaccines of other company where there are videos available that explain

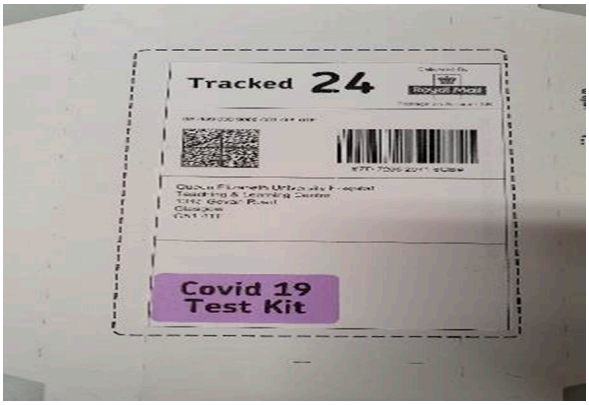


Photo. 4 COVID-19 test kits barcoded with GTIN

their use further (https://www.janssencovid19vaccine.com/hcp/check-expiration.html). These QR codes are used to check the information including expiry date because these vaccines are approved for emergency use and expiry date may be extended during distribution.

Assembly of serialised diagnostic test kits that tracked a patient with the Brazilian variant

DHL operations undertook a number of projects in Europe where our Supply Chain business assembled COVID-19 diagnostic test kits on behalf of medical device manufacturers and Governments. These included COVID-19 test kits of people entering the UK. The Department of Health provided DHL with several unique serial numbers to be applied to parts of the kit, i.e. test tubes, swabs etc., as seen in **Photo. 4**. The kits were supplied with a GTIN so did comply with basic global standards.

During February 2021, the UK government had found six cases of a new Brazilian variant had entered the country from passengers who had arrived on recent flights. The Government officials had quickly tracked five of the passengers but a sixth had gone missing because contact details were not given. The Government were keen to track the individual to put in measures to prevent a new variant spreading.

Because there was a unique serial number on the tube with the test sample, DHL was able to go through over 60 million serial numbers and locate the address of the sixth passenger. As the process was not digitalised at the time this was a manual exercise but they found the patient isolating by the authorities from the data provided by DHL.

Conclusion

DHL's experience during the COVID-19 pandemic has confirmed GS1 standards are in place and there are good practices where key stakeholders in the supply chain can and do use them as identified in the excellent article in Vaccine[11] and Deloitte's Paper on securing trust in the Global COVID-19 supply chains.[12] The experience DHL has found from the COVID-19 pandemic is the Standards are not universal. The 2D barcode GS1 DataMatrix is not used everywhere, and by everyone in the supply chain, unless mandated by law, so for patient safety needs the process is reliant on good authentication of barcodes at the point of use in hospitals and vaccination centres. Therefore a takeaway is the global pandemic reinforces the need for global standards and further standardisation. There is a case more digital standards are required in transportation. Having the barcodes in place is one part of the solution but without interoperable digital systems, as DHL found with the investigation into test kits, what should have taken a matter of minutes to track a patient took a few days of working through millions of items of data.

It is quite clear the COVID-19 Pandemic has seen a greater use of QR codes deployed in new user cases on primary unit vials such as managing expiry dates on COVID-19 vaccine vials, and increasingly seen on the actual rapid antigen diagnostic test kits that enable automatic scanning by patients to upload into healthcare systems and vaccine passports. The use of QR code technology requires further development to see if their use should form part of global standards going forward.

Moves towards strategic global manufacturing and lean logistics with fewer inventory stock points has seen a trend back to more traditional logistics methods with countries having their own strategic stocks. It was clear at that production of COVID-19 vaccines would be done locally using in country vaccine producers to produce vaccines under license. As of the 1st of September 2021, it became law in France that two months inventory of essential medicines needs to be available for use in the country. At the start of the pandemic the world did witness 'COVID-19 Nationalism', preventing the export to other countries.

COVID-19 pandemic has led to a number of new innovations in packaging, tracking vaccines and other healthcare products with use of cargo tracking devices and contract/postponement manufacturing of COVID-19 vaccines. Whilst postponement manufacturing or late stage customisation of vaccines where logistics providers are engaged as a Contract Manufacturing Organisation (CMOs), such as the final packaging and labelling including applying serial numbers, is not new the activities of handling nude vials at ultra-low temperatures has resulted in innovative solutions.

A large proportion of the world's COVID-19 vaccines (45%) and medical devices (15%) are distributed as airfreight, this means to meet IATA standards cargo tracking devices that have GPS and temperature tracking capabilities are equally important as GTIN and SSCC bar codes. As air cargo follows IATA rules when it comes to the identification of the AWB this means the AWB numbers do not follow GS1 or ISO standards. However, the IATA regulations does allow for the identification of the transport units using ISO 15459 which means freight forwarders can use GS1 SSCC. This highlights an opportunity for the logistics industry to support GS1 standards linking SSCC with the Airline Industry and IATA. It would be ideal if GS1 and IATA standards could support each other more effectively.

As the world is starting to evolve back to traditional vaccine distribution, the investment into ULT freezer farms will enable further developments in Cell Gene Therapies (CGTs) and personalised medicine distribution in the future.

The COVID-19 pandemic has been a rapid rollercoaster journey operating in a highly regulated environment. Some countries adopted current supply chain models and adapted and changed their logistics models by using their military to secure supply chains. It has been amazing what can be achieved, none of the DHL Healthcare operations closed anywhere during any wave of the pandemic and it has been great to have been part of this journey.

Author

Mike Meakin has 40 years' experience within healthcare and chemical logistics, including pharmaceutical wholesale operations. Over 23 years, he has been focusing on healthcare logistics covering biologics, medical devices and pharmaceuticals. He has also spent the last 15 years engaged with the GS1 Healthcare sector and has been part of GS1 leadership team for nearly half of that time. His current role as Vice President Global Quality & Regulatory Compliance is based on DHL's dedicated Life Sciences & Healthcare global network with over 200 pharmaceutical warehouses around the world supported by over 175 DHL dedicated pharmacists and quality managers.

References

1) NHS, *Explaining Pandemic Flu, A guide from the Chief Medical Officer,* February 2005

2) NHS, *Pandemic FLU, UK INFLUENZA PANDEMIC CONTINGENCY PLAN*, October 2005

3) Homeland Security, *National Strategy for Pandemic Influenza*, November 2005

4) DHL, *Delivering Pandemic Resilience*, white paper, Sept 2020

5) Supply Chain Brain, *Airlines Face Mission of the Century in Shipping Vaccines*, November, 2020 https://www.supplychainbrain.com/articles/32279-airlines-face-mission-of-the-century-in-shipping-vaccines

6) Deloitte, *Securing Trust in the global COVID-19 supply chains* - Chapters "Anticipating challenges for safe and efficacious delivery of vaccines" and "Optimizing delivery and last mile cold chain challenges."/Deloite White Paper, 2021

7) DHL, *Revisiting Pandemic Resilience* White Paper, May 2021

8) IATA, *Guidance for Vaccines and Pharmaceutical Logistics and Distribution Edition 1*, 16 November 2020

9) IATA, *Guidance for Vaccines and Pharmaceutical Logistics and Distribution Edition 5*, 1 June 2021

10) Jarret, S, Wilmansyah T et al., *The Role of manufacturers* in the *implementation of global traceability standards in the supply chain to combat counterfeiting and enhance safety monitoring*, Vaccine, November 2020

11) R.H.Vander Strichle, Christian Hay, et al., *How to ensure we can track and trace global use of COVID-19 vaccines?,* Vaccine, 2020

Ensuring supply chain reliability for COVID-19 vaccines

What we achieved from the COVID-19 vaccine supply system and issues to be solved.

Yoichi Kaminishi
Life Science & Healthcare Director, Deloitte Tohmatsu Consulting LLC

Introduction

Almost two years have passed since the outbreak of COVID-19.Healthcare professionals have been working very hard with the burden as never before, and people are still exposed to the never-ending picture.

In such circumstances, ensuring the reliability of the supply chain is essential for the delivery of safe and secure vaccines. In this article, global trends, as well as the current status and issues in Japan, in the supply chain, are discussed in greater depth.

Global trends in the vaccine supply chain

Deloitte is one of the world's largest professional services organisation in the fields of audit and assurance services, consulting, financial advisory, risk advisory, tax services, and related professional services. It provides services to 80% of 'Fortune Global 500' companies through member firms spread across more than 150 countries and regions, and the global network of related corporations (collectively, 'Deloitte Network').

Moreover, it publicises various surveys and information on the COVID-19 vaccine supply chain. This article outlines four elements with regard to ensuring reliability of vaccine distribution by referring to the report entitled 'Securing trust in the global COVID-19 supply chain'.

1. Encouraging industry collaboration

Multiple COVID-19 vaccines have been approved owing to unprecedently quick development, clinical trials, and expedited review, which came from collaborative work among pharmaceutical companies, regulatory bodies, and other stakeholders from the beginning of the spread of the virus. It was truly impressive, but on the other hand, we could easily conceive of the complexity of vaccine distribution across the world to meet the demands in a fair and equitable manner. It was predicted that the already complicated supply chain might get worse as vaccines needed two doses at certain intervals (discussion about three is starting now) so that the distribution should meet the prompt shot schedules.

Under such circumstances, it is obvious that collaboration among entities, regardless of the entity formation, such as governments, Non-Governmental Organisations (NGOs), private companies, and others is desired.

A notably great movement was initiated by the public-private partnership 'Gavi the Vaccine Alliance' to collectively secure the necessary number of vaccines for developing countries to improve immunisation coverage. Many organisations, including the WHO, UN, UNICEF, Coalition for Epidemic Preparedness Innovations (CEPI), Pan American Health Organization (PAHO), World Bank, Bill and Melinda Gates Foundation, and others, have been cooperatively working with Gavi.

2. Ensuring traceability throughout supply chain

Ideally, a traceability system can uniquely identify products throughout the globe, including drugs, medical devices, and consumables. Without correct product identification (product ID, lot number, and expiry date), healthcare providers and patients are not confident about the right drugs and face difficulties providing the right medical services.

During the COVID-19 pandemic, where vaccine demands significantly surpassed supply, unbalance of supplies and stocks, the incursion of counterfeit vaccines, and the recall of contaminated products required prompt actions to settle. The International Criminal Police Organization (ICPO) warned countries to be vigilant against the invasion of such drugs after local police charged a false vaccine supplier in northern

The article is basically the translation of its Japanese issue (GS1 Japan Review, Vol.4, 2021), and is slightly modified as needed for English readers.

South Africa and found 2,400 doses of it in a warehouse in December 2020.

In order to ensure safety and traceability, WHO recommends utilising DataMatrix (2D symbol) to identify the product type, and expiry date, lot number, and serial number of those products. The WHO recommends the symbol be displayed not only on the secondary packages, but also on the primary packages such as vials, prefilled syringes, and others, indicating their strong intention of securing traceability.

3. Optimising distribution channels for cold chain

Another major logistical challenge for the COVID-19 vaccines is to meet various storage and handling demands accordingly for each type of vaccine. It has been implied that meeting the prerequisites for the logistics, which require sophisticated cold chains, over the countries is an enormous challenge. According to the German logistics company DHL, there are only 25 countries worldwide, which have cold chains with ultra-low-temperature (ULT) systems satisfying the logistical prerequisites of COVID-19 vaccines, including the Pfizer vaccine.

Even those countries that meet the requirements have planned their logistics systems as simply as they can to ensure the requirements.

In the US, logistics service providers, designated by the Centers for Disease Control and Prevention (CDC), deliver the vaccines directly to the vaccination sites, and in Europe, a number of countries are planning to set up large-scale vaccination sites.

This suggested that western and other industrialised countries were concerned about possible difficulties supplying vaccines to rural and remote areas. Balancing 'assured quality' with 'accessibility to healthcare' will continue to require flexible leadership.

4. Communicating and supplying information on vaccines clearly and transparently

The question, which remains at the end, is whether people agree to vaccine shots even though vaccines can be delivered in a timely and safe manner. Right now, most vaccines are mRNA types, which have received accelerated approvals, and people are continuously arguing about their safeness.

