Working Group on Epidemic Preparedness

Preventing the Spread of Epidemics Using ICT

September 2018

BROADBAND COMMISSION
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Working Group on Epidemic Preparedness:

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korea telecom

FOREWORDS

Dr. Chang-Gyu Hwang
Chairman and CEO, Korea Telecom

Chair, Broadband Commission Working Group on Epidemic Preparedness

Advancements in ICT have contributed to overcoming many challenges. Particularly in the area of healthcare, the role of ICT goes beyond simple connectivity to becoming an innovative tool that improves the quality of life.

However, there is still much more work to be done by ICT. In particular, it is not an overstatement that infectious diseases are one of the biggest enemies of humankind, threatening our very existence and safety. They not only take precious lives but also incur huge social costs. Infectious diseases or epidemics of the modern era are much more powerful than the ones in the past in terms of the speed of spread and the scope of damages they wreak upon us. Tackling them has quickly become our common goal that requires collective efforts of us all.

Healthcare institutes, governments, research institutes, and private companies around the globe are making full scale efforts to fight epidemics with ICT. As a result, we are witnessing a new set of approaches, such as epidemics monitoring system based on fixed and mobile networks, epidemics data platform, and remote training programs aimed at enhancing public awareness toward epidemics. In addition, new breakthroughs give us hope that we might soon be free from the threats of epidemics in the near future. ICT is also playing a role as a hub through which we share use cases and know-hows to fight epidemics throughout the world. Considering the nature of modern epidemics, which cannot be tackled by regionally fragmented responses, there is a strong need for us to build a united front at a global level to fight infectious diseases.

KT proposed the Working Group on Epidemic Preparedness to use big data with the aim to help prevent the spread of infectious disease with ICT. The Working Group shared much insight and ideas about epidemic preparedness through meetings held in Kigali, Rwanda and a number of conference calls. Today, it is my privilege to present this report titled "Preventing the Spread of Epidemics using ICT" based on such invaluable insights we gathered.

In this report, a wide range of multi-dimensional analysis was carried out to explore the potentials of ICT as a game changer in fighting epidemics. Through a framework analysis, new trends were identified in solutions that are expanding to include not only medical data but also roaming data and social data gathered from mobile phones. Based on this finding, we looked at some key use cases of ICT in tackling modern infectious diseases, such as Ebola, SARS, and MERS, to verify the actual application of ICT. It is my firm belief that the research outputs will contribute to the foundation of ICT-based solutions against epidemics and provide insights and recommendations for greater usage.

Once again, I would like to extend my deepest gratitude to all members who actively participated and contributed to the Working Group and many experts for their insights and expertise. We will continue our efforts to enhance the global initiative for epidemics prevention and ensure cooperation and support from international organizations, governments around the world and private corporations.

As the Chair of the Working Group on Epidemic Preparedness, KT will continue to strive to lead sustainable growth of the global community through innovative technologies that put people first. I sincerely hope for your support and encouragement.

Thank you.

Dr. Chang-Gyu Hwang
Chairman and CEO
Korea Telecom

Houlin Zhao

**Secretary-General,
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Information and Communication Technologies (ICTs) can play a pivotal role in making available timely, high quality and reliable health information during epidemic outbreaks. Broadband is one of the core technologies to provide continued communication services, content delivery, knowledge exchange and information dissemination to facilitate the achievement of "Sustainable Development Goals" (SDGs), in particular, SDG 3 that aims to "ensure healthy lives and promote well-being for all people at all ages". SDG3 is an essential goal in seeking to guarantee all human beings the right to health information and services.

ITU has carried out a range of activities to assist in improving global health by supporting countries in the areas of infrastructure development, emergency telecommunication, development of national e-health strategies and others. In this effort, ITU forged partnerships with the private sector and other United Nations Organizations in particular the World Health Organization. ITU supported response efforts to the Ebola virus epidemic outbreak in West Africa during the 2014 and 2015 crisis, within the framework of ITU Resolution 202 (Busan, PP-2014) – "Using information and communication technologies to break the chain of health-related emergencies such as Ebola virus transmission" – and a jointly funded project with the Ministry of Communications (MIC), Japan on Big Data and the use of Call Detail Record (CDR).

The ITU project on Big Data demonstrated that Member States can use ICT infrastructure to securely exchange information on citizens' mobility with the aim of ensuring better response to outbreaks of infectious diseases. The processed data can be useful for better decision making by humanitarian national and international organizations including UN agencies.

This Working Group report includes use cases on an international level, which highlight the role that ICT plays in response facilitation when dealing with infectious and other types of diseases. In addition, the report also emphasizes the importance of global cooperation to address various challenges that we face as human beings. It also provides guidance on political, technological, and structural directions that we have to pursue to realize such cooperation.

As Co-Vice Chair of the Broadband Commission for Sustainable Development, I sincerely welcome the publication on "Preventing the Spread of Epidemics Using ICT," and hope to see more cases of cooperation aimed at tackling infectious diseases drawn from lessons learned.

ACKNOWLEDGMENTS

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History of Epidemics and Leading Causes

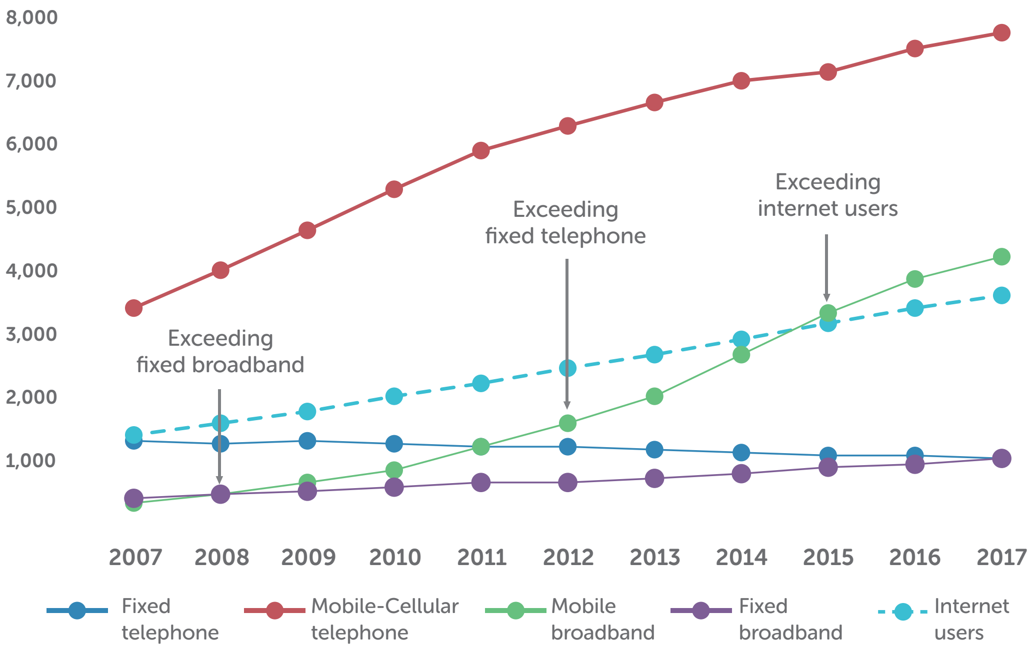
Humanity has long fought a war against infectious diseases. From the Plague of Athens, the first recorded infectious disease in history, to modern epidemics such as Ebola and MERS, infectious diseases have incurred significant social and economic losses. In particular, modern epidemics pose a great threat to humanity with its unprecedented speed and scale. The economic loss of modern epidemics are estimated to be approximately 60 billion dollars per year.

What is more concerning is that global changes have made it more difficult to address modern epidemics. Growing international exchanges since the 1970s, increase in population and urbanization, intensification of global climate and environmental changes, and inadequate systems of disease prevention and control are considered the leading causes of epidemics in modern society. Stakeholders from various fields around the world are addressing such challenges in an effort to free humanity from the threats of epidemics.

ICT as a Game Changer in Fighting Epidemics

ICT has also actively joined such efforts. Explosive growth in mobile broadband penetration in the last decade has been contributing to resolving universal challenges of mankind (poverty, famine, disease, etc.) through mobile services, and big data analysis based on data science is drawing increasing attention as a key ICT solution for fighting epidemics.

[Subscriptions of key ICT network infrastructures (Unit: Million)]

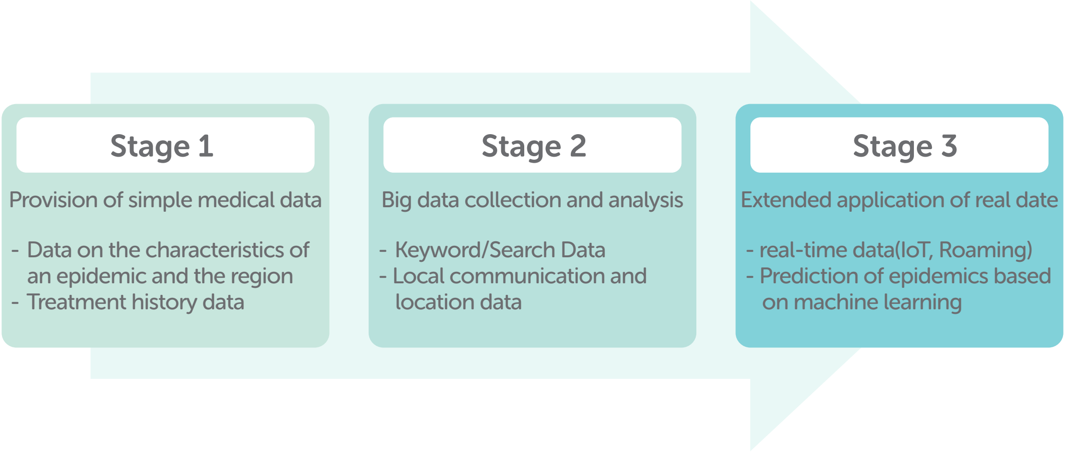


Big Data Based ICTs for Fighting Epidemics

As for data science technologies currently being utilized in the fight against epidemics, representative examples include Genetic data analysis, Cell phone mobility data analysis, Social media data analysis, Location-based information mash up, and Large-scale simulations. These technologies collect various epidemics-related big data and mash up with map and location data, thereby serving as a solution to identify the course of epidemics spread and potential infected populations.

