# 감염병과의 전쟁, 백신을 통해 찾은 희망

이철우 국제백신연구소 (IVI)

제9회 부산국제항만컨퍼런스 (BIPC 2021) Nov 4, 2021 (Thursday)



International Vaccine Institute

#### History Repeats Itself



A scene from a plague poster. (Photo by Hulton Archive/Getty Images)

A view of a quarantine area in Malta. Credit: Wellcome Collection

## Trentino (30) $\rightarrow$ Quarantino (40) $\rightarrow$ Quarantine

Beyond leprosy and plague, various forms of self-isolation and physical/social distancing has been adapted to and contain outbreaks (e.g., smallpox, yellow fever, flu, SARS, etc.)



#### Mask Wearing During Spanish Flu



Source: New York Times



#### **Epidemiologic Investigation for Disease Control**



ILLUSTRATION BY JOHN SNOW, IMAGE COURTESY FINAVON, WIKIPEDIA

Father of modern epidemiology; proving cholera is waterborne disease (vs. miasma theory)



Outbreak Occurs Among Men in New York and California —8 Died Inside 2 Years

#### By LAWRENCE K. ALTMAN

Doctors in New York and California have diagnosed among homosexual men 41 cases of a rare and often rapidly fatal form of cancer. Eight of the victims died less than 24 months after the diagnosis was made.

The cause of the outbreak is unknown,



#### **Emerging Infectious Diseases**

#### **Global Examples of Emerging and Re-Emerging Infectious Diseases**





#### The 26 Vaccine Preventable Infectious Diseases





SARS-CoV-2



Varicella and herpes zoster (shingles)

Human papilloma-virus



Rotavirus gastroenteritis



Yellow fever

]apanese encephalitis

#### Vaccines wipe out deadly diseases

Last case, variola minor, 1977, Somalia







#### **SMALLPOX**

Last case, variola major, Bangladesh, 1975







#### Next: Polio?





#### Impact of Immunization



Source: Value of Immunization Compendium of Evidence

Source: GAVI



#### Impact of Immunization Beyond Health

#### A VIRTUOUS CYCLE



Source: GAVI



#### Immunization - Healthy Return on Investment



Gavi, the Vaccine Alliance is dedicated to addressing this issue. the social and economic wellbeing of communities.

More than US\$ 586 billion in economic benefits for 94 of the world's poorest countries (2011-2020).





#### Time between pathogen discovery and vaccine





#### Valley of Death in Clinical Trial



<sup>12</sup> Source: https://www.brightfocus.org/, https://www.cancer.nsw.gov.au

## Vaccine Clinical Development under Pandemic



<sup>13</sup> Source: https://www.nejm.org/doi/full/10.1056/NEJMp2005630



#### **COVAX for Equitable Access to COVID-19 Vaccines**

#### COVAX Forecasted Supply, Cumulative, M doses, 2021 and 20221



Source: COVAX Supply Forecast

#### 189 countries have joined COVAX

- Organized by CEPI, GAVI, WHO
- 92 LMIC could be supported by the COVAX AMC
- 2 billion doses of WHO PQ'd vaccines by end of 2021
- 5 billion doses secured
- Roughly 20%- > 30% of need



#### **COVID-19 Vaccine Supply Shortage**



- Rapid large-scale manufacturing along with contracting/licensing agreements enabled billions of COVID-19 doses; global demand > supply
- Successful development of additional vaccines and scale-up manufacturing of approved vaccines are critical
- Due to quick ramp-up, manufacturing process may not have been optimized resulting lower yield (Planned vs. Actual)
- Flow of raw materials affecting supply chain



Source: New York Times, 3 Aug 21

#### Vaccine Manufacturing Process



Source: Chatham House: Toward Vaccinating the World, 2021

## Vaccine manufacturing is a complex process where quality makes a difference in efficacy and safety



### Intellectual Property is one (complicated) thing

- Underlying technology used to develop a vaccine can be protected by patents
- Foundational technology needed to develop a vaccine invented in academia/biotech companies (Protected through patents) → subsequently licensed out to a larger entity for further development and commercialization; increases complexity involved in IP protections and licensing
- Patents, trade secrets and know-how may impede future research and development of existing vaccine technology by creating legal barriers



Source: Gaviria et al, Nature 2021



## Inequitable Vaccine Distribution Across the World



COVID-19 vaccine doses administered by country income group

Source: Official data collated by Our World in Data, World Bank

Our World in Data

- Humanitarian crisis: Without equity in the first 2 billion doses global COVID-19 deaths will double
- Biological crisis: Failure to control pandemic generates mutants that will undermine the efficacy of vaccines
- Economic crisis: Without equity, 49% of the global economic costs of the pandemic in 2021 (\$4-5 trillion) are borne by the advanced economies (2021: NBER, Brookings Institute, ONI)



<sup>10</sup> Source: Our World in Data

## Safety, benefit and risk of COVID-19 vaccines



Slide Courtesy of Dr. Anh Wartel, IVI

Source: Winton Centre for Risk and Evidence Communication Cambridge University



#### Vaccine Hesitancy

Willingness to get vaccinated against COVID-19, South Korea, Mar 15, 2021 to Sep 15, 2021

Share of the total population who has not received a vaccine dose and who are willing vs. unwilling vs. uncertain if they would get a vaccine this week if it was available to them. Also shown is the share who have already received at least one dose.



Source: Imperial College London YouGov Covid 19 Behaviour Tracker Data Hub – Last updated 2 November 2021, 09:00 (London time) Note: Months containing fewer than 100 survey respondents are excluded. We infer willingness to get vaccinated in a country's population from survey responses of people aged 18 years and above, which may not be representative of the entire population. Nevertheless, we expect such differences to be small.