Ipsos conducted an awareness survey on COVID-19 vaccine shots in collaboration with the World Economic Forum (WEF) for 15 countries in January 2021. About 73%, by a simple average, of valid responses, were 'had the intention to get vaccinated' when the vaccines became available to them. Per contra, about 27% were unaffirmative against the shot, and in the report, they noted that the number cannot be disregarded, as, in many countries and regions, immunisation is possibly left to the independent judgement of people, and if it is refused, the shot rate will not be increased. This is because vaccination is likely to be a voluntary option in many countries or regions, and the vaccination rate will not increase without individual acceptance.

There have been many attempts to lessen the number, resolving the 'suspiciousness'. At the London School of Hygiene & Tropical Medicine (LSHTM), they are facilitating their research in the Vaccine Confidence Project and, in the project, listening to early warning signals of public confidence losses of COVID-19 vaccines. The CDC has announced its 'COVID-19 Vaccine Confidence Strategy' guidance for building trust in COVID-19 vaccines and is deploying multilateral communication strategies to reinforce confidence in COVID-19 vaccines.

Vaccine supply chain in Japan, status quo and challenges

Having explained the global trends above, the Japanese situation is explained hereafter. In Japan, vaccination began with healthcare professionals on 17 February 2021, followed by elderly people on 12 April, and the government announced that 49.8% of citizens had their second shot by 9 September. Although this percentage exceeds the global average (29.5%), it is placed regrettably in the very last spot among G7 countries as of 10 September 2021, according to 'Our World in Data (OWID)' operated by Oxford University.

There is no doubt that, due to the international competition, it is really hard to secure enough vaccine vials for safe delivery to each vaccination site of municipal corporation during the current pandemic. Even so, in the situation we may have to live with COVID-19, reviewing the status and issue of the vaccine logistics and supply chain has a certain value for further strengthening their reliability. To help you better understand the current situation in Japan, this section reviews and discusses it from three perspectives.

1. Securing necessary items from around world

As of September 2021, five domestic companies, AnGes, Inc., SHIONOGI & Co., Ltd., DAIICHI SANKYO COMPANY, LIMITED, KM Biologics Co.,Ltd., and Takeda Pharmaceutical Company Limited, have been running clinical trials on 'national vaccines', and some of them are expected to start supplying by the end of the year. A 'national vaccine' approval is highly significant

for safe medical services, even from the supply chain perspective, as the vaccine battle is deemed to continue in the world.

Although, indeed, the national vaccine development is not catching up with other foreign pharmaceutical companies. Despite the fact that the Japanese government has hastily budgeted JPY 60 billion for a second supplementary budget for the R&D of COVID-19 vaccines and therapeutic drugs, it also reminded us of the necessity of anticipating potential threats to the assumption of what should be prepared for them, even in ordinary times.

For instance, Moderna, Inc. in the US furthered its global reputation with their COVID-19 vaccine, and this fruitful outcome was made possible by their persistent long-term pursuit of the development of their mRNA technology in ordinary times. Their success is partly owing to the award supports from the US government; they received $ 25 million from the Defense Advanced Research Projects Agency (DAPRA) of the U.S. Department of Defense (DoD) in 2013 and $ 125 million from the Biomedical Advanced Research and Development Authority (BARDA) of the U.S. Department of Health and Human Services (HHS) in 2016.

In Japan, following the H1N1 influenza pandemic, the governmental advisory council proposed to support vaccine companies and to propel the developments in 2010, and the National Institutes of Biomedical Innovation, Health and Nutrition (NIBIOHN), a national R&D corporation, promoted the development. However, over time, funding for vaccination clinical trials has been significantly reduced, and in 2018, the plan was frozen.

Remember that during the start of the outbreak, in addition to the vaccines, there was a severe shortage of many other vital goods including mechanical ventilators, pulse oximeters, and medical equipment like face masks, which was in some respects related to the supply chain operation. Other concerns about the supply risk of the goods and materials may exist, but it is assumed to have been challenging to properly track and trace the logistics situation of foreign active pharmaceutical ingredients and components, which is due in part to Japan's heavy reliance on overseas companies for such items. This goes beyond merely advocating a 'return to domestic services', since it is crucial from the standpoint of a stable supply to visualise what is imported from which providers and what kinds of vulnerabilities and risks lie behind in the supply chain. Personally, I think that such supplier management falls mostly under the responsibility of individual manufacturers and distributors, but in the event of a pandemic, if a supply shortage problem develops across the nation, it might be desirable to monitor supply risk at the national level.

Although it is unrealistic to visualise the operations and personal risks that individual supplier owns, it is important to apprehend the degree of dependency on specific countries and manufacturing sites and to proactively foresee supply risks in Japan considering various circumstances. Such contingency measures should be discussed in view of the likely future situation.

2. Ensuring traceability in broader end-to-end supply chain

As is widely known, the Japanese government launched the 'Vaccine System (V-SYS)' to streamline the logistics and supply of vaccines. (**Figure 1**) The entire supply chain flow for vaccines begins with the government, which then allocates a volume to each prefecture, which then distributes it to each municipality, and finally, delivery companies (including pharmaceutical wholesalers), which deliver the allocated amounts to each vaccination site in accordance. A single delivery company appears to have been designated in a municipality, to mitigate possible delivery complexity.

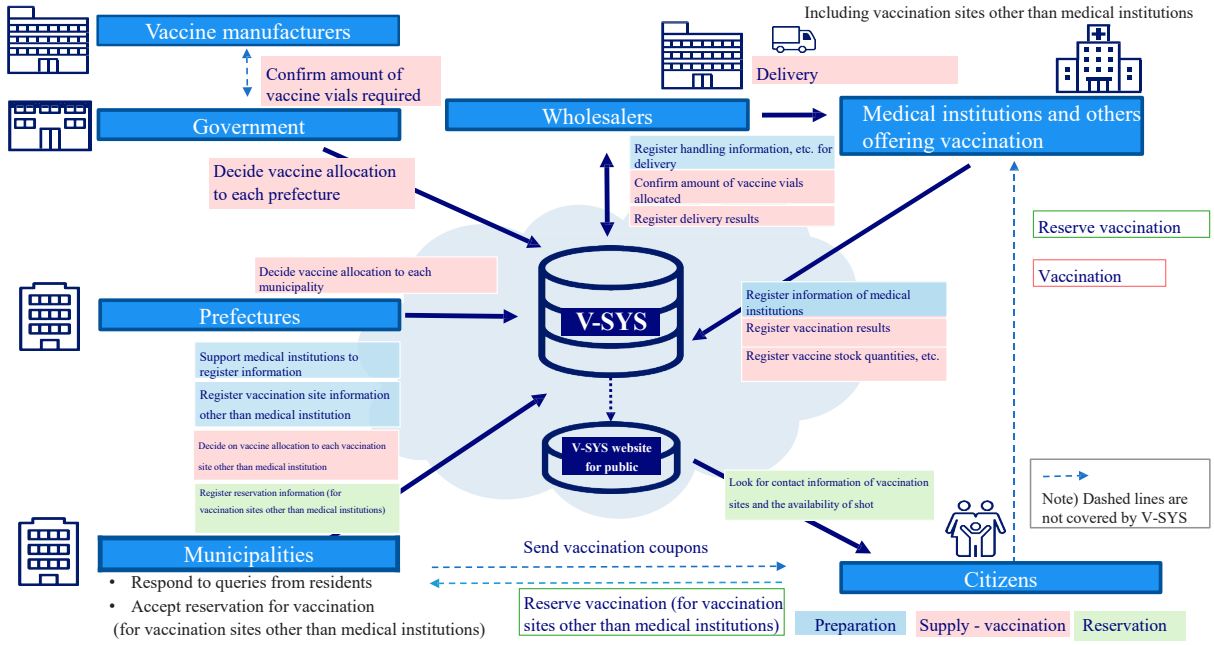
In such a pandemic, the government-led centralised control that allocates adequate quantities to each destination and then centrally manages the supply situation should make sense and function well. (Given that the V-SYS explanation meeting for each logistic company and municipality took longer than intended and had lower user friendliness than anticipated, there may be disagreement around the launch of the system.)

On the other hand, what might be highlighted as challenges are (a) traceability after they delivered vaccines to the sites, and (b) interlinking with vaccination information. Regarding (a), regretfully, a significant volume of vaccines had been disposed of in some medical institutions and vaccination sites due to deep-freezer breakdowns, human errors, etc. It is a strong reminder that staff working in medical organisations, and engaged in vaccinations are also 'suppliers' who maintain quality controls and traceability under different circumstances than usual operations.

With regard to (b), the request for vaccine volume has been misinterpreted as V-SYS does not capture individual immunisation information. The information, 'when and who received which vaccine', is not recorded in the V-SYS, although the flow released by MHLW includes 'Register vaccination results'. (**Figure 1**) Regarding this information, it is true that despite requests from various municipalities to manage it centrally using the V-SYS, it was deferred from the personal information handling perspective and ultimately concluded that the information should be

Vaccination system (V-SYS)

- Government, prefectures and municipalities to adjust the allocation of vaccines and others, wholesalers to deliver vaccines and other supplies to each medical institution, and medical institutions to report immunisation status and stock quantity.
- The government to establish V-SYS to transmit and share the data on the cloud.
- Information regarding medical institutions where vaccination services are available needs to be made public based on V-SYS registered information to guarantee that the public has access to the most recent information.



(Source) Ministry of Health, Labour and Welfare (MHLW)

Figure 1 Overview of 'Vaccination System (V-SYS)'

managed by each municipality establishing a system or on paper. Consequently, the government has lost the opportunity to seize the information 'when and who received which vaccine'.

In addition, it became quite difficult to grasp the vaccine demands because the vaccination available sites had been gradually increased.

(Initially, they had considered a vaccination system based on the group and individual shots, with municipalities acting as the primary drivers. Nevertheless, to reduce the burden on municipalities, and meet the accelerated vaccination, large-scale vaccination sites have been set up, which were conducted by the Japan Ministry of Defence, and prefectures, and workplace vaccination conducted by companies, universities, and some other groups.) In such a situation, since the government was unable to collect data on 'when and who received which vaccine', the necessary number of vaccine vials had been estimated based on voluntary reports from companies and universities, which highlighted problems such as cancellation and double booking of immunisation, and suspension of workplace immunisation at companies and university sites caused by excess requests for the shot.

In fact, similar issues have been addressed in other medical practices outside the current immunisation system. For example, a medical facility, working on autologous cell therapy (e.g. CAR-T preparations) collecting the cells used as raw material for the formulation, falls into the 'supplier' roll, and the quality control and traceability securement are extremely important there. Therefore, pharmaceutical companies provide adequate and throughout trainings for such facility staff, creating and providing comprehensive operations manual. Formulation handling demands careful works to administer formulation at the appropriate timing (match demand and supply), so that central information management, which is associated with a series of demand and supply, is deemed important. This series of processes, using a cold chain, requires delivering the right formulation timely to the right patient taking their health condition in mind, and then at the appropriate time, it should be administrated.

In any event, it is noteworthy that the challenges we are currently facing with the COVID-19 vaccine are not unique to this case. It is considerably worthwhile to ensure traceability of the end-to-end supply chain in a broad sense, including medical institutions, healthcare professionals and patients, not only in response to

possible future pandemics, but also in the case of advanced therapies such as gene and cell therapies.

3. Providing and communicating vaccine information in clear, open, and honest manner

Looking back at the Ipsos awareness survey presented earlier, 64% of those surveyed in Japan answered they would be receive the COVID-19 vaccination when it is made available, which is lower than the average of 73% across the 15 countries surveyed. Compared to other nations, Japan has the exceptionally highest concern about adverse reactions. This survey also included the question 'What is the reason for denial of vaccination?' and all countries commonly expressed their concern as 'adverse reactions' and 'slow pace of clinical trials', and among all countries, Japan expressed an exceptionally high concern about 'adverse reactions'. (Among all negative reasons, it reached 66 %.)

