DEVELOPING PANDEMIC RESILIENCE REVISITED

Bottlenecks to breakthroughs: What we’ve learned one year into COVID-19 and how we’ll be ready for the next health emergency

DHL CSI – Customer Solutions and Innovation
Revisiting Pandemic Resilience in a nutshell

Out of the starting blocks

It’s a marathon, not a sprint

The home stretch

Getting ready for the next race
CHAPTER 1: Out of the starting blocks

Out of the starting blocks

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Although the last year was difficult, there are ten key achievements of the global community

1. COVID-19 vaccine development occurred five times faster than any other vaccine in history
2. Two new vaccine platforms, that can tackle diseases beyond COVID-19, have emerged and begun to mature
3. Total global vaccine production quadrupled within a year
4. The complex global vaccine supply chain was ramped-up successfully
5. Extreme cold-chain requirements were met at scale – flawlessly!
6. The vaccination rate already outpaces the infection rate by a factor of nine
7. Multilateral action was taken to ensure global access to vaccines
8. Vaccine economics work: on a per capita basis end-to-end costs for vaccination equal just one week of lockdown costs
9. Markets quickly met the high demand for testing, ancillary supplies, and PPE
10. Large-scale research on therapeutics has been promising
COVID-19 vaccine development occurred five times faster than any other vaccine in history.

Vaccination innovation
Time from infectious agent identification to vaccine approval in the US, years

<table>
<thead>
<tr>
<th>Agent</th>
<th>Time, years</th>
</tr>
</thead>
<tbody>
<tr>
<td>COVID-19</td>
<td>0.8</td>
</tr>
<tr>
<td>Mumps</td>
<td>4</td>
</tr>
<tr>
<td>Measles</td>
<td>10</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>16</td>
</tr>
<tr>
<td>Human papillomavirus</td>
<td>25</td>
</tr>
<tr>
<td>Diarrheal disease</td>
<td>33</td>
</tr>
<tr>
<td>Ebola</td>
<td>43</td>
</tr>
</tbody>
</table>

Note: COVID-19 vaccines have received Emergency Use Approval, whereas the other vaccines have received biologics license application approval in the stated time.


1: 5x faster

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Total global vaccine production quadrupled within a year

### Vaccine production

2021, billion doses

<table>
<thead>
<tr>
<th>Vaccines before COVID-19</th>
<th>COVID-19 vaccines</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

- **Pipeline**: 5 million doses
- **Authorized in at least 1 geography**: 10 million doses

**Total global vaccine production quadrupled within a year**


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The complex global vaccine supply chain was ramped-up successfully

DPDHL is the trusted partner for Covid-19 vaccine logistics worldwide

Key contributions to date

- >338 million doses distributed internationally
- >140 countries served
- >9,000 flights operated to deliver vaccines
- >350 DHL facilities involved in the process
- >50 collaborations in the pharma & public sector
- >10 new and dedicated services introduced
The vaccination rate already outpaces the infection rate by a factor of nine.

### Covid-19 vaccination vs. cases

**Million people**

- People who have received at least 1 dose: +550 since Jan 2021
- Total COVID-19 cases: +65 since Jan 2021

Source: Our World in Data COVID-19 data explorer, Apr 28, 2021

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Vaccine economics work: on a per capita basis end-to-end costs for vaccination equal just one week of lockdown costs.

E2E logistics represent <1% of the total vaccination cost.

COST PER PERSON
EUR

Simplified illustration based on a sample calculation for 3 industrial countries. Lockdown and vaccination costs for the adult population over 18 years. Vaccination costs vary based on used vaccines, as well as points of vaccination in the different countries. Lockdown costs (total economical costs due to the closure of e.g., shops and restaurants) are based on estimates by independent economic researchers.

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CHAPTER 2: It’s a marathon, not a sprint

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Only a small fraction of vaccination rollout achieved – upcoming phase will be challenging

With 1 of 10 bn of the required doses administered, ...