However, considering that the increased complexity of modern epidemics requires multi-faceted solutions, epidemics solutions that solely depend on big data might not be able to produce tangible and meaningful outcomes in the future. This challenge can be resolved by utilizing various ICT technologies in data collection and analysis, thereby lowering the dependency on a single source of data. More recently, the effort to fight epidemics is further evolving by using real data such as roaming data, social media and IoT in an effort to collect more practical data and to enhance the effectiveness of data analysis.

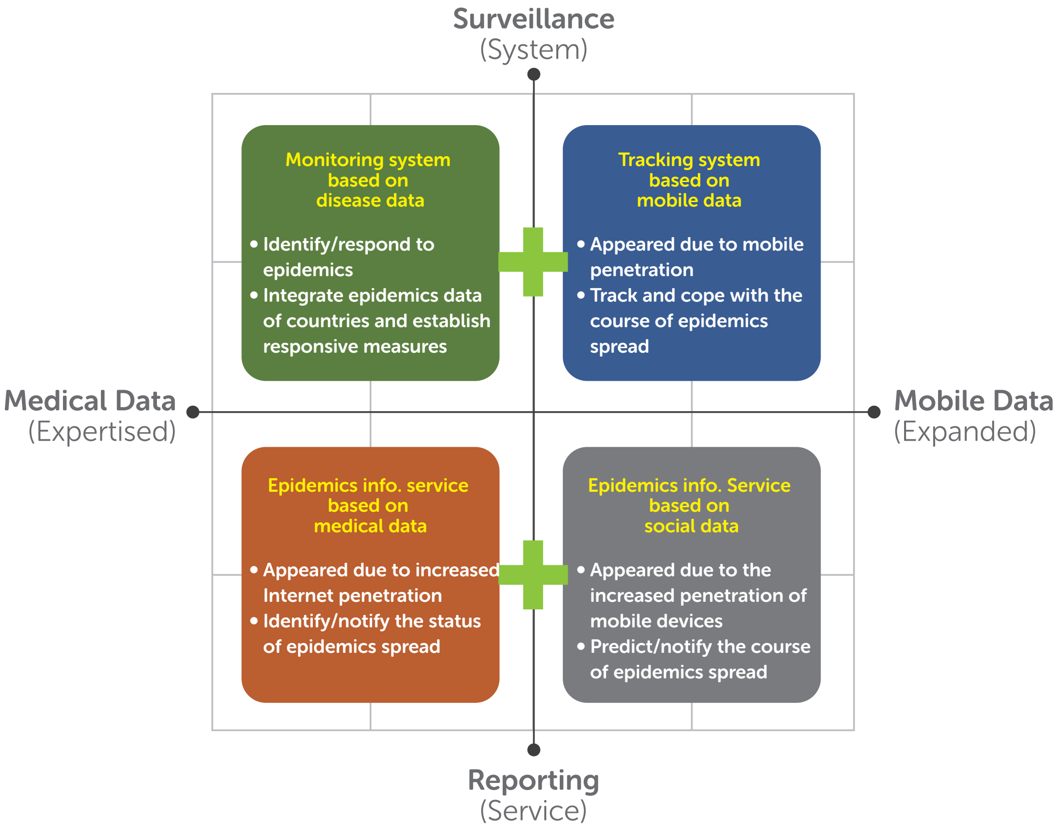
[Data Expansion for Effective Epidemic Response]



Diversification of Big Data Based Epidemic Solutions

Along with the expansion of data usage scope for effective response to epidemics, various big data based solutions began to emerge. ICT has expanded the scope of data use from previous medical data to mobile data and contributed not only to helping enhance public awareness but also to helping the public more proactively respond to prevent the spread of epidemics. Big data based epidemics solutions that currently exist can be divided as follows.

[Data Expansion for Effective Epidemic Response]



In the figure above, the horizontal axis represents the expand in data field, and the data tends to further expand and integrate with one another from expertised small data (medical) to big data (mobile). The vertical axis represents the enhancement of epidemics solutions and signifies that the purpose of using ICT solutions is changing from epidemics information provision (Reporting) to epidemics monitoring (Surveillance).

① Monitoring system based on disease data

This system identifies and responds to the spread of epidemics based on disease data of each country. The main objective of this system is to establish a hotline among each nation's government ministry in charge of epidemics management and international health authorities (or regional associations) through which epidemics data can be shared and coping method can be established. Even though this is the most initial type of solution, this is still an important system considering that the very basic step of establishing epidemics measures is to collect index-based data and to analyze them from a comprehensive standpoint.

② Epidemics information service based on medical data

While the existing solutions focused on supporting the efforts to respond to epidemics at the national level, new epidemics solutions have added a new objective of directly notifying citizens of the status of the epidemics spread. As for the data to be used, previous epidemics data were aggregated with de-identified medical data provided by various institutions, thereby evolving in a direction that has significantly enhanced the accuracy of epidemics spread trends.

③ Tracking system based on mobile data

The penetration of mobile devices has contributed to enhancing the instantaneity of epidemics solutions that are based on epidemics and medical data. If the epidemics solutions based on medical data aimed to establish ex post coping methods through identifying the spread of epidemics outbreaks, new solutions based on mobile data were utilized in minimizing the gap between the outbreaks and the response by tracking the course of epidemics outbreaks. So, this solution can be said to be the first of its kind in terms of big data based epidemics solutions.

④ Epidemics information service based on social data

Social data has invited smartphone users around the world as the main player of data production, thereby further minimizing the gap between epidemics outbreak and the response. In addition, accumulated information has been provided as a form of mobile application, which enabled access to the latest epidemics information anytime, anywhere. In the meantime, social data has been contributing to improving the accuracy of epidemics spread forecast. What we should note is that various solutions exchange their own data in an effort to effectively prevent the spread of epidemics. Not only epidemics information services used by citizens but also other solutions used for public purposes in the field of epidemics monitoring system are more increasingly doing so.

Global efforts on improving epidemic preparedness capabilities

Internet and mobile data not only supplement traditional public health infrastructure, but are also used as the hub of epidemic data and offer greater diversity in the methodology for early warning and data collection. With new types of data accumulating, such as internet search queries and social media, new efforts are being made to enhance surveillance efficiency by making direct use of this data or combining it with traditional data for analysis. Governments, companies, and international organizations around the world are seeking meaningful use cases for ICT based disease response.

[Cambodia] Mekong Basin Disease Surveillance

The MBDS (Mekong Basin Disease Surveillance) cooperation is a self-organized sub-regional network commenced in 2001 among six Mekong Basin countries and provinces of China, including Cambodia, Yunnan (and, since 2006, Guangxi) provinces of China, Laos, Myanmar, Thailand, Vietnam. It aims to strengthen national and sub-regional capabilities in epidemiology surveillance and outbreak response, especially on 18 currently designated priority diseases, to rapidly and effectively control them. The cooperation focuses on collaborative cross-border disease surveillance and response activities, through programming at approximately 25 designated cross-border sites.

[ProMED] Disease Notification Mailing Service

ProMED (Program for Monitoring Emerging Diseases) is the biggest private, open system of unofficial disease surveillance and reporting in international health. This web and email based service aims to continuously and rapidly monitor and report potential outbreaks of infectious diseases and exposures to toxins that could affect human or animal health. Through ProMED system, thousands of scientists, health professionals, journalists, and non-professionals interested in infectious diseases can receive news of epidemics in near real-time. ProMED played an important role in identifying the outbreak of SARS in 2003.

[ITU] CDR Based Ebola Outbreak Data Repository

IIn 2015, when 3 West African countries were hit by the Ebola virus, ITU initiated its first big data project. In collaboration with the beneficiary member states of Guinea, Liberia and Sierra Leone, the project was able to showcase the potential of big data to facilitate the timely exchange of information to respond to epidemic outbreaks. In close cooperation with the national telecommunication regulatory agencies in Guinea, Liberia and Sierra Leone, and with all mobile network operators (MNOs) operating in these countries, ITU conducted a preliminary study on sample Call Detail Records (CDR) data. After collecting the anonymized CDR data, ITU consolidated it into a single platform and opened it to third-party, then used data de-identification, location information calibration, and data standardization to predict the possible paths of Ebola outbreak.

[KT] Roaming Data Based Smart Quarantine Solution

During the MERS outbreak, Korean authorities had a difficult time verifying infections for those travelers that visited unaffected countries after visiting contaminated regions. KT, a mobile communication company in Korea, suggested a quarantine solution that uses communication data collected in accordance with the 'Infections Disease Control and Prevent Act', which had been useful during the avian influenza outbreak. KT linked the roaming data of its subscribers with KCDC's data on epidemics to select at-risk travelers, and successfully built an SMS solution to send texts with disease information and guidelines. This data was also used to secure statistics about Korean citizens residing in contaminated areas and those that arrived in Korea during the incubation period, which was developed into a statistical dashboard for quarantine policies and measures.

[HealthMap] Map Based Real-Time Disease Information App

HealthMap is an open service that aggregates and analyzes social data on infectious diseases and public health reports, and provides them free of charge to a diverse audience from public health workers to ordinary citizens. Disease information is available whenever, wherever through the very accessible mobile app. The primary objective of HealthMap is to provide disease information in real-time. To this end, HealthMap monitors global online news (i.e. Google News, Baidu) and reports by international health organizations (i.e. WHO) around the clock, and allows users to customize the map and time series as they want to see them.