It is conceivable that the government and experts are conveying alerts and messages on the COVID-19 vaccine on a case-by-case basis to avoid being overly concerned about the reactions. Even so, it seems they have not yet published strong guidance, which aims to dispel mistrust as the CDC's 'Vaccine Confidence Strategy' mentioned above. (It is, of course, conceivable that MHLW and each municipality are adequately publishing objective data, FAQ, or a variety of other information for easy immunisation on their websites including COVID-19 Navi of MHLW.)

They have not issued forcible guidance, which may be largely attributed to a history of adverse drug reaction prosecutions. The case for a cervical cancer vaccine, which was filed in 2016, is still fresh in our minds, and while the vaccine is covered by routine immunisation, it is not actively being recommended. It should therefore be noted that this COVID-19-related issue also reflects the history and national character and requires careful discussion. Indeed, regardless of how reliable a supply chain or distribution system is established, their values are cut in half if they do not eventually result in adequate 'demand stimulation'.

Conclusion

This article focused on global trends and the situation in Japan, with regard to the COVID-19 vaccine supply chain. In the event that the end of COVID-19 cannot be predicted, it becomes apparent that largely secured traceability and reliability are truly indispensable, compared to those covered by the ordinary supply chain we apprehended. In the current Japanese domestic market, the government purchases the necessary amount of vaccines centrally and then distributes them to municipal corporations through a government initiative system. However, in the near future, more pharmaceutical companies, including domestic firms, will begin commercialising their new vaccines, providing more vaccine options, and free competition, as with other medicines, may begin.

Standardisation of distribution system data can be comprehended as one of the essential requisites for ensuring the supply chain's traceability and reliability in such circumstances. International organisations such as GS1 have high expectations since standardisation requires the cooperation of many stakeholders, including national governments, local governments, and the commercial sector. Making full use of the technology and know-how that have been put to practical use in industries other than healthcare, in my opinion, will help advance this distribution reform in the healthcare sector significantly.

Author

Yoichi Kaminishi
Deloitte Tohmatsu Consulting LLC
Director

A core member of Life Science & Healthcare. The author has worked on a variety of projects, most notably in the field of distribution and supply chain, and has expertise in establishing several supply chains for new modalities and reforming primary distribution, including pharmaceutical wholesalers and dispensing pharmacies.

References

1) Deloitte, *Securing trust in the global COVID-19 supply chain*, 2020

2) The Bill and Melinda Gates Foundation, Gavi, 29 July 2020

3) Times LIVE, *Interpol warns of-fake vaccines targeting the desperate in SA*, 29 December 2020

4) DHL, *Key Logistics trends in Life Sciences 2020* +, 2020

5) Ipsos survey for The World Economic Forum, *Global attitudes on a COVID-19 vaccine*, 28 - 31 January 2021

6) Vaccine Confidence Project, *What is the Vaccine Confidence Project*, accessed 2 December 2020

7) CDC, *Vaccinate with Confidence*, accessed 2 December 2020

8) Yomiuri Shimbun, *Second Vaccination Received by 50% of the Citizens ... The Rate among People Aged*

64 Years or Younger Varies between Regions, 10 September 2021

9) Our World in Data, *Statistics and Research-Coronavirus (COVID-19) Vaccinations*, accessed 10 September 2021

10) Based on our company's interview with the couriers of vaccines (as of March 2021)

11) Ministry of Health, Labour and Welfare, *A document for the first briefing for resident's associations*, 18 December 2020

Digitalisation under COVID-19 pandemic; Drug e-labelling initiative across world

APAC's new challenges on e-labelling

Japan Pharmaceutical Manufacturers Association
Rie Matsui
APAC e-labeling EWG Japan (Expert Working Group)
Yukiyo Yamamoto
Koji Yamaguchi

Asia Partnership Conference of Pharmaceutical Associations (APAC)

Asia is deemed as one of the engines of the world economy, and its pharmaceutical market is expected to show steady growth at a higher rate. However, as is the case in similar growing countries, they are facing challenges including clinical trials, reviews, reimbursements, and accesses to new drugs, which need to be addressed and resolved to build reliable pharmaceutical market.

Japan Pharmaceutical Manufacturers Association (JPMA) had been holding regular meetings with Asian industry groups and governments on the basis of Japan-China and Japan-Korea cooperation before the launch of 'Asia Partnership Conference of Pharmaceutical Association (APAC)' which hold its first meeting in 2012. JPMA established APAC aiming at solving the issues together from broader perspectives as Europe and Americas have been pursuing while encouraging Asian pharmaceutical groups (**Figure 1**). Under the APAC's mission 'To expedite the launch of innovative medicines for the people in Asia', they intend to contribute largely to developing high-quality drug markets in each country and region which should bring them advanced pharmaceutical industries, setting a forum of discussion among Asian pharmaceutical organisations, governments, and academic institutions.

Here in this article, we introduce our efforts on 'e-labelling initiative'. We picked up e-labelling as a topic to discuss at APAC since 2020, because it is considered, even in Asian countries, as one of the important DX measures which is to be further strengthened under the pandemic. Our intention is to raise awareness of the benefits of e-labelling and together proceed toward the harmonised direction with a unified approach under mutual cooperation.

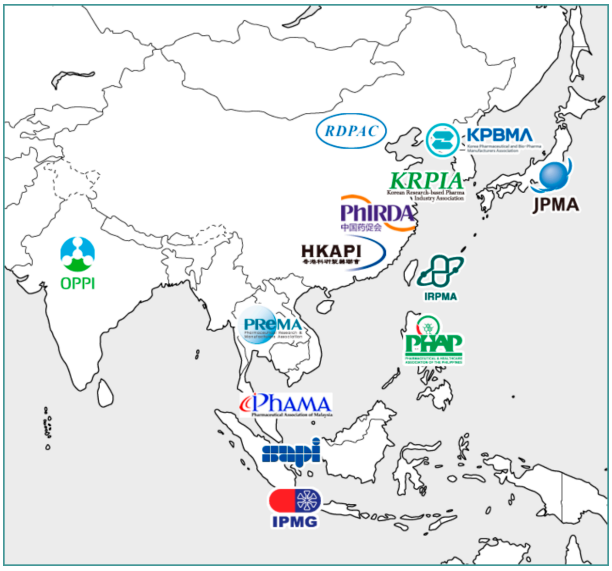


Figure 1 Member associations of APAC
(Source) https://apac-asia.com/about/member.html

'Labelling' of pharmaceutical product

Labelling (package insert) is an instruction of the usage of the drugs which contains necessary information on the drugs based on the latest knowledge. The significance of the labelling information is well known to the persons concerned and that interconnects pharmaceutical companies and healthcare professionals. In this report, we define the insertion as the labelling which conveys product information created abiding by the requirements of each country's regulatory authority. Labelling is one of the essential

The article is basically the translation of its Japanese issue (GS1 Japan Review, Vol.4, 2021), and is slightly modified as needed for English readers.

application documents (Common Technical Document (CTD)) in order to be approved as a new drug and is positioned as an official document after the approval. Labelling is prepared in two types, one is for healthcare professions and the other is for patients, and regarded as a critical risk minimisation measure.

In Japan, physical labelling for healthcare professionals used to be required to be included in the product package. In the US and many Asian countries, the physical labelling for healthcare professionals is still required in the product packages. Meanwhile, labelling for patients is a document written in patient-friendly terms, although it has not been prepared for all the products in Asian countries yet. We presume it will be a future issue, how digitisation will propel discussions on the labelling for patients. In Japan, information of package inserts for patients are provided on the Pharmaceuticals and Medical Devices Agency (PMDA) website as Drug Guide for Patients instead of physical paper inserts. On the other hand, in Europe, labelling for patients are obligatory inserted in all the product packages as Package Leaflet to provide the necessary information. It provides information on the products and is included with the products.

Labelling in the scene

Recently, many countries are facing various challenges with the labelling. Labelling inserted in packages may not be the latest version as the content is frequently updated in order to reflect the new knowledge. It is essential, in the post-marketing phase, that the latest product information, including the efficacy and safety of the product, should be conveyed to healthcare professions and patients immediately and properly for their appropriate uses. The same applies to the new drugs, granted conditional approval with less comprehensive clinical data, which require additional efficacy and safety information to report in the post-marketing phase, and they have recently increased in number.

However, it is the fact that in about half of the Asian countries most products are coming only with paper labels not with an electronic means. Thus, in these countries, it is difficult to deliver the latest information to medical professionals in a timely manner and the obsolete documents are discarded every time of the revision. In addition, each time a same drug is delivered to a medical institution or pharmacy, the same labelling is also being delivered, which requires reviewing efficient paper resource use from the viewpoint of the Sustainable Development Goals (SDGs).

Another issue is the grace period for updating labels. In some countries, the grace period, which is from the approval of the revised label to its replacement, is relatively short. This might undermine the stable supply and prolong the lead-time when the replacement of labelling is required in such countries.

Now-a-days, the volume of available information on the internet is rapidly increasing and, benefitting from the internet, peoples are usually searching and acquiring information on the internet. It is also true for patients, but there are some risks that incorrect and obsolete information could be hit with the searches. Thus, it is very important for us, including healthcare professionals and patients, to find appropriate sites where we can access the latest and trusted information.

In some Asian countries, there are cases where they did not have a standardised label template with unified information order and item names. Many of them are following the template of possible destination countries: 'US Prescribing Information (USPI)' for the products shipped to the US, 'EU Summary of Product Characteristics (EUSmPC)' to EU countries, and PMDA template to Japan. It is troublesome from the healthcare professional's point of view if the item description order varied among the labels. It may require the professionals longer time finding information such as contraindications, effect-efficacy, and other important instructions. In addition, recently, labelling tend to contain more information than before which brings readers to a little confused world before reaching the target information.

Benefits and challenges of e-labelling (digitisation of labelling)

There are many expectations of e-labelling from different aspects, but its unified definition is not suggested yet. The primary objectives of e-labelling are to make prompt and appropriate access and obtention to the latest product information possible, to provide labelling information in user-friendly way, to lead to appropriate drug use, to improve understanding of the products, and to bring about better therapeutic outcomes. Moreover, it saves paper resources, shortens the product lead-time to market, and maintains a stable product supply. Manufacturers and regulatory bodies often discuss the labelling content until just before the approval. Therefore, the duration of post-approval to labelling insertion work should be made shorter to reduce the lead-time for the products. It is, we believe, important for accomplishing APAC mission that we support them to build up a framework which is competent enough to deliver the latest labels without delay in digital format for the proper use of drugs, even in the post-approval phase.

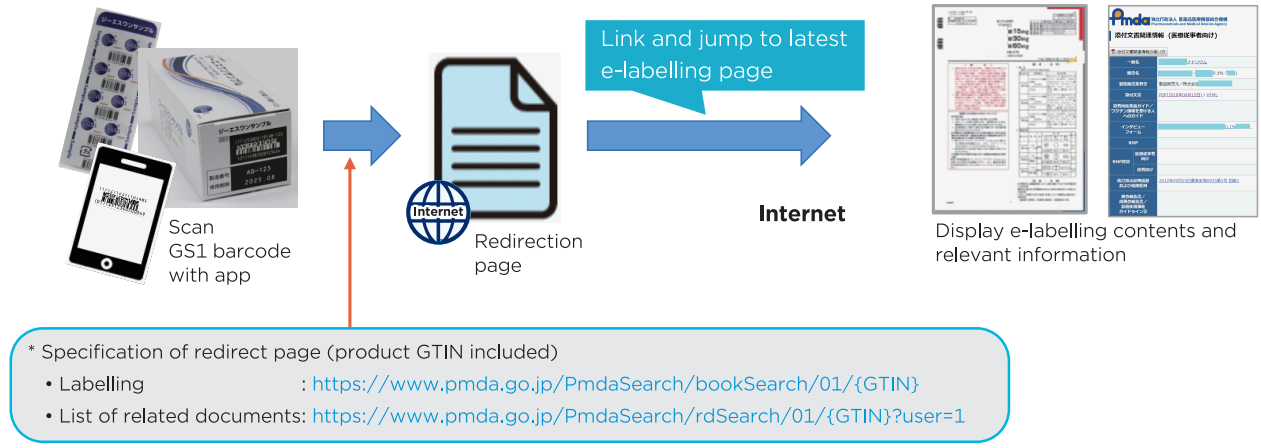


Figure 2 GS1 barcode to e-labelling

(Source) GS1 Japan documents

[Advantages of e-labelling]

- To improve accessibility to the latest labelling, and convenience as the documents can be utilised in a user-friendly fashion with enhanced readability (font size adjustment) and searchability.
- To enhance the understanding of healthcare professionals and patients to the products information with the above-mentioned refined usefulness of the labels, and realise better treatment outcomes and health improvement.
- To contribute to paper resource savings by eliminating paper labelling and to SDGs achievement, and the lead-time reduction and man-hour cutdown.
- To play a role in the Digital Transformation (DX) in the healthcare industry, integrating digitised labelling and medical information as well as Electronic Health Records (EHR).