OurWorldInData.org/coronavirus • CC BY

Source: Our World in Data

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#### December 2020

Our World in Data Vaccinated (with at least one dose) Unvaccinated and willing to get vaccinated

Unvaccinated and uncertain if willing to get vaccinated 📕 Unvaccinated and not willing to get vaccinated

United Kingdom	23%		59%			6.8%	11%	
Denmark		69%	5		10%	16%		
Netherlands	4%	59%		17%		21%		
Singapore		45%		29%		21%		
Italy	3%	59%		16%		22%		
Spain		53%		19%		24%		
Sweden		59%		12%		25%		
Norway		57%		14%		25%		
Germany		57%		13%		26%		
Canada		54%		16%	16%		27%	
Australia		53%		19%		28%		
United States	11%	42%	1	13%		33%		
France		39%	15%	42%				

#### October 2021



#### Why Do People Have Vaccine Hesitancy?

#### WHO: Top 10 Global Health Treats **Air Pollution** Ebola Noncommunicable Diseases Weak Primary Healthcare Influenza Vaccine Hesitancy Vulnerable Settings Dengue Antimicrobial Resistance HIV Source: WHO, Medscape

- Misinformation
- Underestimate severity
- Believes there is still a debate
- Misinterpret information
- Anecdote versus scientific fact
- No vaccine = no risk thinking
- Distrust of government



#### Vaccine Acceptancy in Korea



## Lessons Learned from COVID-19 Pandemic

## What has worked well to-date



HICs providing **at-risk funding** for R&D has enabled Phase III studies for multiple candidates



Efficient and rapid clinical development of vaccines



Promising coordination around securing adequate fill/finish capacity and glass vials



Increased funding and interest for newer vaccine platforms (e.g. mRNA)



Establishment of opt-in COVAX facility with efforts to make fair global allocation decisions

## What has not worked well to-date



Relatively small vaccine supply secured for LMICs



Nationalist procurement of early vaccine doses (well above need for most HICs)



Postponement of vaccinations (campaigns and routine), increasing risk of multiple outbreaks



Procurement scramble creates dependence on a high volume of tech transfers



Emerging risk of vaccine hesitancy and distrust of clinical approval process integrity



#### Vaccine to Fight Next Pandemic



## Vaccine Saves Lives

## Vaccination/Immunization Saves Lives

- 1) Vaccine
- 2) Vaccination System
- 3) Vaccinee



Slide Courtesy of Dr. Jerome Kim, IVI

#### DIAGRAM1 | The 100 Days Mission

# Topological and the set of the se

to respond to future pandemic threats

#### Science

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#### **ARPA-H: Accelerating biomedical breakthroughs**

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Accurate and

approved rapid diagnostic tests

An initial regimen

of therapeutics

Vaccines ready

to be produced

at scale

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The biomedical research ecosystem has delivered advances that not long ago would have been inconceivable, exemplified by highly effective COVID-19 vaccines developed by global partners and approved in less than a year. The United States stands at a moment of unprecedented scientific promise and is challenged to ask: What more can we do to accelerate the pace of breakthroughs to transform medicine and health? Toward that end, President Biden recently proposed to create a new entity, the Advanced Research Projects Agency for Health (ARPA-H), within the National Institutes of Health (NIH) "to develop breakthroughs—to prevent, detect, and treat diseases like Alzheimer's, diabetes, and cancer," requesting \$6.5 billion in the fiscal year 2022 budget (1). The idea is inspired by the Defense Advanced Research Projects Agency (DARPA), which follows a flexible and nimble strategy, undeterred by the possibility of failure, and has driven breakthrough advances for the Department of Defense (DOD) for more than 60 years. To design ARPA-H, it is critical to understand what is working well within the biomedical ecosystem, where there are crucial gaps, and the key principles of DARPA's success.

Source: www.science.org



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Source: G7 Summit, UK (June 2021)

#### **Innovations Driving New Vaccine Platforms**



## **Consolidated Approach for Research and Sustained Investments**

WHO R&D Blueprint: prioritizing diseases for research and development for emergency

- COVID-19
- Crimean-Congo hemorrhagic fever
- Ebola virus disease and Marburg virus disease
- Lassa fever
- Middle East respiratory syndrome coronavirus (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS)
- Nipah and henipaviral diseases
- Rift Valley fever
- Zika
- "Disease X"

<sup>27</sup> Source: WHO, CEPI

#### **CEPI's strategic portfolio targets**



## Tech Transfer and Manufacturing Scale-Up

Transfer steps typically take 27 to 29 months and involve many key stakeholders.

#### Step activity typical lead time timeline, months





Slide Courtesy of Martin Friede, WHO



### Vaccine Security Beyond COVID-19

- Build, expand, re-purpose manufacturing sites
- Staff and talent acquisitions
- Harmonization of regulatory requirements;
  collaboration and collective regulatory review
- Foster collaboration, establish technical assistance mechanism (tech transfer)
- Establish 'push-and-pull' strategy (e.g., advanced commitment)
- Information sharing
- Joint emergency stockpile



#### **Examples of Innovation for Mass Vaccination**







#### 1. Secure disposable needle





One-way valve in multi-dose syringe

3. Dispense needle

#### Single dose prefilled injector

















ATH



#### **Preparing for Next Pandemic**





#### IVI is an International Organization dedicated to Global Health



#### **Global Vaccine** Research Institute

- HQ and labs at Seoul National University
- Field programs in 28+ countries: Asia, Africa, Latin America
- 23 nationalities in workforce of 183

#### **OECD-recognized** International Organization (not for profit)

- UNDP initiative
- First international organization in Korea (1997)

Republic of Korea

 36 countries and WHO as state parties (Madagascar, Argentina, and Spain pending final submission to UN)

Taiikistan

Thailand

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