[Ericsson, GSMA] Mobile Information Notification Infrastructure for Ebola Management

Ericsson and GSMA aimed to overcome the Ebola Outbreak in West Africa by building mobile infrastructure. This effort was significant in that it laid the foundation on which disease solutions can operate by investing physical resources in a region with insufficient ICT infrastructure. GSMA focused its efforts on providing accurate disease information to ordinary citizens in Ebola affected regions. It built a mobile information notification system where WHO approved Ebola information could be viewed through feature phone channels like SMS and interactive voice response (IVR). Ericsson concentrated its efforts on providing mobile communication support for healthcare personnel working in the affected countries. It built an emergency communication network for the volunteers in the affected regions, while also distributing smart devices to the 40,000 healthcare personnel for better information sharing.

Recommendations

Regulation for Safe Personal Data Utilization

Currently, many countries around the globe have privacy protection laws in place. However, this should not lead to the loss of opportunities to prevent the spread of epidemics in an early manner. Considering the fact that epidemics can harm not only individuals but also the public health as a whole, we could consider that relevant privacy laws enable the processing of public health data without consent in contexts where the processing is necessary to protect the public interest in the area of public health during epidemiological emergencies. In addition, we need to continue our efforts to create an environment where the use of personal information takes place in a safe and reliable manner.

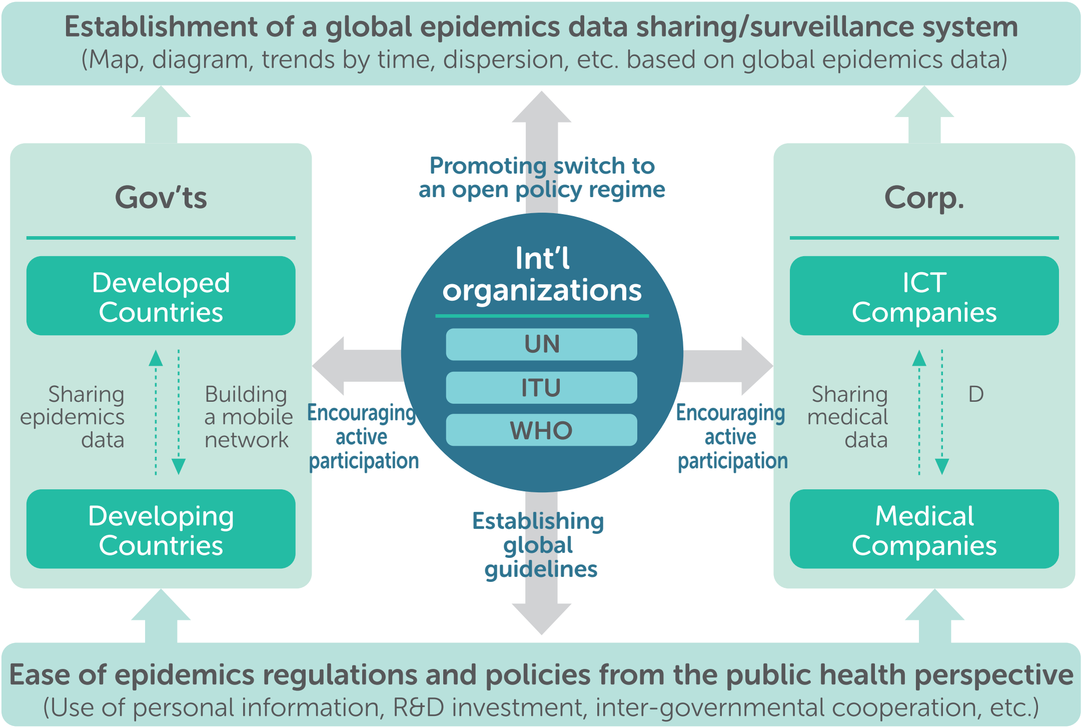
Establishment the of epidemics data sharing/ monitoring system

Data sharing and utilization among nations around the world is essential to more effectively fight epidemics. Under the shared goal of epidemics eradication, governments around the world need to have a renewed perspective toward epidemics data sharing and make more concerted efforts in establishing a common system. In particular, active participation from Asia and Africa, which are often prone to epidemics, is required. However, some of the countries in those regions do not have enough resources and budget and lack technological infrastructures, thereby failing to operate the epidemics response system. Hence, it is the responsibility of the international community to think about how to best provide economic and technical support so that these regions in need can build an epidemics monitoring system.

Expansion of global governance

There is a pressing need for the international community to actively collaborate in fighting epidemics. Private enterprises need to develop epidemics solutions based on their various ICT technologies and data, and nations around the world should pursue more open and integrated approach so that the data and solutions of private companies can be effectively shared on a single global system.

[Epidemics governance structure led by international organizations]



At the same time, there is an increasing need for global governance to be jointly led by international organizations of various fields, such as UN, ITU, and WHO. Remaining tasks for international organizations now include the establishment of epidemics-related regulations and policy guidelines that governments around the world can refer to and the promotion of the private-public-international community participation to build an integrated system.

1

Background

1.1 Infectious Diseases: The Biggest Threat to Humanity

1.1.1 Definition and History

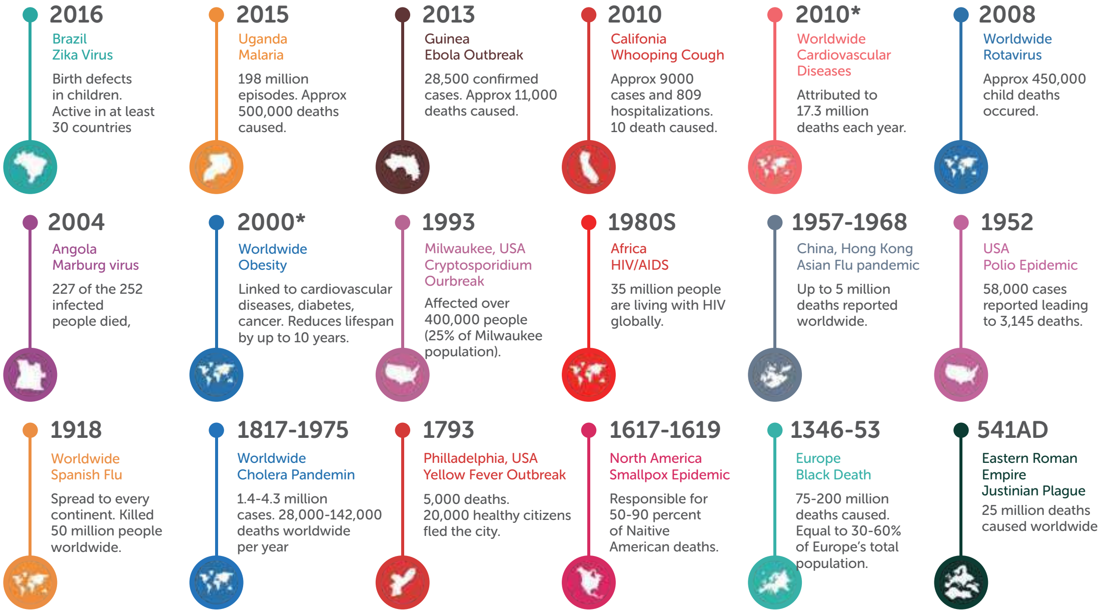
On August 26, 1976, a 44-year-old man by the name of Mabalo Lokela, a teacher in the village of Yambuku in the Bumba region of northern Zaire (now Democratic Republic of the Congo), was hospitalized for severe headache and fever. He had just returned from a 10-day excursion along the Ebola river. Lokela was diagnosed with malaria and given an injection of chloroquine. But his symptoms kept getting worse and the fever was now accompanied by profuse bleeding from all orifices of his body. It was not malaria. Lokela had become the first victim of the disease that would be named after his travel destination, Ebola. Fourteen days later, he passed away from excessive bleeding. Shortly after his funeral, Lokela's mother fell ill and his pregnant wife and sister, who had helped move the body, all showed similar hemorrhagic symptoms around this time. The nuns and nurses who attended to them also suffered. The virus had already spread. Lokela's mother passed away within days, as did most of the infected people. Lokela's wife survived, but his unborn baby succumbed to the illness.

Since then, the Zaire Ebola virus has reemerged time and again to claim the lives of many people. Zaire is considered one of the deadliest types of Ebola with a fatality rate of 83%. A Zaire species of Ebola virus is believed to have been the cause of the 2014 West African Ebola epidemic. The outbreak around Liberia, Guinea, and Sierra Leone infected over 10,000 people.

Infectious diseases are illnesses caused by bacteria, spirochaeta, rickettsia, virus, fungi, parasite, or other pathogens as they enter and spread in the human or animal body. They can be transmitted via food consumption, inhalation of pathogens by breathing, human contact, or dissemination by animal.

Humanity has fought a long battle against infectious diseases since early ancient civilization days of state formation. Epidemics caused by pathogenic microorganisms have changed the course of human history time and time again. Epidemics always break out without a warning and have been inexplicable and uncontrollable with the medicine of the times. Nevertheless, humanity has strived to develop medicine and vaccine for the eradication of infectious diseases and its own survival. History of medicine shares its path with humanity's efforts to find the cause and cure of infectious diseases and ways to prevent them.

FIGURE 1: Global health epidemic timeline[1]



2016
Brazil
Zika Virus
Birth defects in children. Active in at least 30 countries

2015
Uganda
Malaria
198 million episodes. Approx 500,000 deaths caused.

2013
Guinea
Ebola Outbreak
28,500 confirmed cases. Approx 11,000 deaths caused.

2010
Califonia
Whooping Cough
Approx 9000 cases and 809 hospitalizations. 10 death caused.

2010*
Worldwide
Cardiovascular Diseases
Attributed to 17.3 million deaths each year.