The following four challenges are vital to achieving the above advantages:

(1) To prepare a platform for providing e-labelling information on a secure and reliable site (e.g., website of a regulatory agency).

(2) To help people easily access the latest e-labelling information with, for example, smartphone app with a scan of GS1 barcode or some other equivalent on the product outer packages (**Figure 2**).

(3) To standardise digital browsing of e-labelling dismissing paper labelling inserts. Change of law is compulsory in countries where paper inserts are mandatory.

(4) To process the insertion as electronic data, create a structured electronic document using, for example, XML. Ideally, an interoperability standard is implemented, and finally, e-labelling is utilised as a part of the digital health systems interlinking and integrating with EHR and electronic prescription systems.

As for the issues to be solved, we can list the connectivity of the internet, affordability of the platforms, and motivation of people who are not digital natives. In addition, APAC member countries are progressing in different stages for e-labelling and in order to move forward, an agreement on e-labelling standards, including interoperability clauses maybe needed in the future.

e-labelling initiatives around world

As previously mentioned, e-labelling brings about many benefits such as improvement of searchability and accessibility of product information, easiness of revision, and utilisation to digital health, and there are many e-labelling initiatives around the world proactively cooperating and progressing for a better world.

In Japan, paper package inserts had been abolished in principle by the Amendments to the 'Law on Securing Quality, Efficacy and Safety of Products Including Pharmaceuticals and Medical Devices (PMD Law)', and the transition period started, on 1 August 2021, and, instead, digital insertions essentially became compulsatory. This is one of the Japanese initiatives leading the world in the digitisation field. They use PMDA website as the platform, and already e-labelling of prescription drugs are available there (https://www.pmda.go.jp/PmdaSearch/iyakuSearch/). Manufacturers create e-labelling as structured documents using the XML/SGML format so that healthcare professionals just need to visit the PMDA website as a portal site for advanced search instead of visiting independent webpages of each supplier for the information. Both Japanese and the US regulatory agents mandate structured formats for insertion documents.

'Tenbun-Navi' is an app for mobile terminals jointly developed by the Federation of Pharmaceutical Manufacturers' Associations of Japan (FPMAJ), the Japan Federation of Medical Devices Associations (JFMDA), and GS1 Japan which was timing to the enforcement of electronic labelling by the Amendment to the PMD Law. This app allows for scanning GS1 barcodes on packages of drugs and medical devices, and displays insertion information on mobile terminals.

Start screen

Insertion document is displayed

Realated documents are listed

Figure 3 'Tenbun-Navi' package insert browsing app

(Source) GS1 Japan documents

In Japan, they started the smartphone app 'Tenbun-Navi' (**Figure 3**) service on 1 August 2021, which allows scanning GS1 barcodes on drug packages and browsing right e-labelling information on the PMDA website. They have selected GS1 barcode for this application, as GS1 is the global standard and GS1 barcodes have already been widely approved and employed for drug identification around the world, consequently, the interlink between product GTINs and e-labelling number is easily accomplished and appropriate e-labelling can be acquired referring to the product GTINs without fail. In addition to displaying the e-labelling information, expiration date and lot number information can technically be acquired and displayed, although the amendment law does not address such information. Japan is the first country in the world to officially approve GS1 barcodes for e-labelling identification. Accordingly, paper package inserts have to be abolished after 31 July 2023.

This amendment to the PMD Law, stating the paper package insert abolishment, was promulgated in December 2019 and enforced in August 2021 as mentioned above. In Europe and the US, paper labelling are still obligatory inserted in drug packages, therefore, paper documents are indispensable yet, although paper elimination contributes to an environmentally friendly and ecological world. In Europe, they are studying on e-labelling implementation for both healthcare professions and patients. In Japan, e-labelling are mainly focused on healthcare professionals. Although, it can be clearly mentioned the e-labelling initiative in Japan is advanced in the world, we have to discuss further the e-labelling utilisation in various other applications including digital health. At the 10th APAC, we announced and explained about the English translation version of Japanese e-labelling guidance for prescription drugs (English Version of Japanese Labelling, PSEHB/PSD Notification No. 0329-8, 29 March, 2019). It was suggested that Japanese information, including the latest Japanese drug review reports, insertion documents, drug guidance for patients, and other relevant information is translated into English and posted on the PMDA website, many stakeholders around the world may access the information and refer them for their review process and they could facilitate their process.

e-labelling initiatives are progressing also around the world. In Europe, European Medicines Agency (EMA) released Electronic Product Information (ePI) for human medicines in the EU: key principles in January 2020 and, in 2021, initiated ePI set-up project for one year period to define ePI criteria, which is commonly used in EU member countries.[1)] The e-labelling study is scheduled to start in 2022.

Their e-labelling initiatives are planned to transform leaflets for both healthcare professionals and patients digital. In Europe, the pioneering countries, Germany, France, Iceland, The Netherlands, Norway, Spain, Sweden, and Austria, are working closely together with EMA/EC on the ePI initiative. Meanwhile, some other European countries are independently pursuing each e-labelling pilot. In Belgium and Luxembourg, they started a hospital pilot called the electronic Patient Information Leaflet (e-PIL project), where in hospital use certain medicines will no longer have a paper patient information leaflet. Achieving excellent feedback, this pilot is going to be prolonged. Similar hospital pilots are scheduled in the Baltic and other

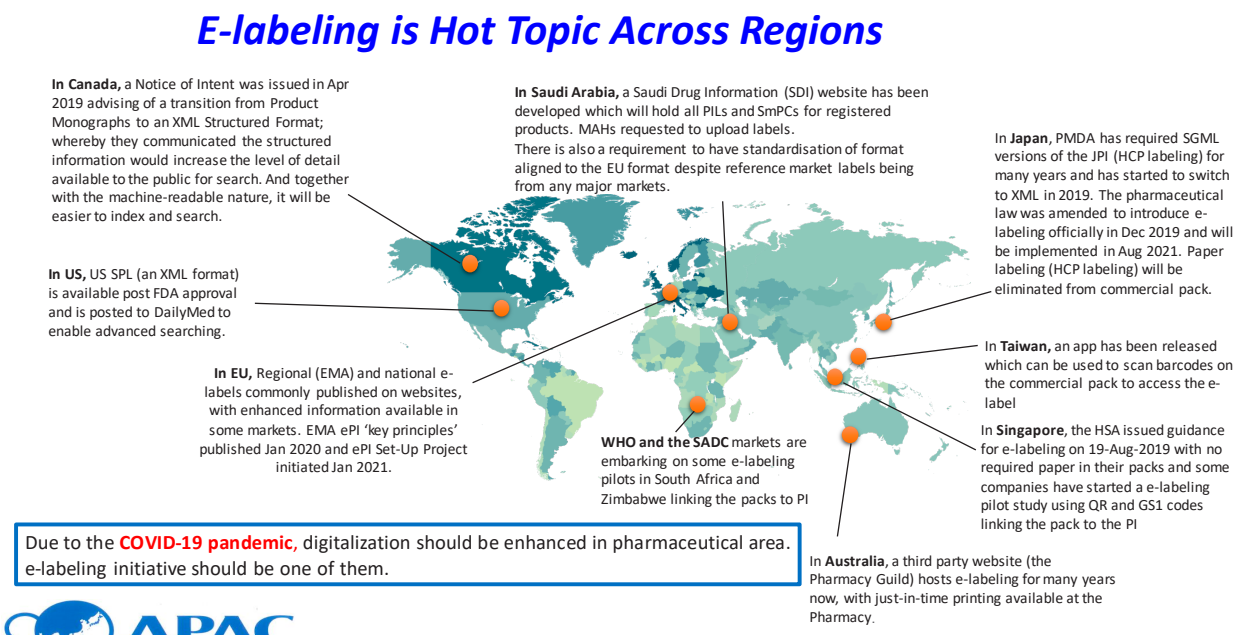


Figure 4 Major e-labelling initiatives

(Source) Materials for Asia Partnership Conference of Pharmaceutical Associations

countries. In Germany, after completing the pilot phase early in April 2020, they released an app named 'GebrauchsInformationen 4.0 (GI 4.0)' for patients' access to medicine information which is also available as a web tool. The current coverage of the app is approximately 10% of the drugs available in the pharmaceutical market and is expected to increase.

In the US, DailyMed, a platform supplying labelling information, is providing post-marketing drug information in XML format via the interoperability standard 'Structured Product Labeling (SPL)'.[2] In Canada, they released a notice on the transition of drug information to the structured format of the 'Product Monograph (PM)' in April 2019.[3] Health Canada website offers the PDF version of the PM.

Taiwan has excellent experiences through their 'Drug license online search system (online search system for drug approval)' started in 2006. By utilising the experiences, they are going to develop a more advanced system with a more user-friendly interface and open data structured e-labelling, after defining and releasing XML format standard.

In Singapore, they issued the final version of the e-labelling guidance document in April 2021.[4] As of March 2021, about 270 products follow the e-labelling initiative carrying 2D barcodes which link to the companies' websites. A large number of healthcare professionals have provided positive feedback on the e-labelling initiatives.

In the both Republic of South Africa and Zimbabwe, the WHO has launched its e-labelling pilot project, which employs QR code and other equivalents (**Figure 4**).

Future directions of APAC e-labeling EWG

APAC e-labeling EWG, in the COVID-19 pandemic, is looking back on the product information supply means with paper resources in the Asian countries. We, as APAC, are pursuing not only strengthening digitisation for innovatively and quickly providing the latest labelling information, but also contemplating how to deliver the information capturing user viewpoint and utilise it as one of the future digital health services, considering Asian situations. An agreement was made on collaborative activities about e-labelling, which is deemed essential, between regulatory agencies and pharmaceutical company associations at the 10th APAC held in April 2021. In addition to the agreement, they plan to proceed with the implementation of e-labelling sharing common themes, benefits and issues among the Asian region, create a position paper to enable a unified approach in some degree to bring Asian members better options suggesting many choices, and explore the development of an e-labelling platform commonly used for members of the Asian region. Furthermore, as one of our endeavours to realise those objectives, we are thoughtfully propelling the e-labelling project for healthcare professionals and patients in the Asian regions, investigating regulations, needs and others in APAC member countries, and developing a roadmap.

1) *EU, Electronic product information for human medicines in the EU: key principles*, 2020, https://www.ema.europa.eu/en/electronic-product-information-human-medicines-european-union-key-principles

2) US, *Structured Product Labelling Resources*, https://www.fda.gov/industry/fda-data-standards-advisory-board/structured-product-labeling-resources

3) Canada, *Notice of Intent: Transitioning Product Monographs to a Structured Format*, April 2019 https://www.canada.ca/en/health-canada/services/drugs-health-products/drug-products/announcements/notice-structured-product-monograph.html

4) Singapore, GUIDANCE ON ELECTRONIC LABELLING FOR THERAPEUTIC PRODUCTS, https://www.hsa.gov.sg/docs/default-source/hprg-tpb/registration/tpb-gn-021-000_appendix-7a-guidance-on-electronic-labelling-for-therapeutic-products.pdf

Medical supply logistics management system in response to COVID-19

Research and development for Platform Smart Med Supply

Duangpun Kritchanchai, PhD
Associate Professor, Centre of Logistics and Healthcare supply chain,
Faculty of Engineering, Mahidol University, Thailand

Introduction

The novel coronavirus disease (COVID-19) has spread to almost every nation since its outbreak in December 2019. World Health Organisation (WHO) declared it a global pandemic, and an outbreak has also been recorded in Thailand. COVID-19 has caused shortages of medical supplies such as alcohol gel, N95 face masks, and personal protective equipment, and many countries have been facing high demand for them.