... a concentrated production footprint

... and the rollout to 220 countries pose challenges for logistics

With 1 of 10 bn of the required doses administered, …

<table>
<thead>
<tr>
<th>Doses administered to date</th>
<th>Objective until end of year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 bn vaccine doses</td>
<td>10 x10 bn vaccine doses</td>
</tr>
</tbody>
</table>

95% of global vaccine production is concentrated in 8 countries*

5% in the rest of the countries

Number of countries clustered by the share of people fully vaccinated

- >50%: 4 countries
- 10-50%: 28 countries
- <10%: 188 countries

Many countries with suboptimal conditions

* US, BE, DE, RU, IN, CN, ZA, UK

* US, UK, IL, CL

Source: COVID-19 Tracker from Our World in Data, Apr 28, 2021

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10 building blocks to go from 4 to 220 countries with successful vaccination campaigns

- **Fostering collaboration**
  1. Partnerships without borders
  2. Supportive data backbone

- **Securing inbound flows**
  3. Transportation capacity management
  4. Packaging sustainability

- **Setting up the last mile for success**
  5. Strategic warehousing
  6. Synchronized flow of goods
  7. Vaccination points

- **Maximizing demand for vaccines**
  8. Well-informed population
  9. A User-Friendly Process
  10. Incentives convincing last movers
CHAPTER 3: The home stretch

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Going forward, 7-9 bn additional doses will be needed annually to keep COVID-19 in check

The need for an additional 7-9 billion doses will be driven by three factors:

- **Booster shots**: 4-5 billion doses will account for "booster shots" to maintain the immunity of people who were vaccinated in 2021.
- **Patients in new groups**: Another 2-3 billion doses will be earmarked for patient groups, such as children under the age of 12, who will likely be eligible after the conclusion of ongoing clinical trials.
- **New patients**: With time willingness to get vaccinated will likely increase, these new patients will account for an additional ~1 billion doses (assuming a 10-percentage point uptake).

### Estimated additional vaccine quantities for 2022 and beyond

<table>
<thead>
<tr>
<th>Category</th>
<th>Estimated Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Booster shots</td>
<td>~4-5 billion</td>
</tr>
<tr>
<td>Patients in new groups</td>
<td>~2-3 billion</td>
</tr>
<tr>
<td>New patients</td>
<td>~1 billion</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>~7-9 billion</td>
</tr>
</tbody>
</table>

Source: UN Department of Economic and Social Affairs; Johns Hopkins Center for Communication Program; DHL analysis
3 watchouts needed to be implemented to ensure that today’s supply chain provides a solid platform for the next years

Players need to implement 3 measures:

1. Remain prepared for high patient and vaccine volumes
2. Maintain logistics infrastructure and capacity
3. Plan for seasonal fluctuations

... then supply chain provides solid platform due to 30% lower volume

### Projected global vaccine shipping volumes

<table>
<thead>
<tr>
<th>Year</th>
<th>Billion doses</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>~5</td>
</tr>
<tr>
<td>2021</td>
<td>~10-15</td>
</tr>
<tr>
<td>2022</td>
<td>~7-9</td>
</tr>
<tr>
<td>2023</td>
<td>~7-9</td>
</tr>
</tbody>
</table>


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CHAPTER 4: Getting ready for the next race

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Getting ready for the next race
## Getting ready for the next race: 10 strategic actions governments and other stakeholders should consider pursuing now

<table>
<thead>
<tr>
<th>Prevention and early identification</th>
<th>Containment and countermeasures</th>
<th>Medication rollout capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Institutionalize active partnerships and systems</td>
<td>5. Implement national containment and escalation plans</td>
<td>8. Maintain “ever-warm” manufacturing capacity</td>
</tr>
<tr>
<td>2. Double down on global early-warning systems</td>
<td>6. Leverage digital contact tracing and monitoring app</td>
<td>9. Define blueprint research, production, and procurement plan for diagnostics, therapeutics, and vaccines</td>
</tr>
<tr>
<td>3. Create and follow through on integrated epidemic-prevention agenda</td>
<td>7. Establish an emergency stockpile and associated “supplies and logistics” emergency system</td>
<td>10. Maintain and expand rollout capabilities for diagnostics, therapeutics, and vaccines</td>
</tr>
<tr>
<td>4. Invest in targeted research and development to improve diagnostics, therapeutics, and vaccines</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>