2008
Worldwide
Rotavirus
Approx 450,000 child deaths occured.

2004
Angola
Marburg virus
227 of the 252 infected people died,

2000*
Worldwide
Obesity
Linked to cardiovascular diseases, diabetes, cancer. Reduces lifespan by up to 10 years.

1993
Milwaukee, USA
Cryptosporidium Ourbreak
Affected over 400,000 people (25% of Milwaukee population).

1980S
Africa
HIV/AIDS
35 million people are living with HIV globally.

1957-1968
China, Hong Kong
Asian Flu pandemic
Up to 5 million deaths reported worldwide.

1952
USA
Polio Epidemic
58,000 cases reported leading to 3,145 deaths.

1918
Worldwide
Spanish Flu
Spread to every continent. Killed 50 million people worldwide.

1817-1975
Worldwide
Cholera Pandemin
1.4-4.3 million cases. 28,000-142,000 deaths worldwide per year

1793
Philladelphia, USA
Yellow Fever Outbreak
5,000 deaths. 20,000 healthy citizens fled the city.

1617-1619
North America
Smallpox Epidemic
Responsible for 50-90 percent of Naitive American deaths.

1346-53
Europe
Black Death
75-200 million deaths caused. Equal to 30-60% of Europe's total population.

541AD
Eastern Roman Empire
Justinian Plague
25 million deaths caused worldwide

Source: Sound Vascular & Vein

The first record of an infectious disease can be traced back to the Plague of The first record of an infectious disease can be traced back to the Plague of Athens that spread for nearly 3 years from 430 B.C. The disease, unknown at the time, is what we now refer to as the typhoid. Around 75,000 to 100,000 people are estimated to have lost their lives, nearly 25% of the entire population of Athens.

The Black Plague that spread throughout the Eurasia continent in the 14th century is also considered a historical event. An estimated 75 to 200 million people fell victim to the pandemic, with records showing a population decrease of 30~50% in affected regions.

In the 19th century, cholera became a global disease. Epidemic Cholera moved beyond Asia and began spreading to Africa and even Europe and the Americas from 1826. The cholera bacteria were later discovered, resulting in stronger systems of prevention and overall containment of the disease. However, it resurfaced in the 20th in Asia and continued to take many more lives. Caused mostly by poverty and unsanitary environments, cholera has also influenced the shaping of regulations and public facilities of nations.

The Spanish Influenza that was rampant in early 20th century killed between 30 and 50 million people around the world in the relatively short period of 2 years. In the United States alone, nearly 28% are believed to have been infected and up to 675,000 people left dead. The world was stricken with terror once again when the Asian Flu followed in 1957 (2 million deaths estimated) and the Hong Kong Flu in 1968 and 1969 (1 million deaths estimated).

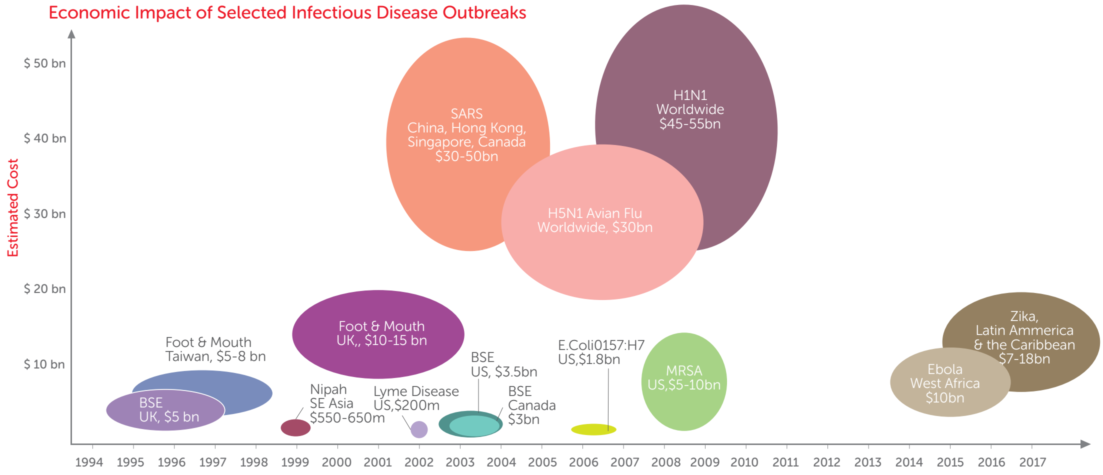
The earliest evidence of the first known infectious disease, smallpox, was found in the mummified remains of the Egyptian Pharaoh Ramses V who died in 1157 B.C. The smallpox killed nearly 400,000 lives annually in Europe until the 18th century. The disease killed 20% to 60% of those infected, or 80% in the case of young children. Smallpox continues to take lives in the 20th century, resulting in 300 to 500 million fatalities. Vaccination in the 19th and 20th century led to a significant reduction in smallpox infections, and the World Health Organization (WHO) certified the disease eradicated in 1979.

The history of Infectious diseases is not expected to come to an end anytime soon. In fact, new types of infectious diseases have emerged almost every year in the past 20 to 30 years. From the appearance of AIDS in early 1980s to SARS in China in 2002 and MERS and Ebola in the 2010s, humanity continues to lose lives to infectious diseases. The increase in human and material exchanges between countries has also caused greater exposure to infectious diseases. There have also been more cases of humans being infected with pathogens that cause diseases in animals due to the lack of a proper system of prevention. Even though 20th century prevention systems and treatments have reduced the number of epidemics and lowered the mortality rates, infectious diseases continue to pose a threat to all of humanity living in this globalized world.

1.1.2 Impact of Infectious Diseases

There have been four epidemics including AIDS, Spanish Flu, Asian flu, and Hong Kong Flu that each resulted in over 1 million fatalities in the past century. This means epidemics have become more frequent in recent days, considering such incidents occurred only five times in all of history before the 20th century. Even with treatments and preventative vaccines, many lives have been lost due to the rapid spread and mutation of diseases. AIDS, cholera, and measles continue to cause great damage to this day, either from their lack of vaccination or the difficulty to control them.

FIGURE 2: Economic impact of selected infectious diseases



Figures are estimates and are ppresented as relative size. Based upon bio-era, Worlad bank, and UNDP data. Chart updated by EcoHealth Alliance.

Source: Bio-era

Infectious diseases can have negative impacts, including economic losses and social chaos. If a disease is running rampant, people are likely to avoid crowded public places. Governments use their resources to curb the spread of the disease, resulting in weakened production and consumption. The economic loss of epidemics since 2003 is estimated to be over 800 billion dollars[2]. According to a study by the U.S. based biotechnology research firm Bio Economic Research Associates, the global economic loss of infectious diseases amounts to 40 to 50 billion dollars for SARS, 25 to 30 billion dollars for Avian Influenza (H5N1).

1 .2 Infectious Diseases Around the World

1.2.1. SARS

Severe Acute Respiratory Syndrome (SARS) is a viral illness caused by the SARS coronavirus (SARS-CoV). The outbreak of SARS in Guangdong Province, China in November 2002 spread quickly to 29 countries in Northern Latin America, Europe, and Asia within just 8 months. According to WHO, the epidemic infected 8,096 worldwide and killed 774.

FIGURE 3: Summary of SARS cases around the world

	No. of Cases	No. of Deaths	Case fatality ratio	No. of HCWs affected
Global	8,096	774	10%	1,706(21%)
China	5,327	349	7%	1,002(19%)
Hong Kong	1,755	299	17%	386(22%)
Taiwan	346	37	11%	68(20%)
Canada	251	43	17%	109(43%)
Singapore	238	33	14%	97(41%)
Vietnam	63	5	8%	36(57%)

Source: CDC

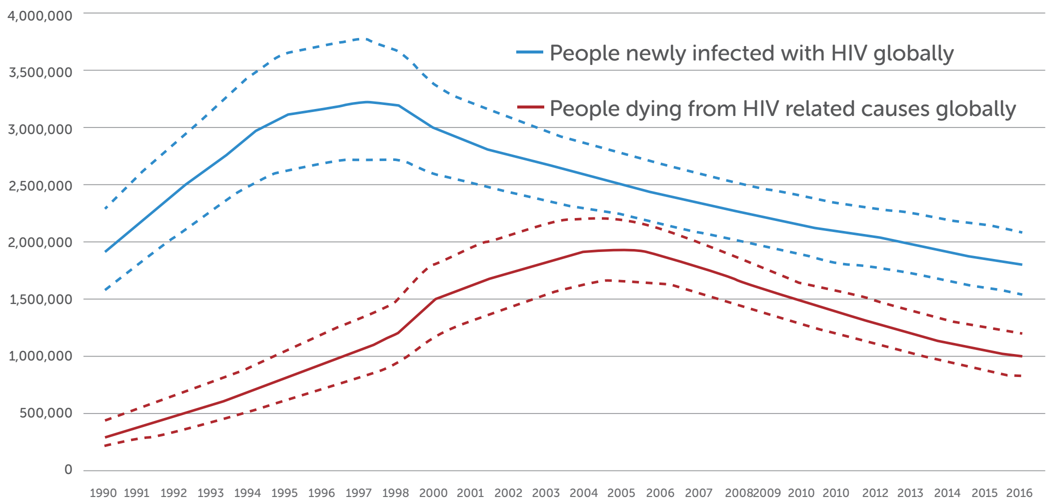
The SARS epidemic was contained through close cooperation between WHO and the affected countries. Although China's reluctance to share information with WHO in the early stage of the outbreak resulted in infections all over the world, Hong Kong and Taiwan cooperated closely with WHO to contain the disease. WHO issued warnings and recommended travel restrictions, sparing no efforts to mitigate the global spread of the disease. In July 2003, WHO removed Taiwan from the list of affected areas and declared the SARS outbreak contained.