In Thailand, it has been determined that supply chain management is one of the most important factors to curb the spread of the virus, and that the government must manage and control it to ensure that the products are available to the hospitals, pharmacies, medical staff, and the public. Therefore, the current logistics management for medical supplies is under government procurement and donation acceptance, and such products have to be accepted by the Ministry of Public Health before being distributed to medical facilities. However, there is no centralised system to check on the distribution of the products or if the hospitals have received the requisite products that meet their quality and quantity requirements. Most of information is manually transferred from one to another, affecting work performance and sustaining a long time for traceability. This can cause delays in logistics.

Recently, many researchers have been focusing on this issue and a handful of researchers is developing a supply chain system, which includes the function to trace purchase orders and donations of medical supplies across the country via virtual stock, in order to meet the increasing demands from the hospitals. In responding to the COVID-19 situation, using an appropriate supply chain system will be able to address the shortage of medical supplies and unbalanced inventory, and enable to cover both smart donation and central purchasing systems. The system developed in this research will also benefit the government and related agencies. Further, it will provide a central information system for managing medical supply logistics that can be applied following the information received from the hospitals, manufacturers, and distributors and can also be used in production planning, distribution, monitoring, and the control of possible future epidemic situations.

Research framework

The construction of conceptual framework of this study started with the situation which COVID-19 has spread across the world. In Thailand, it was initially observed that many organisations and agencies were mobilised and large amounts of medical supplies were allocated to various hospitals. Consequently, some national hospitals and nursing homes received a large number of medical supplies. However, the medical supplies could not be used at some of the facilities because they did not meet the requisite standards. Many collaborative information was sent from many departments, however, they wert not available to use effectively because those were not standardised. Accordingly, insufficient support has been observed in many cases. An effective system that can track the purchases, usage, and supply of medical supplies should be developed to ensure efficiency in response to the widespread impact of COVID-19. **Figure 1** shows the framework for research methodology.

The concept of product database system used in this study is based on the National Medicinal Product Catalogue Database (NMPCD), a database system that collects information and features of drugs that are retailed in Thailand (**Figure 2**). This system can link target drug information to the applicable data on the database. NMPCD ensures the following three elements:

The article is basically the translation of its Japanese issue (GS1 Japan Review, Vol.4, 2021), and is slightly modified as needed for English readers.

(1) the collection of medicine information codes: medicine 24 digits, Thai Medicines Terminology (TMT) code, and GTIN, (2) the mapping of these different medicine codes, (3) the controlling dissemination of medicine codes, which are stored in the Material Management Information System of the hospitals.

NMPCD links the track and trace systems and business intelligence (BI). This database is used to collate the information of more than 25,000 drug items with various standard codes; these codes are mapped manually and semantically.

Several standard codes are used by each stakeholder in Thailand to address different objectives; this concept is used as a model of medical supplies logistics management system. The system was developed to address the COVID-19 crisis situation by conducting interviews with the relevant or involved parties. It was determined that both the designed data flow and system connections must be on the same platform and interface exists for other external systems (**Figure 3**).