1.2.2. HIV/AIDS

Human Immunodeficiency Virus (HIV) is a type of virus that destroys the immune system and makes the body more vulnerable to diseases and cancers. The Acquired Immune Deficiency Syndrome (AIDS) refers to the final stage of HIV infection where the immune system is completely destroyed with occurrences of opportunistic infections and tumors. There are numerous theories on the exact origin of HIV, but the first case of AIDS was identified in the United States in 1981.

About 36.7 million people around the world currently live with HIV. The majority of them live in Africa at 25.6 million, followed by 3.5 million in Southeast Asia, and 3.3 million in the Americas[3]. The number of people newly infected with HIV has decreased since the late 1990s with 1.8 million new cases in 2016, and the number of deaths has also declined steadily since mid-2000s with 1 million deaths in 2016, and a cumulative total of 35 million deaths since 1980 (WHO).[4]

FIGURE 4: Global HIV incidence and mortality over time



Source: UNAIDS

Over the past 30 years, international organizations like UNAIDS and WHO have made great efforts to reduce the spread and impact of HIV/AIDS. Efforts include prevention education to curb the spread of the disease, as well as building infrastructure in low-income countries by calling on the international community for their interest and support to provide medicine and medical facilities.

1.2.3. Ebola

Ebola Virus Disease (EVD), also known as Ebola hemorrhagic fever, shows initial symptoms of fever, muscular pain, and headaches, followed by vomiting, diarrhea, rash, decreased function of the kidney, and bleeding both internally and externally. The disease initially spreads from wild animals to humans, then by human to human contact. Ebola has killed between 25 and 90 percent of those infected, with an average mortality rate of about 50%. The disease first appeared in 1976 in Congo and Sudan in two simultaneous outbreaks, causing 280 and 151 deaths respectively.[5]

The Ebola virus epidemic in Guinea, West Africa is considered the largest outbreak to date. The disease spread from Guinea to neighboring countries like Sierra Leone and Liberia, infecting 28,616 and killing 11.310. Cases of infection and death were also reported in the U.S., Spain, U.K., and Italy[6]. The outbreak was exacerbated by its spread to urban and rural areas, unlike the first case of Ebola that broke out near a tropical forest.

FIGURE 5: 2014 West African outbreak summary

Country	Total Cases	Total Deaths
Sierra Leone	14,124	4,810
Liberia	10,678	3,956
Guinea	3,814	2,544

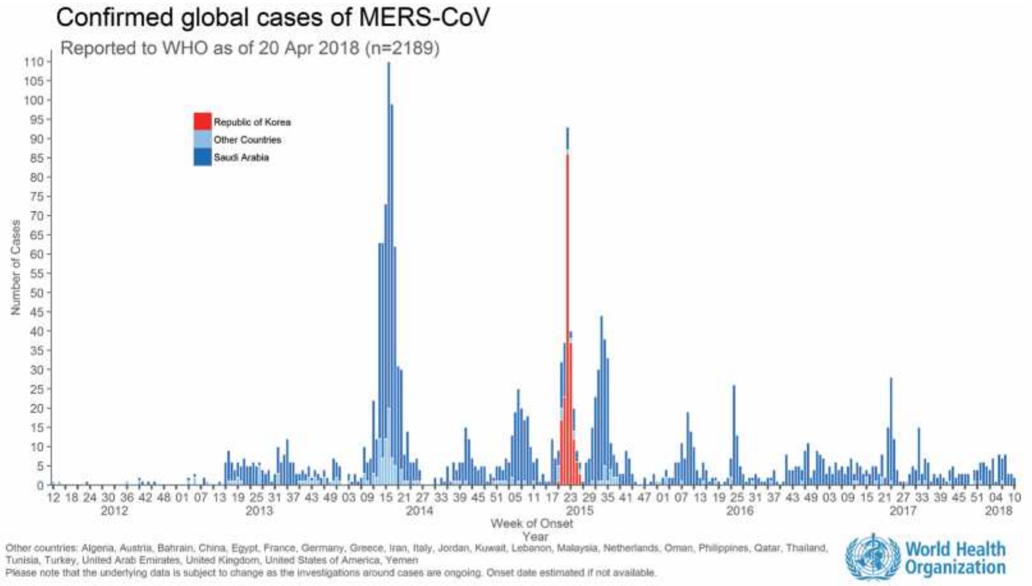
Source: WHO

The spread of the Ebola epidemic began to decline in September 2014. UN Security Council held an emergency session and unanimously adopted a resolution urging member states to provide more support, which led to over 30 countries and the African Union deploying medical experts to affected regions. As a result, WHO declared the end of the Ebola outbreak in West Africa in March 2016.

1.2.4 MERS

Middle East Respiratory Syndrome is a severe acute respiratory infection caused by the MERS-coronavirus. Initial symptoms are similar to the common cold - fever, cough, chills – with an incubation period of 2 to 14 days possibly leading to pneumonia or respiratory distress syndrome. Although its route of transmission is currently unknown, all patients infected with MERS were linked either directly or indirectly to the Middle Eastern region (in particular, coming in contact with Arabian camels). Close contact is the biggest cause of person to person transmission, with infections occurring mostly in hospitals or among family. The mortality rate of MERS is around 40%, but its many variants have made it difficult to develop vaccines and preventative medicine for the disease6.[7]

FIGURE 6: Confirmed global cases of MERS-CoV (As of November 2017)



Other countries: Algeria, Austria, Bahrain, China, Egypt, France, Germany, Greece, Iran, Italy, Jordan, Kuwait, Lebanon, Malaysia, Netherlands, Oman, Philippines, Qatar, Thailand, Tunisia, Turkey, United Arab Emirates, United Kingdom, United States of America, Yemen
Please note that the underlying data is subject to change as the investigations around cases are ongoing. Onset date estimated if not available.

Source: WHO

The outbreak of MERS in Saudi Arabia in 2012 spread throughout the region to countries such as the United Arab Emirates, Jordan, and Qatar and caused a severe damage. According to WHO, the disease infected a total of 2,121 people in 27 countries around the world as of end of 2017, leaving 740 of them dead. The first case of MERS in South Korea was confirmed in 2015 and resulted in the infection of 186 people (9% of all infections). This was the second largest outbreak of MERS in the world, following Saudi Arabia's case of 1,600 people (80% of all infections).

1.3 Leading Causes of Epidemics

Vaccines for new types of infectious diseases usually take years to develop, and a vaccine for just one pathogen could require as much as 1 billion dollars to make. If a flu vaccine developed in 2009 had existed during the 1918 flu pandemic, it could have saved the lives of 200,000 people around the world. Until recently, there has been no fully-approved vaccine or cure for the Ebola virus, despite all the damage it has caused for decades since its first discovery in 1976 — there is a vaccine that has been licensed and used in the DRC Ebola outbreak, 100% effectiveness but it is not commercialized yet.

What is more concerning is the fact that changes in the global landscape have made it even more difficult to fight against new diseases. Growing exchanges between countries, increasing population and urbanization, changes in the environment and ecosystem, and inadequate national systems to prevent infectious diseases have given way to new challenges to be addressed.

1.3.1.Growing International Exchanges

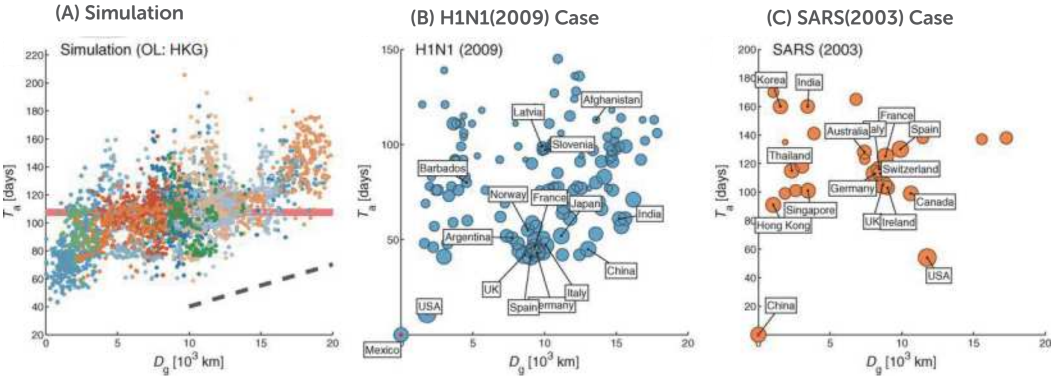
Globalization has progressed rapidly with the increase in international exchanges and migrations that began in the 1970s. It has brought forth many benefits for humanity, such as facilitated understanding of cultural differences and enriched economies through trade, and countries have become more secure and peaceful through political exchanges.

However, globalization has also become an obstacle to efforts to mitigate the spread of infectious diseases in modern society, resulting in a globalization of infectious diseases. Active exchanges with countries, especially in Africa, that used to lack international exchanges have increased the risk of epidemics. Diseases and pathogens can now move more quickly to other parts of the world through ships and airplanes.

Globalization has also reduced the differences in the human, economic, political impacts of infectious diseases between regions of the world. Recent global epidemics demonstrate the impact of population mobility on the spread of diseases.

When a disease breaks out, the next area to be affected can be calculated on the assumption that the disease spreads like a wave at a constant speed. This assumption was validated during the bubonic plague of the 14th century because people did not travel very far back then. However, long distance travels have made it possible for new outbreaks to reach greater distances in short periods of time (refer to graph A in the figure below). Geographic distance no longer correlates with arrival time. As illustrated by the data from the 2009 H1N1 outbreak (graph B in the figure below) and the 2003 SARS outbreak (graph C in the figure below), it has become almost impossible to predict when the disease is going to hit a particular location after the original outbreak.

FIGURE 7: A simulation of outbreaks and actual data from the real events


(A) Simulation (B) H1N1(2009) Case (C) SARS(2003) Case

Dg: distance of a particular location to the origin of the outbreak, Ta: time of arrival at that particular location.

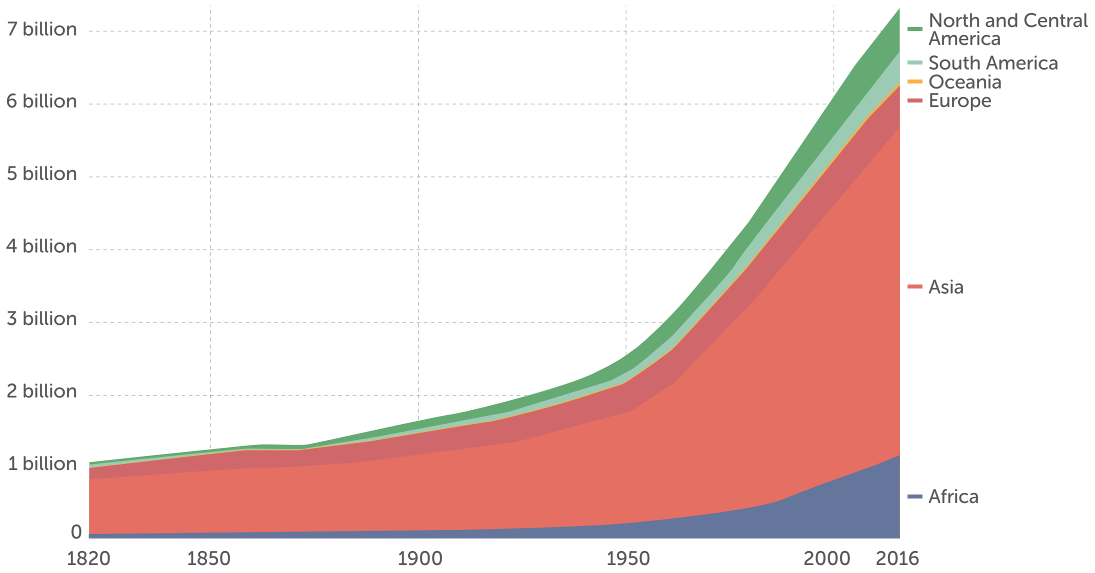
Source: Dirk Brockmann (2017)

Today, approximately 4 billion flights travel through 25,000 routes on 4,000 aircrafts. The annual trade volume of major product groups has surpassed 15 trillion dollars and is expected to grow further in the future. This means that epidemics and pandemics will spread further and in more complicated ways in the future. It is time for countries around the world to come up with national measures and to work together to prepare for such a future.

1.3.2 Increasing Population and Urbanization

The growing population is another main cause of epidemics. According to the UN, the current total world population of 7.6 billion is expected to reach 8.6 billion in 2030, 9.8 billion in 2050 and 11.2 billion in 2100. The number has more than doubled since 1960 when the population was 3 billion. Global population has grown nearly sevenfold in the past 200 years, with a 5 to 50 percent increase in major cities. Experts forecast that about two-thirds of the world's population will be living in urban areas by 2030 at the current rate.

FIGURE 8: World population by region



Source: Max Roser and Esteban Ortiz-Ospina (2017)

A higher population density also means a higher chance of catching an infectious disease or transmitting them to others. In particular, the unsanitary, deteriorated conditions of densely populated areas in developing countries could result in faster transmission of diseases through air, waste, insects, animals, or humans. This is because the bacteria or viruses that cause crowd infections require a large population with no immunity in order to survive.

Coupled with increasing population, urbanization is another factor that has had a tremendous impact on epidemics. Urbanization began in 1945 with the development of megacities (cities where the population exceeds 10 million people). It has since enhanced variability of the causes of infectious diseases and has had a negative impact on efforts to mitigate the spread of diseases. Urban areas have greater population mobility and exchanges compared to rural areas, thus having a higher chance to be affected by infectious diseases.

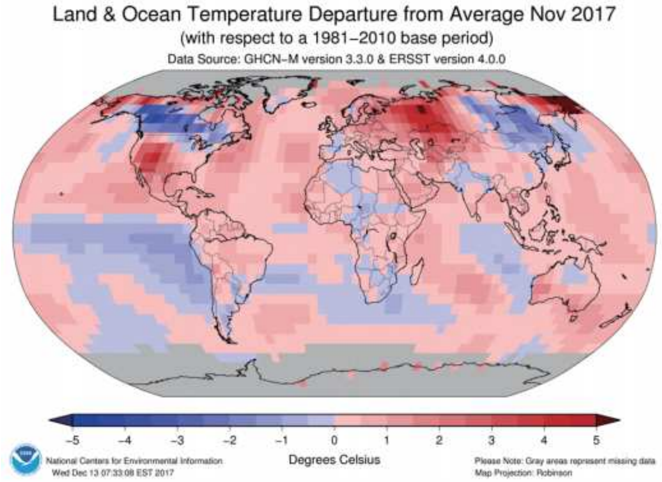
All of these are critical factors that enhance the likelihood of transmitting diseases. If a city, especially with a high population density, does not have the proper infrastructure in place due to rapid and indiscriminate urbanization, variability of the cause of the disease and chances of an epidemic can grow exponentially.

1.3.3 Intensified Changes in Climate and Environment

Climate change can be either man-made or natural. Changes in the global environment due to urbanization are man-made phenomena resulting from human activity, and are destroying nature and contaminating the environment with each day. Factors that impact climate change and changes in the ecosystem can be largely grouped into global warning, meteorological changes, deforestation, and reclamation, all of which are critical factors that increase the likely occurrence and spread of infectious diseases.

A key example of climate change is global warming. According to analysis by the National Oceanic and Atmospheric Administration (NOAA), the most notable temperature departures from average were observed across the Northern Hemisphere during November 2017. The figure below shows the average temperature departures of the world's land and ocean surfaces, and it illustrates that warmer-than-average temperatures dominated across much of the world's land and ocean surfaces during this period.

FIGURE 9: Land & ocean temperature departure from average Nov. 2017 (with respect to a 1981-2010 base period)



Source: NOAA

A temperature increase also enhances the likelihood of being exposed to infectious diseases carried by insects and livestock. This is best illustrated by the increase in arthropod-borne diseases such as dengue fever, and yellow fever, which used to occur only in Africa and Southeast Asia but are now gradually spreading to other parts of the world. The number of people infected with malaria in the northeastern border region of Pakistan was less than 100 in 1983, but rose 250-fold in the 1990s and grew to over 25,000. This is because abnormally high temperatures have enabled malaria to stay active for longer periods of time.

Natural disasters have also given rise to the occurrence and spread of infectious diseases. Residents of a disaster-struck area can become exposed to unsanitary environments if the disaster destroys the basic public health system in the region. Examples include the floods in Mozambique that led to an increase in exposure to typhoid and cholera, and storms and floods in the United States that paralyzed the sanitation system and resulted in the spread of waterborne diseases.

Another leading cause of epidemics is deforestation. Viruses that cause new infectious diseases are harbored by animals like monkeys, rats, and bats in the tropical forest. The risk of humans infecting such diseases was very low when these animals lived deep in the forest. However, the contact between human and forest animals has been expedited with deforestation driving animals closer to humans and indigenous people going deeper into forests to hunt wild animals, which has resulted in a spillover effect where humans are being exposed to pathogens of animal to animal infections.

Examples include the HIV that originated from wild chimpanzees, Ebola from bats, and SARS from Chinese horseshoe bats.

1.3.4 Imperfect Prevention and Control System

Inadequate system of prevention and control is also another leading cause of infectious diseases. Unlike natural disasters that occur in specific regions, epidemics can take place around the world simultaneously. A pandemic like the one that took place in 1918 could lead to a shortage of hospital rooms and medical supplies such as respirators. Examples of inadequate disease control systems causing epidemics can be found even in advance countries.

In the United States, funding is provided on a disease-by-disease basis after the outbreak of the epidemic. During the Ebola outbreak, a budget of 5 billion dollars was provided 5 months after international health groups had declared a crisis. It also took 9 months to approve the funding of 1.1 billion dollars during the Zika virus epidemic. It was clear that the lack of systematic preparation in the earlier stage led to a delay in response.

The MERS outbreak in Korea is another noteworthy example. When the first MERS patient was identified in Korea in May 2015, the Ministry of Health and Welfare led efforts to control the disease. However, the country lacked a systematic response because such an epidemic was unprecedented in Korea and it lacked the infrastructure to mitigate the spread. Consequently, Korea suffered a huge damage resulting in a total of 186 people infected, 38 people killed, and 16,752 people quarantined. Health authorities led the epidemiological investigation and quarantine of those infected, and the outbreak was finally declared contained in December 2015.

As evidenced above, many nations still lack a proper system of prevention and control for infectious diseases, regardless of whether they are developed or developing. It is important for countries to remember the lessons learned not only from the recent MERS and Zika outbreaks but also epidemics of the past. Efforts must be made to reform the national preventive systems to prepare for new epidemics.

Endnotes

[1] Sound Vascular & Vein, "Is the Increasing Problem of Worldwide Obesity and Cardiovascular Disease Worthy of the Term "Epidemic?", 2016. (http://soundvascular.com/blog/cardiovascular-disease-epidemic)

[2] The socioeconomic cost of 2003 SARS and avian influenza (H5N1) outbreaks, 2009 flu pandemic, 2015 MERS outbreak, and 2015 Zika virus and avian influenza (HPAI H5N6) outbreaks (World Bank estimates)

[3] WHO, "HIV estimates and WHO HIV policy uptake," 2017.