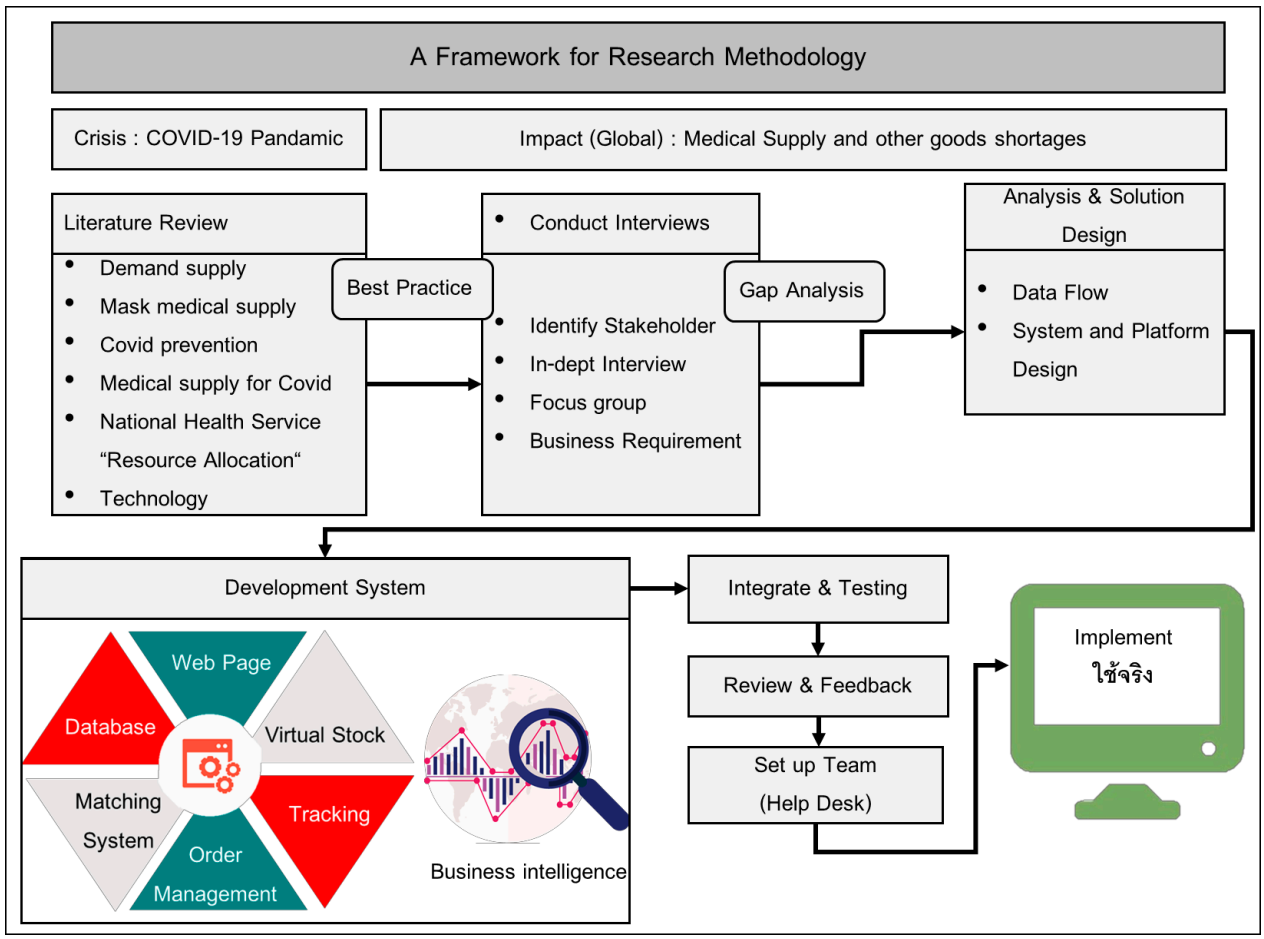


Figure 1 Framework for research methodology

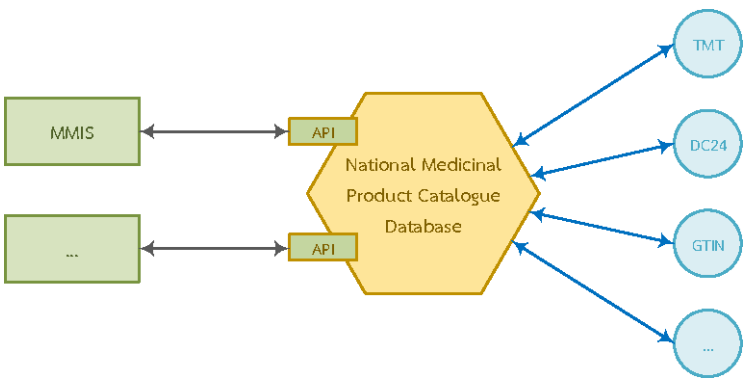


Figure 2 Structure of NMPCD

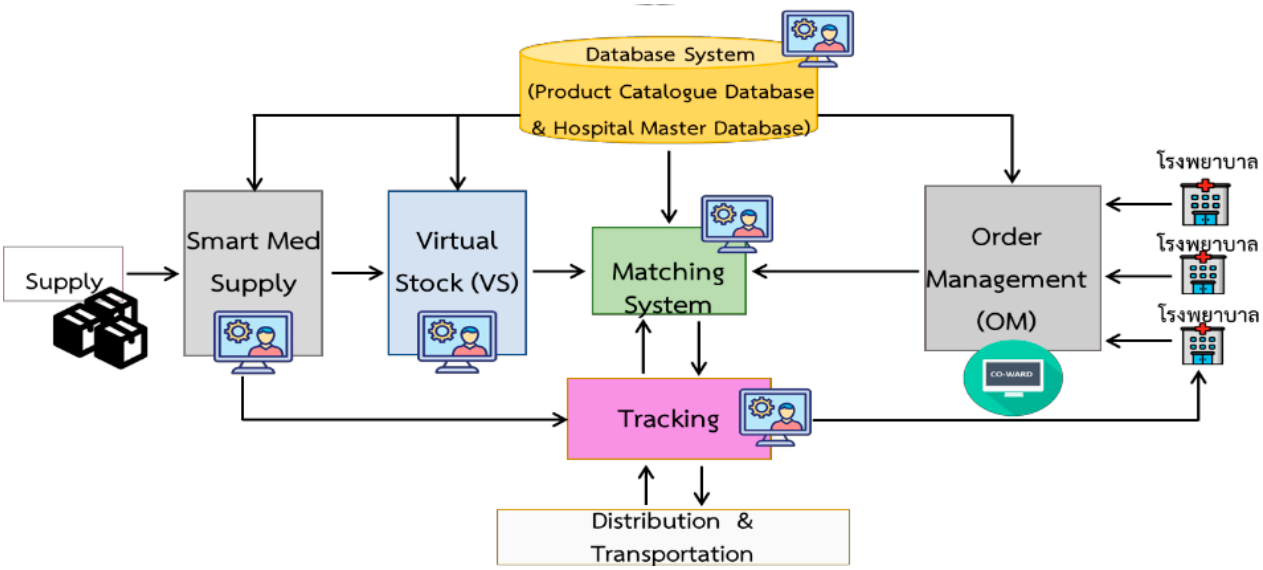


Figure 3 Conceptual framework of the system design

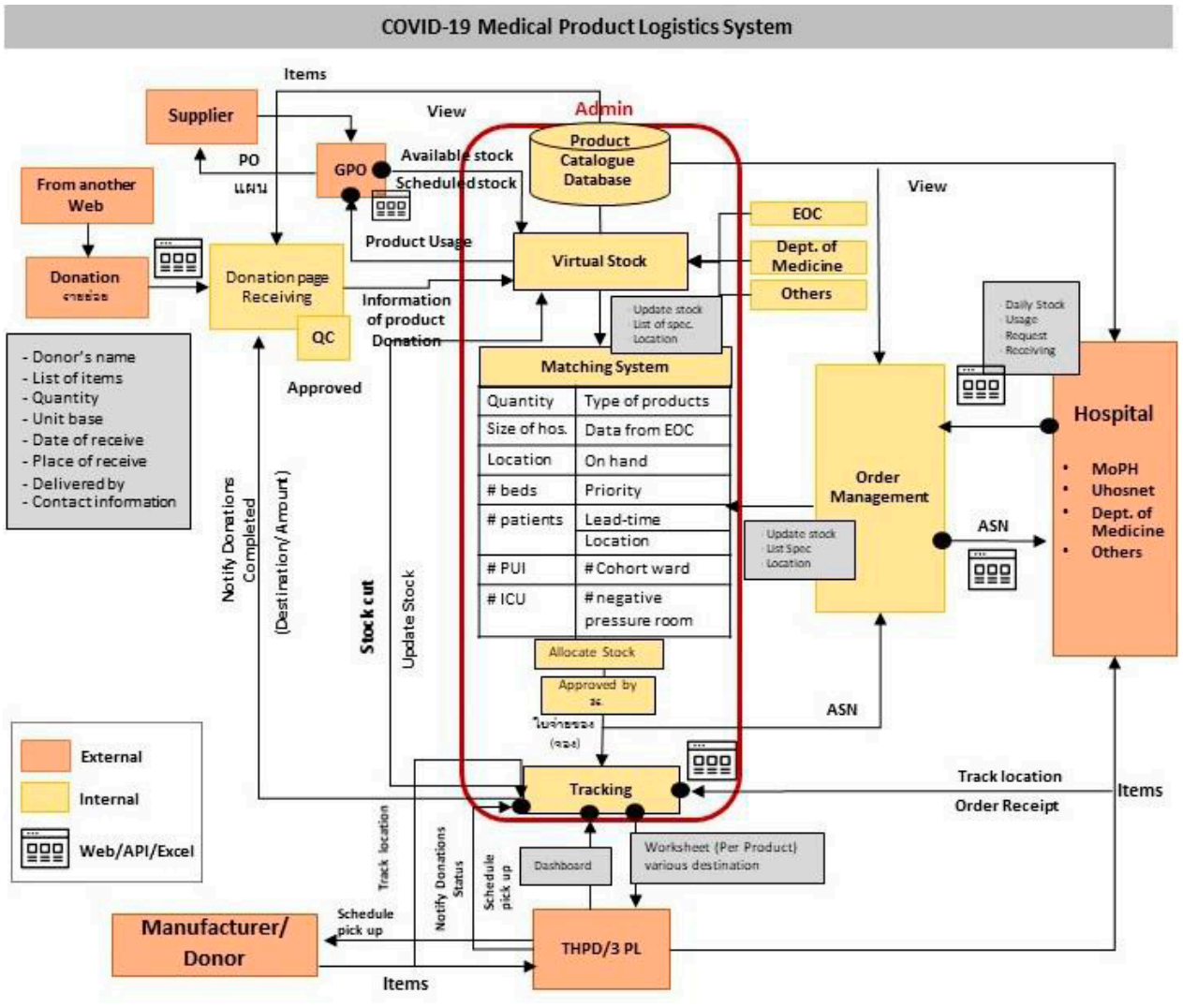


Figure 4 Principle of Platform Smart Med Supply

The Platform Smart Med Supply

1. Principle

It is necessary to design an appropriate platform that not only connects donors and recipients, but also balances supply and demand, both for government procured and donated products. A newly designed platform, the Platform Smart Med Supply, consists of six systems and one business intelligence (BI) processing system (**Figure 4**). The six systems are the followings: (1) product catalogue database and hospital master database, (2) web page, (3) virtual stock, (4) matching, (5) order management, and (6) tracking systems.

The system is triggered by a supply, once a government procurement or donation is entered into the website via the entry system, the medical supply must be allocated through the system. The website retains catalogues and pictures of the products transferred from the database for user-friendliness. The system collects the information of the medical supplies and sends those to virtual stock for allocation. Thereafter, stock a matching is carried out for each demand based on urgent needs, factors associated with the epidemic, and the current situation at the hospitals. At this stage, the assignment of government procurements or donations to the hospitals is determined to address the actual hospital situations. The data on the needs of the hospitals in this system comes from the information sent by the hospitals to the Ministry of Public Health system. The subsequent process is then permitted based on the algorithm depending on the number of patients, number of medical personnel, available quantity, and rate of use severity.

2. Product Catalogue Database and hospital master database

2.1 Product Catalogue Database

The medical supply code structure is based on the Anatomical Therapeutic Chemical (ATC) and TMT drug codes. The advantage of the ATC code can be interpreted as a comprehensive coding system composed of several meaningful elements. For example, A10ba02 is the code for Metformin. A refers to the alimentary tract and metabolism, A10 represents drugs used in diabetes, A10B refers to blood glucose-lowering drugs, e.g. insulins, A10Ba is biguanides, and A10Ba02 is Metformin.

The design of the medical supply code structure in the Product Catalogue Database is based on the running number principle to ensure ease while retrieving and for the convenience of adding information to the system. Furthermore, it must be easy to group each medical supply code. Therefore, the design of the medical supply code is based on the concept of a relational database system, and GTIN plays as one of the key codes of medical supplies. Platform Smart Med System inherits the concept of NMPCD which is to link GTIN to the information of medical supplies with the data from major medical product database systems in Thailand. This standardises the code of each item with the same structure in the whole nation. Utilising GTIN in the platform, users will be able to customise and lookup for the important information of each medical supply during the process of logistics management, which realises the easy monitoring of the supply status to meet the demand of product to the right place in the right situation.

2.2 Hospital Master Database

The Hospital Master Database system is developed to compile the general information on the hospitals, nursing homes, and other entities based on the database of the Ministry of Public Health. The details required for the system are as follows: hospital code (HosPcode), five digits of this code are used as a central information to connect, run, and retrieve information within the system of the Platform Smart Med Supply, hospital name, health area, region, type of the infirmary, group or department specific, the number of staff, and address.

3. Web page

An order entry system (Web-based) receives information about the medical supplies to be allocated. This is established for donors, such that they can donate medical supplies through a web application; this is also intended to assist the staff that manages donation information, including the central staff responsible for the allocation of medical supplies from the government procurement (**Figure 5**).

Type of users who have access to the Smart Med Supply include the following.

1. Administrator: This individual is the controller who has the privilege to enter the system.
2. Supply chain manager (SCM): This individual has the right to check the donation and undertake the relevant decision pertaining to it.
3. Donor or central staff: There are two different levels of donors: 1) the donors who are not required to check the donation or are defined as direct donors of the Ministry of Public Health and 2) the general non-drug donors whose donations must be checked and confirmed by SCM.

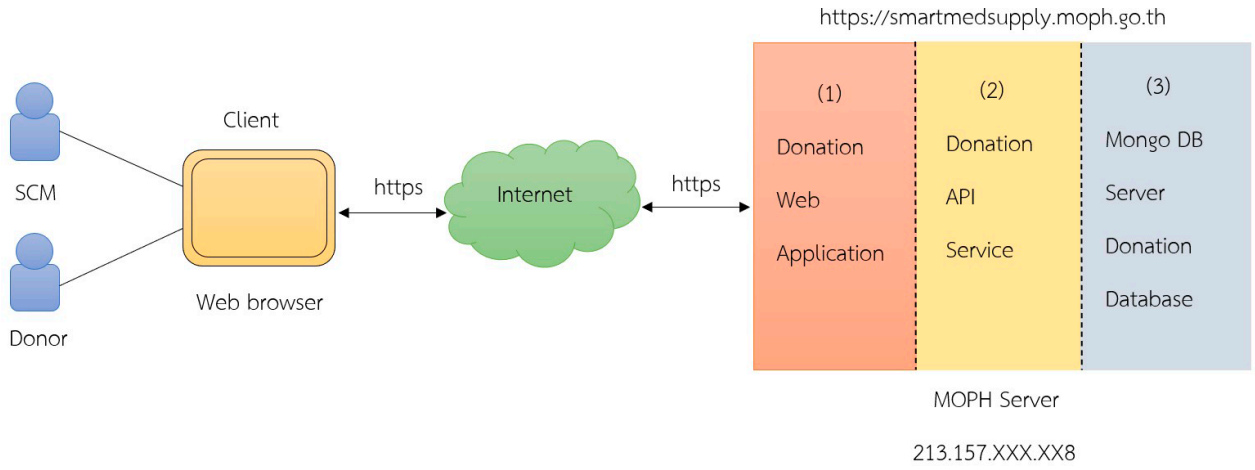


Figure 5 Web page for Smart Med Supply System

4. Virtual stock

This system holds information about virtually stocked items, which are the brand, quantity, package behaviour, location, and lead time for receiving the product through a transport unit. The information about virtual stock needs to be separated into two parts. First, all data received are transferred to the virtual stock and taken by matching system in order to calculate the allocation candidates. Second, the information of donator also will be used in order to arrange the delivery route of receiving product to the destination. After the all calculation is done, the allocation information and donator's data are delivered to the Thai Post's Dxplace (the company that developed the gateway connection for the Thai Post Company) system.

5. Matching system

The matching system has been designed for the planning and allocation of the medical supplies, such that they can be distributed to the hospitals that require them. The process of the matching system uses data from (1) order management (including patient level and the workforce of the hospital) and (2) current information on the number of product inventories from virtual stock.

6. Order management

Order management is a system that obtains the information on medical supplies from the hospital and processes the data usage per day. This information is used for planning and allocating the products. The system has been developed by the Information and Communication Technology Center Office of the Permanent Secretary of the Ministry of Public Health in order to link and transmit information in each way, and the hospitals can track the status via the tracking system. The system was developed using angular and typescript.

7. Tracking system

This system monitors the status of medical supply distributions. It functions after the matching system matches the stock with various hospitals. The operation of the tracking system involves transferring information on the medical supplies received to donors or the central staff. The delivery status of medical supplies is tracked to determine if the donated or allocated items have been delivered to any track point, which is extracted from the Thai Post parcel tracking system via the website Dxplace and APIs. Consequently, the Thai Post Company processes the data, route, and scheduled transportation to receive medical supplies from factories or distributors and delivers them to the specified destinations. The entire process can be tracked by referring to the tracking number. The tracking system sends the information to subtract the quantity of medical supplies from the inventory of the Virtual Stock when the product is delivered to the destination successfully.

8. Business Intelligence (BI)

This system is designed in accordance with the Power BI program that incorporates data from various systems. The detailed design of a pharmaceutical logistics management system is to develop a supportive decision system for monitoring, evaluating, and analysing the status of demand for medical supplies. Taking the product shortages the world had faced and its effective utilisation into the consideration, the country needs to limit the target group of medical supplies for maximum efficiency; this is because the COVID-19 crisis has caused problems in the global supply chain system. The system can determine the demand situation of medical supplies as needed and

provide a detailed view of the list of candidate medical supplies, and information on delivering destinations that include nursing homes in the provinces as well as the health service areas in Thailand.

Practical implications and discussion

COVID-19 spread worldwide, including in Thailand; it led to a shortage of medical supplies. The construction of an efficient supply chain management is one of the most important key factors to address this problem. Accordingly, the Platform Smart Med Supply has been designed, which consists of a non-pharmaceutical code database (Product Catalogue Database), a database of the hospitals and the nursing homes (Hospital Master Database), Order Entry System (Web Page), Virtual Stock System, analysis of matching demand and stock (Matching System), hospital horizontal demand management system (Order Management), shipping tracking system (Tracking), and BI processing system.

Platform Smart Med Supply is able to store proper demand data based on the hospital horizontal demand management system (order management), analysis of the quantity of medical supplies, number of patients, and their demand for the product. It also allows to check which products are currently being distributed and if they are covered by the tracking system. Since the system is in the scope of the healthcare supply chain system with imported products in addition to the domestic products, GS1 standards and support of GS1 Thailand are very important. To identify the medical supplies without any restrictions or errors will help ensure the safety of the patient.

Previous studies conducted within the country or outside primarily focused on the logistics system in the health industry, but they did not consider the supply chain. Furthermore, the spotlight had been focused on the guidelines and strategies for managing pharmaceuticals in times of crisis at the national level. Enough research about non-drug medical supplies have not been conducted, especially for developing a system that covers the comprehensive supply chain that can be applied in this manner. The collaboration among the stakeholders is one of the most important keys to its successful implementation. We believe this study introduced in this article could serve as a model for developing a response in situations of crises or in the possible incidence of emerging diseases.

GS1 Digital Link launched during the pandemic

Utilisation for digitisation of package inserts and COVID-19 vaccine delivery

Koichi Uemura
General Manager, Solution Department 1, GS1 Japan

Introduction

The COVID-19 pandemic has inflicted serious damage on many countries. At the same time, it became apparent that Japan is behind the curve in terms of digitalisation. The people realised once again that many procedures were still carried out manually and that information was not linked to each other.

GS1, an organisation promoting international standards, has been developing GS1 standards as the global common language in business by organising them into three elements: 'identify,' 'capture,' and 'share.' In particular, Global Trade Item Number (GTIN), which is an element of 'identify', and GS1 barcode, which is an element of 'capture', are the most well-known standards. In addition to the above three elements, GS1 has recently been emphasizing the importance of the 'use' of the standards for information linkage, traceability, recall and so on.

In 2018, GS1 announced a new standard called 'GS1 Digital Link' to support 'use' in digitalising society. GS1 Digital Link is a system that uses GS1 identification codes such as GTIN as key elements to link related information and services on the Internet. It has drawn attention as a standard that can be used in various ways in the future.

In the healthcare sector, information such as expiration dates and lot numbers has additionally been encoded in GS1 barcodes and used globally, not only for efficient logistics and inventory management but also for improvement in medical safety. Furthermore, the use of GS1 Digital Link was initiated Under the COVID-19 pandemic, which greatly contributed to improving safety of medical products supply chain.

How GS1 Digital Link works

In GS1 Digital Link, a GS1 identification code (and accompanying attribute information, if necessary) is incorporated in a specified format with GS1 application identifiers in the form of a web-based URL. This form is called GS1 Digital Link URI (**Figure 1**). The first part of the URI is a domain name, when implemented as a web server called a resolver. This coding format allows a unique GS1 identification code (e.g., GTIN) to be used as a key for various useful information and services via a designated resolver. With this system, multiple information and services can be reached form one QR code or GS1 barcode, suppliers do not need to prepare

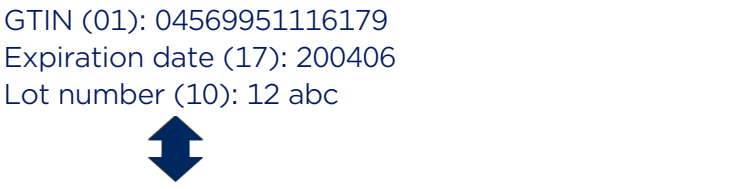


Figure 1 The URI structure of the GS1 Digital Link

The information expressed by the GS1 application identifier is in the form of a URL used on the Web. The example shows the GTIN, expiration date, and lot number.

(Source) GS1 Japan document

The article is basically the translation of its Japanese issue (GS1 Japan Review, Vol.4, 2021), and is slightly modified as needed for English readers.

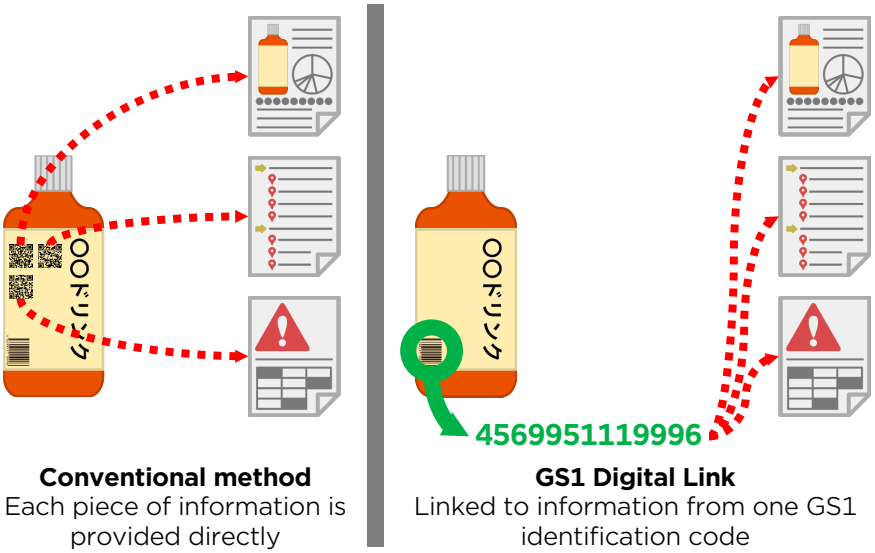


Figure 2 Image of information linkage from a GS1 identification code using GS1 Digital Link

(Source) Modified by the author based on the article of Sato[2)]

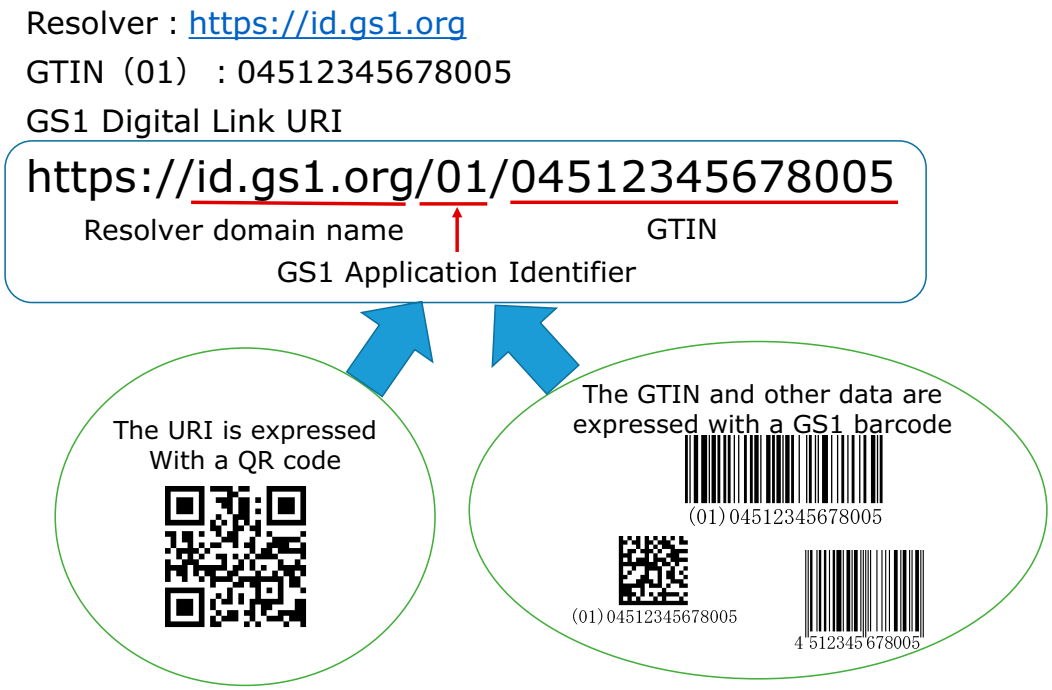


Figure 3 Barcode expression of the GS1 Digital Link URI

The URI may be expressed directly with a QR code (the left figure), or GTIN, and necessary attribute information may be expressed with a GS1 barcode (the right figure). The GS1 Digital Link URI may be generated using the application installed in the reader.

different QR code for each information or services. (**Figure 2**).

The specifications of GS1 Digital Link are published and can be used by anyone.[1)] GS1 Digital Link specifies the URI in details, but not the data encoding procedures into a barcode. It is possible to generate a GS1 Digital Link URI from a GS1 barcode using a specific application or encode a URI in its form into a general QR code or data matrix (**Figure 3**). This article introduces two use cases of GS1 Digital Link; digitalising medication package inserts using GS1 barcodes, and ensuring repacked COVID-19 vaccine vial deliveries using QR codes.

Digitisation of package inserts according to the revised PMD Act

Barcode labelling on prescription drugs and medical devices has been promoted based on notifications from the Ministry of Health, Labour and Welfare (MHLW). The notifications were issued for prescription drugs in 2006 and for medical devices, including in vitro diagnostics, in 2008. These notifications have pursued GTIN allocation, and almost of all product packages now have a GS1 barcode on them.[3)]

Under the circumstances, the "Act for Partial Revision of the Act on Securing Quality, Efficacy and Safety of Pharmaceuticals, Medical Devices" (hereinafter referred to as the Revised PMD Act) promulgated in December 2019, made the barcode labelling of prescription drugs and medical devices mandatory. Furthermore, according to the revised PMD Act, package insert must be digitised, and the barcode is used for the access to the digitised package insert (hereinafter referred to as e-leaflet). GTIN, GS1 barcode, and GS1 Digital Link are together used as standards to support the digitisation of the package inserts.[4)]

Access to e-leaflets using GS1 Digital Link

Paper package inserts, denoting dosage and administration, indications, and precautions, have been packed with prescription drugs and medical devices. However, because the inserts are often revised, the information may become old and inefficient during the distribution and/or the inventory periods at medical institutions. Thus, it had been posing a problem to provide information only on paper. In addition, the fact that the inserts supplied with all the products had been regarded as a waste of paper resources. For these reasons, it was decided that the packed paper form is abolished, and electronic information is released on the website of the Pharmaceuticals and Medical Devices Agency (PMDA). Moreover, a following measure was taken for easy access to e-leaflets on the PMDA website using the GS1 barcodes labelled on product packages. Specifically, redirect pages for each e-leaflets are set up on the PMDA website, and users are guided to the latest e-leaflets. The GTINs encoded on GS1 barcodes and the appropriate e-leaflets are connected on the PMDA website, and the GS1 Digital Link is adopted as the URL specification for this redirect link (**Figure 4**).

According to the revised PMD Act, digitisation of the inserts came into force on August 1, 2021 with a two-year transitional measures period. And now, almost all of prescription drugs provide GS1 barcodes on the packages which can available to access the e-leaflets. However, to do so, it is necessary to scan the GS1 barcode and convert it to the GS1 Digital Link URI for the PMDA redirect page. Therefore, GS1 Japan developed an app for mobile terminals called 'Tenbun-Navi' in cooperation with the Federation of Pharmaceutical Manufacturers Associations of

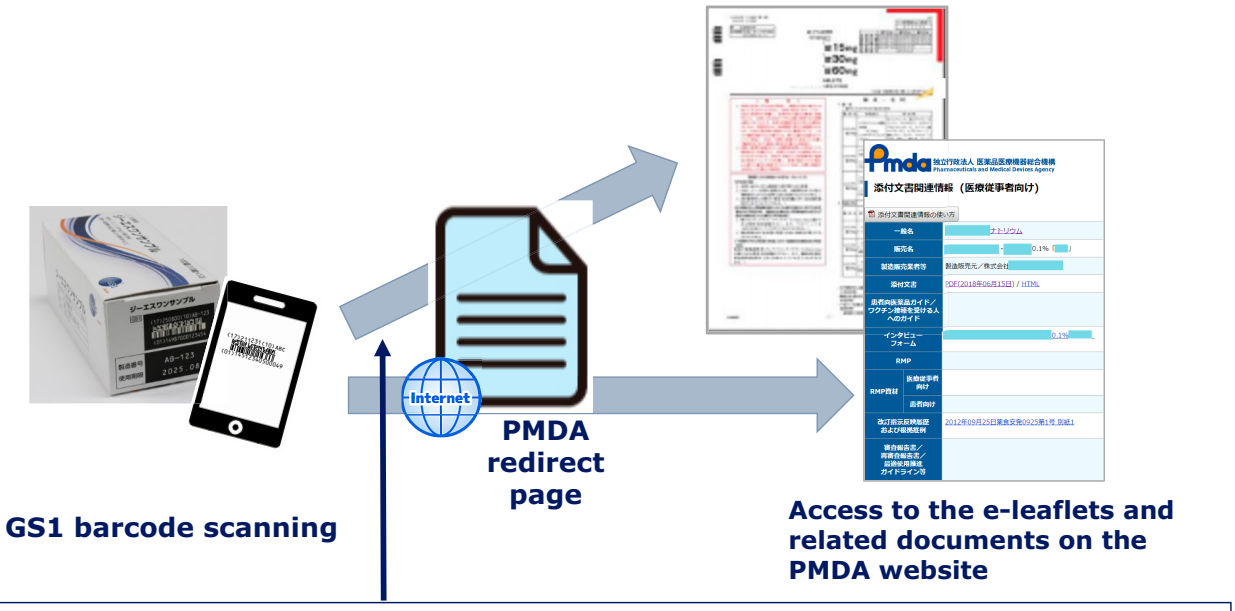


Figure 4 Scheme of access to e-leaflets and GS1 Digital Link

The PMDA redirect page can be accessed by adding the GTIN to the specified URI. When the Tenbun-Navi (e-leaflet navigation system developed for scanning) is used, the URI for access is automatically generated from the GS1 barcode, and the e-leaflet is displayed on the screen.