[4] UNAIDS, "Fact sheet – Latest statistics on the status of the AIDS epidemic," 2017.

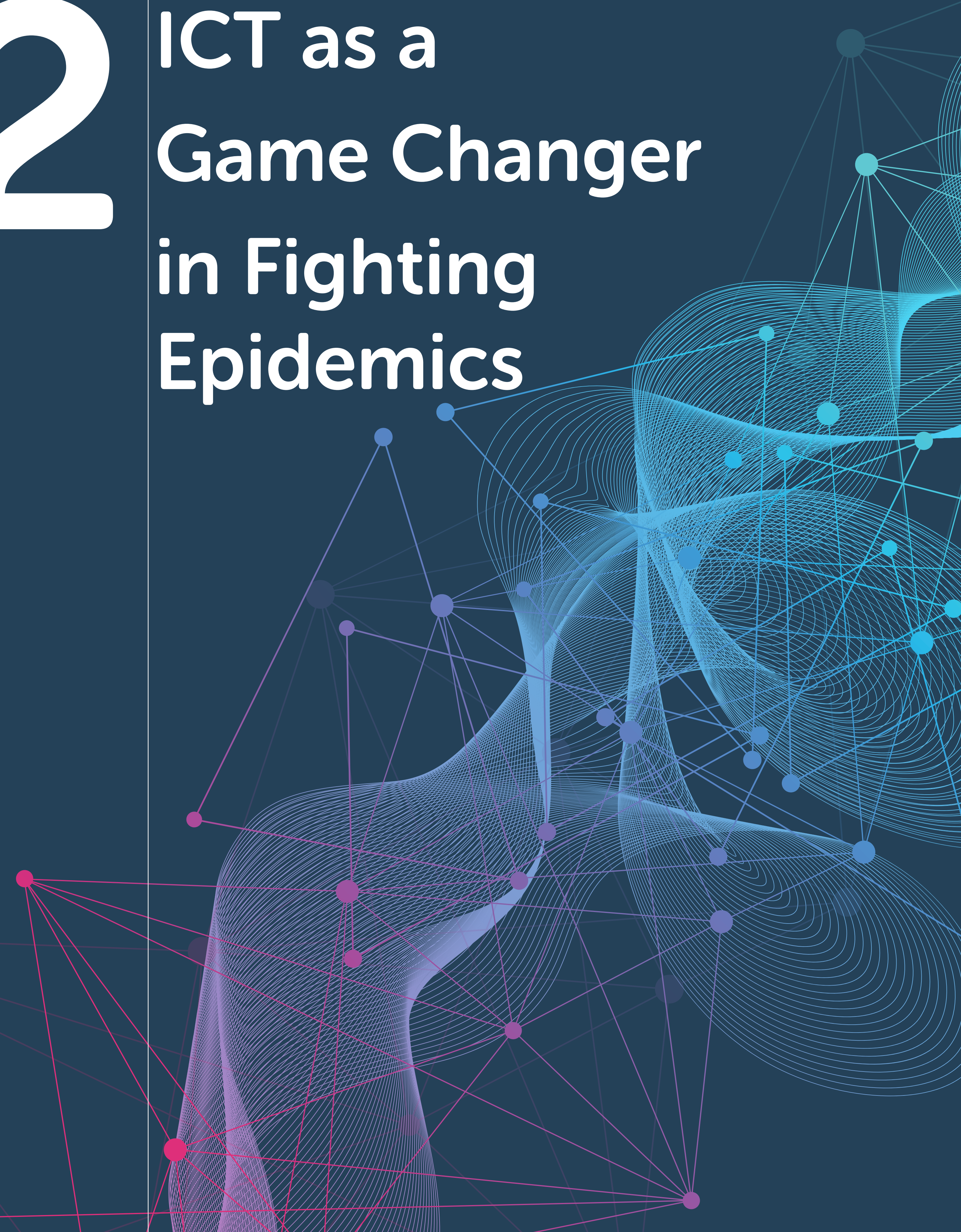
[5] WHO, "Fact sheets, Ebola Virus Disease," 2017.

[6] WHO, "Ebola Situation Report," 2016.

[7] WHO, "Fact sheet on MERS-CoV," 2017.

2

ICT as a Game Changer in Fighting Epidemics



2.1 Mobile Broadband and New Opportunities

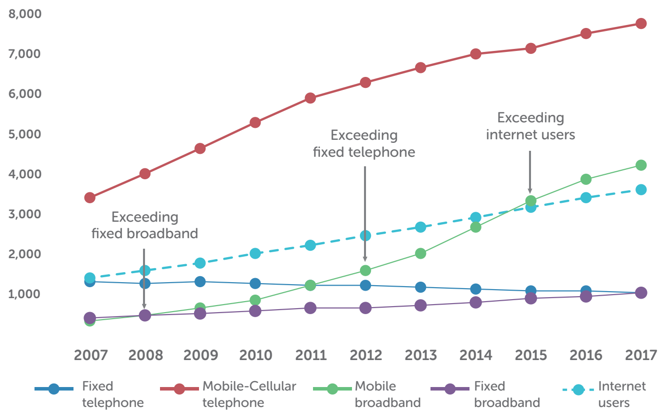
Explosive growth in the penetration of smart devices in the past 10 years has greatly enhanced people's access to various mobile services. Mobile services are not only making contributions to improving the quality of lives by helping us overcome time/space limitations and providing seamless services through their highly instant nature, but are also being utilized in solving universal problems (poverty, famine, diseases, etc.) of mankind. Mobile broadband is what is behind all of these positive changes. Global expansion of mobile broadband made it possible to establish the world's first 'Global Mobile Network' and it is being applauded as an essential tool for achieving sustainable development.

Every year, the International Telecommunication Union (ITU) of the United Nations issues a report titled "Measuring the Information Society", which is on the progress of global ICT development and relevant statistics. This report provides quantitative data on fixed and mobile networks, overall ICT infrastructures, ICT users, etc. According to the report, the number of mobile broadband subscribers has been consistently increasing by more than 5% since 2011, thus spreading fast. This rate of growth exceeds those of fixed telephone, mobile-cellular telephone, and fixed broadband[8], and the figure is bigger than the number of global internet users. This also means that the use of mobile broadband-based mobile services is rapidly expanding.

The number of mobile-cellular subscriptions, which is the highest among all services, increased by more than 2.2 times from roughly 3.4 billion in 2007 to 7.7 billion in 2017, while that of mobile-broadband subscriptions, which once remained at a low of 260 million until 2007, rapidly increased by more than 16.1 times to 4.2 billion in 2017. Such a rate of growth is as much as 8 times higher than that of mobile-cellular telephone, which has approached market saturation, and mobile broadband now has the second highest number of subscription after mobile-cellular telephone. Mobile broadband became one of the universal networks in 2008 when its subscription exceeded fixed broadband. Its penetration rate began to expand rapidly in 2011 and exceeded that of fixed telephone in just a year in 2012.

When converted to a share per 100 inhabitants, the figure translates to mobile broadband subscription of 56.4% in 2017, which is over half the global population. Meanwhile, the penetration rates of mobile-cellular telephone already exceeded 100% in 2016, entering the era of '1 mobile phone per 1 person'. In other words, mobile broadband and mobile-cellular telephone virtually opened up the era of mobile networks.

FIGURE 10: Subscriptions of key ICT network infrastructures (Unit: Million)



Source: ITU

What is notable is that developing countries[9] have been leading the rapid growth of mobile broadband. The number of mobile broadband subscriptions in developing countries was 40 million in 2007 but had risen to about 1 billion by 2013, exceeding those of developed countries in that year, and is now estimated at 3 billion. In terms of the compound annual growth rate (CAGR) for the period of 2007-2017, it was 52.9% for developing countries and 18.5% for developed countries, which means mobile broadband subscriptions in developing countries grew explosively by 3-fold compared to developed countries.

In 2017, mobile broadband penetration in developed countries has approached market saturation with the rate being 97.1%, but in developing countries is still 48.2%, less than half of the market, thus having more room for expansion. In addition, considering the pace of mobile broadband penetration in developing countries, which has been accelerating since 2013, it is estimated that the gap between developed and developing countries will disappear in the next 10 years.

FIGURE 11: Mobile broadband subscriptions (Unit: Million)

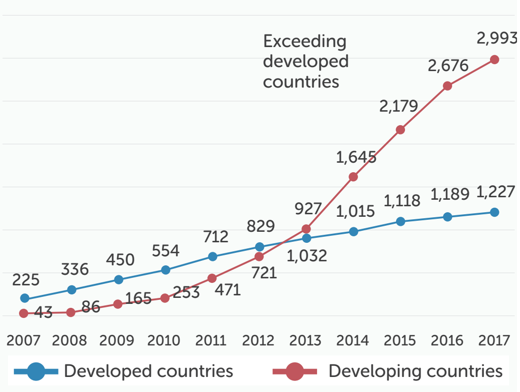
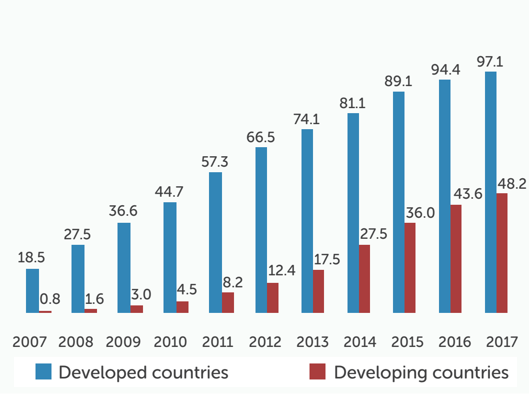


FIGURE 12: Mobile broadband penetrations (Unit: %)



Source: ITU

As mentioned above, mobile broadband expansion will lead to the increased use of mobile services, and this will particularly be manifested in developing countries. As for developing countries which are faced with various challenges such as poverty, famine and diseases, improvements in infrastructures based on mobile services are expected to enhance overall quality of lives.