Japan and the Japan Federation of Medical Devices Associations. Upon scanning a GS1 barcode of prescription drugs or medical devices, this app automatically generates the GS1 Digital Link URI for PMDA redirect page, and the latest e-leaflet is displayed on the screen. Although it is an app for healthcare professionals, anyone can download it free of charge from the App Store and Google Play (**Figure 5**).

Figure 5 Tenbun-Navi : Specific App for access to digitised package inserts

The app can be downloaded for free from App Store or Google Play

Although the subject for barcode requirements for e-leaflets by the revised PMD Act is only secondary packages (sales packages), GTINs of primary and tertiary packages of prescription drugs are additionally associated and registered together. Thus, the e-leaflets can be viewed using the GS1 barcodes on blister sheets, ampoules, vials and so on. In addition to e-leaflets, related documents (risk management plans, review reports, etc.) are also available on the PMDA website. Tenbun-Navi can also help users to access the document pages.

Current situations and issues of COVID-19 vaccine deliveries

COVID-19 vaccination had been considerably slow in Japan until early 2021 among OECD countries, because of the fewer infection numbers. However, the delta variant outbreak changed the situation, facing the rapidly increased infection cases, the vaccination has been increased rapidly. Three types of COVID-19 vaccines currently distributed in Japan: those suppliers are Pfizer Japan Inc., Takeda/Moderna, Inc., and AstraZeneca K.K. Of these, the Pfizer Japan Inc. vaccine was the first vaccine that received fast-track approval and was supplied in large amounts (as of September 12, 2021; each supplied amount is approximately 138 million doses for Pfizer Japan Inc., 28 million doses for Takeda/Moderna, Inc., and 120,000 doses for AstraZeneca K.K.).[5)]

The Pfizer Japan Inc. vaccine is mainly used. However, the vaccine needs to be transported and stored at an extremely low temperature (-60 to -90℃), and a box containing 195 vials is a unit for logistics. In this regard, there are many challenges both for logistics and use. In particular, smaller medical facilities performing individual vaccination faced difficulties to receive a small number of vaccines. Therefore, the vaccine logistic measure was established, where those smaller facilities obtain vaccines indirectly via relatively large institutions which can directly receive vaccines from Pfizer Japan Inc. The MHLW has issued a request on prompt and adequate vaccine usages, for example, sharing unused vaccines with other sites, ensuring avoidance of expirations or disposal[6)]. This requirement includes obligations to record, store, and report various information.

As the vaccines are preserved at ultra-low temperatures, repackaging vaccines for the sharing requires thick gloves, which makes it difficult to perform detailed work. Nevertheless lot number confirmation and recording should be done in a very short time.

Under such circumstances, Kawakita General Hospital[(Note)] has made new efforts to improve the efficiency of sharing vaccines and ensure more reliable traceability.

(Note) Kawakita General Hospital is a regional medical support hospital established in Asagaya, Suginami- ward, Tokyo, in 1928, with 331 beds. The hospital is treating patients with mild to moderate coronavirus infection. This is a core vaccination site for Pfizer Japan Inc. vaccines and is responsible for distributing necessary number of vials to related vaccination sites.

GS1 Digital Link utilised vaccine repacking system

The number of vials required for vaccination varies from site to site. Some sites need only a few vials in a day, and they must be delivered constantly keeping the ultra-low temperatures. This process requires boxes that can infix contents and withstand the ultra-low temperatures throughout shipping. The Kawakita General Hospital, together with Kinshi Seisakusyo Co. Ltd., selected a box for repack and delivery that would protect the vaccines at the low temperatures (hereinafter referred to as the repacking box). They adopted GS1 Digital Link to ensure that the repacked information is recorded correctly and used for reliable traceability, and that the data can be shared and utilised at the destination sites that receive the boxes.

Each box is labelled with a QR code encoded with GS1 Digital Link URI to help uniquely identify each box and link it with relevant information (**Figure 6**). The

GS1 Digital Link URI of the vaccine subdividing system
https://neox-inc.com/resolver/01/04560429680970/21 [Serial No.]

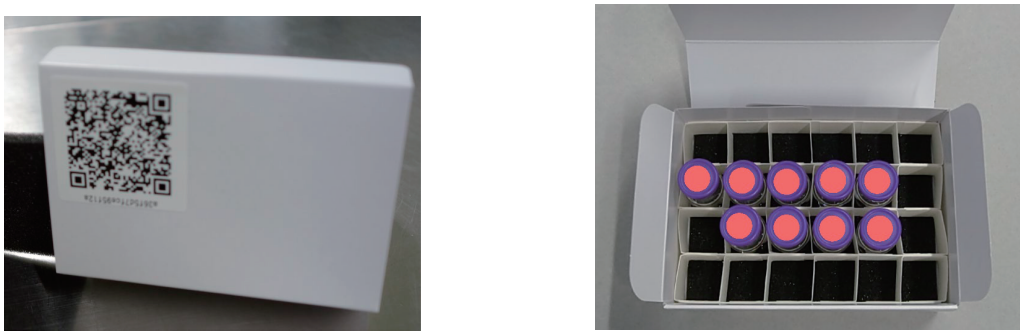


Figure 6 GS1 Digital Link URI for the vaccine repacking system and the box

Left: A subdividing box (the above URI is encoded in a general QR code)

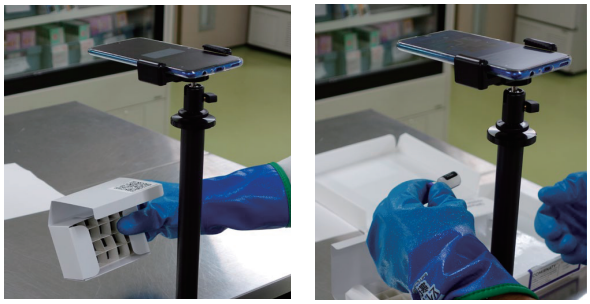
Right: Subdivided vaccine vials (the pink symbol on the cap indicates that the app has recognised the vaccine)

In this approach, using 'GTIN (04560429680970),' GTIN is the code for the subdividing box, and the series number is randomised to strengthen traceability. The resolver is provided by Neox Co. Ltd.

vial repack and delivery work process is supported by a specific app that is equipped with image and voice recognition functions. The actual procedures are as follows:

- Enter necessary data for repacking (delivery destination, number of vaccines, etc.).
- Scan the barcode on the instruction, on which data entered is printed, with a smartphone with a dedicated app installed so that the work flow is confirmed.
- Scan the QR code on the repacking box and associate it with the instruction (**Photo. 1 left**).
- Pick up the necessary number of vials from ULT freezer, retrieve the lot numbers with the OCR function of the app, and then organise them in the box (**Photo. 1 right**).
- Using the smartphone, capture an image of the repacking box with required number of vials. The image recognition technology function automatically counts the vials and confirms if the instructed number of them are in (**Figure 6 right**).
- The work details are uploaded to the system when completed.
- Scanning the QR code on a repacking box, the recipients can acquire the information interlinked with the box via the GS1 Digital Link URI. This system documents the information (number of vaccines, lot numbers, name of vaccine shipping/receiving institutions, and so on) in the format specified by the MHLW.

This app's voice recognition function allows operators hands-free work even with low temperature compatible



QR code reading　　Reading of vaccine lot numbers

Photo. 1 Reading of the GS1 Digital Link URI and vial lot number

gloves on. Instead of tapping on 'OK' button, operator just need to say 'OK' (**Photo. 1**).

This system made the documenting process regarding the vaccine repacking work under the ultra-low temperature simpler, and the boxes are smoothly and securely delivered to the downstream institutions. Under this pandemic circumstance, the COVID-19 vaccines have been categorised as specially approved pharmaceuticals, so that they do not necessarily display a barcode in the format MHLW approved. Therefore, lot numbers are captured using OCR recognition function of the app. We believe this process will be much simpler when lot number and expiration date are encoded with GTIN in a GS1 barcode.

Conclusion

COVID-19 pandemic has caused an immense social crisis in many countries, and at the same time it has spotlighted the medical vulnerability. Global supply chain became dysfunctional because of rapidly increased demands for surgical masks and protective

gears, and closed borders, which was a fatal blow to modern globalised material and product supply chain. Under such circumstances, the use of international standards for product identification, data linkage, and traceability has drawn attention. In Japan, slow digitisation had been deemed as an issue to be improved, and now under the COVID-19 pandemic the demands for the development has been rapidly increased.

Digitisation of the package inserts had already been ordered by the revised PMD Act. and even under the pandemic transition to the digital is going smoothly without causing confusion to the stakeholders utilising GS1 Digital Link in addition to GS1 barcodes which are already being labelled on most of the products. This is attracting rising attentions as advanced measure from other countries even the ones with promoting e-labelling as it is mentioned in the article 'Digitalisation under COVID-19 pandemic; Drug e-labelling initiative across world' (GS1 Japan Review No.4 November 2021).

GS1 Digital Link, a GS1 new standard, is developed aiming to be a kind of key to get various information and services. Most of the products including medical products worldwide are identified with GTINs, and now they are going toward adding expiration date, lot number, and serial number into a barcode together with a GTIN. Under such circumstances, GS1 Digital Link utilisation is getting great anticipation to retrieve additional information of the identified products. Here in this article, the author introduced two use cases of GS1 Digital Link, however, these cases utilise some of the features of GS1 Digital Link and do not take full advantage of this new standards. Standardised system are the fundamentals of promoting digital transformations, and we are looking forward to further expansion to various more necessary information. In the vaccine delivery case, explained above, the system is used just between limited institutions, Kawakita and its cooperative sites, but because the system is developed based on the global standard it is easily diverted to other system, and, as the key identification code is GTIN, there should not be misidentification even if same kinds of systems are parallelly operated.

GS1 Digital Link is just launched but expectations are coming from foods, general merchandise, construction, and other industries. We believe this new standard will be widely used for efficient and secure operations world-wide.

References

1) GS1, *GS1 Digital Link*, https://www.gs1.org/standards/gs1-digital-link, (accessed on September 15, 2021)

2) Sato Y, *Introduction of GS1 Digital Link: Discovering information linked from GS1 identification codes to web*, Logistics Review, No. 461, 2021 https://www.sakata.co.jp/logistics-461, (accessed on September 15, 2021)

3) Uemura K, *GS1 standard utilisations and future prospects in healthcare industry*. GS1 Japan Review, inaugural issue, p43-48, 2020

4) Uemura K, *Revised Pharmaceutical and Medical Device Act and digitisation of package insert*. Monthly Automatic Recognition, Vol. 34, p1-4, 2021

5) The website of the Office of Prime Minister, *About the new coronavirus*, https://www.kantei.go.jp/jp/headline/kansensho/vaccine.html (accessed on September 15, 2021)

6) Vaccination Room, Health Division, Health Service Bureau, Ministry of Health, Labour and Welfare, *Expansion of Pfizer vaccine supply*. https://www.mhlw.go.jp/content/000801667.pdf, (accessed on September 15, 2021)

GS1 Japan

9F, Shin Aoyama Bldg., East, 1-1-1, Minami Aoyama, Minato-ku, Tokyo
107-0062 JAPAN
T +81-(0)3-5414-8535
M healthcare@gs1jp.org

www.gs1jp.org