2.2 Big Data Based ICTs for Fighting Epidemics

As seen in previous chapters, the world is getting connected faster and becoming closer through mobile broadband networks. In this global mobile network era, it is estimated that mobile broadband-based ICT solutions will be more widely adopted in the areas of life including fighting epidemics. The biggest challenge of recent outbreaks of new epidemics is that the pace of spread is getting faster and the range of spread is much bigger compared with the past. In the fight against such epidemics, 'big data' is representative technology that is drawing the biggest attention as a mobile broadband-based ICT solution.

Nowadays, the global strategy for fighting epidemics is going beyond just the prevention or eradication of the outbreaks and is fast advancing toward big data analytics based on 'data science', which will allow outbreaks to be identified earlier and more effectively. Big data analytics includes a set of processes including the collection of a large volume of structured/unstructured data, extraction of values from the data, analysis of the results and reflection of the analysis in key decision making in the future. Regarding the spread of epidemics, the use of big data analytics will allow us to approach and respond to the issue in a more macroscopic and scientific manner.

2.2.1 Data Science for Epidemics Response

Big data enabled by strengthened connectivity among devices is expected to serve as a key asset in addressing the challenges of epidemics. The specific fields of big data analytics that allow epidemics prevention and preparedness based on data science include genetic data analysis, cell phone mobility data analysis, social media data analysis, Location-based information mash up, large-scale simulations.[10]

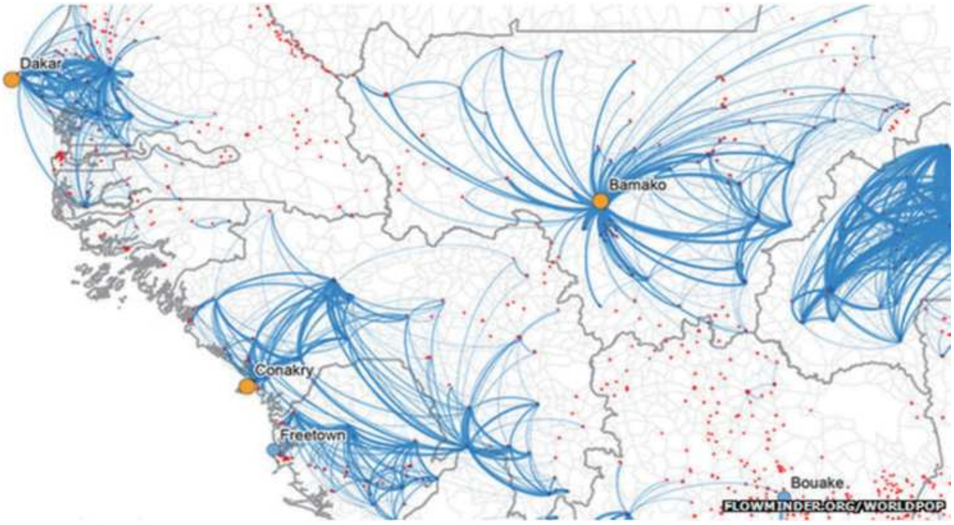
① Genetic data analysis

The genetic mutation of pathogens has a significant impact on the emergence of new and mutant varieties of epidemics. Surveillance of genetic variations that affect pathogenicity is an important method of epidemics control. Evolving analytics technology of genetic information thanks to the advancement of biology and data analytics is creating a vast amount of data, thus allowing biological analysis of viruses as to how micro-organisms are transformed and infiltrate into a human body even at the time of a fast spread of an epidemic. At the stage of initial epidemics spreading, it will enable the investigation of the creation and dissemination of viruses as well as the cause of infection, thereby providing a means to block the potential of the evolution of epidemics. In addition, the analysis will allow systematic organization of data, such as DNA sequencing of pathogens and epidemiologic information, and the establishment of a database, which can be used as key sources of future research.

② Cell phone mobility data analysis

As of 2016, 65% of the global population, or roughly 4.8 billion people, were using mobile devices. In addition, end-2016, global mobile data traffic reached a volume of 7.2 exabytes (1 exabyte = 1 billion gigabytes), which is a whopping increase of 18 times in the last 5 years. According to research by CISCO, the total mobile data traffic worldwide is estimated to increase to 49 exabytes by 2021. Therefore, if we can make full use of such a vast amount of cell phone mobility data which is being rapidly accumulated, it will allow us to better track the pathways of people and epidemics.

FIGURE 13: West Africa mobility mapping[11] based on the data collected from cell phones



Source: Flowminder

For example, at the time of the Ebola outbreak in West Africa, there was a case where cell phone mobility data collected from cell phones was used effectively. This cell phone data provided information on how people in the West African region moved and traveled and thus helped researchers predict the transmission pathways of the Ebola virus. And the prediction was greatly helpful in assessing the risks of virus infection by region and forecasting socio-economic impact of the outbreak. In addition, the data allowed the researchers to predict the future spread scenarios and provided support to make the most effective decisions in terms of preventive measures and public health management.[12 13]

③ Social media data analysis

The number of users of social media services such as Facebook, Instagram, Pinterest, and Twitter is a whopping 2.8 billion, or 37% of the global population. And the number of users of mobile social media services is also as high as 2.56 billion. Therefore, we could consider utilizing this huge amount of data from social media with an aim to gain insight regarding the timing of an epidemic outbreak and its transmission pathways. As discussed earlier, the algorithm of natural language processing can be applied to social media data so as to analyze public sentiment in the event of an outbreak. This will allow the healthcare authorities to predict how epidemics would spread in relation to the behavioral changes of the public due to the outbreak and the data can also be used as reference materials when establishing policies aimed to control the epidemics. For instance, we could use data from Twitter to better predict the peak of loss of human lives or damages. Furthermore, the analysis of social media data can also be helpful in predicting social phenomena resulting from collective public fear manifested by the avoidance of gathering in public places at the time of disease spreading as well as in forecasting the resulting economic impact.

④ Location-based information mash-up

Based on machine learning technology, it is possible to create a high-resolution map platform which provides visualized information about the locations of epidemic outbreaks or the locations with a high possibility of eradication. Machine learning is one field of artificial intelligence which develops an algorithm that, without humans having to manually enter a command, enables a computer to learn from data and to carry out specific analysis tasks. Machine learning allows us to analyze environmental, social, and biological factors of epidemics and to estimate the level of risks people are exposed to by using geological data. With ever-advancing computing capabilities and increasing availability of high-resolution data sets of location-based information, it is expected that this type of forecast modelling will prove to be more effective.

⑤ Large-scale simulation

Big data will enable simulations of the potential spread of epidemics. Data analysis experts could put a vast amount of epidemics-related data sets into a disease spread analysis model, carrying out epidemic simulations consisting of hundreds of Terabytes. In addition, it is also possible to combine various kinds of data to carry out analysis of how to complement vulnerabilities of each data set. These tasks will provide new insights into how to deal with epidemic issues by forecasting the nature of the epidemic spread, the scale of damage to human lives, and economic loss. Ultimately, this method will lead to the best measures that can significantly lower the risks of epidemics.

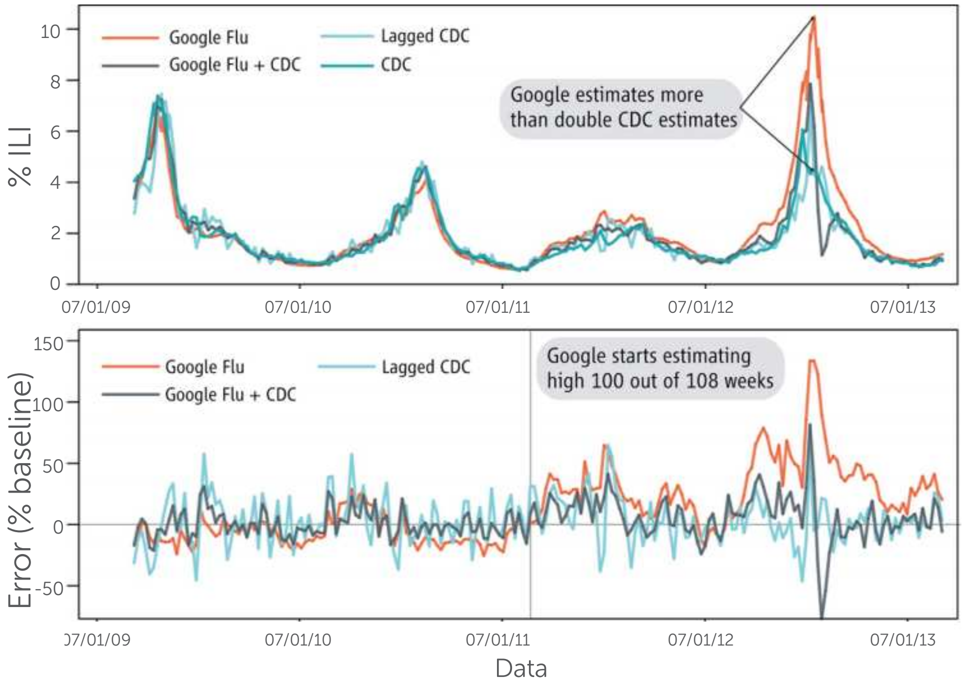
2.2.2. Enhancing Big Data Analytics

The most frequently used technology in epidemics solutions at the moment is big data analysis. However, considering the increasing complexity of epidemics and the resulting need for comprehensive approaches, it could be difficult to deliver meaningful outcomes from the development of epidemics solutions based on single data, and if this situation continues, even the effectiveness of those solutions could be in doubt. A case in point is 'Google Flu Trends', Google's big data-based epidemic forecast service that was launched in 2008, and provided in real-time the estimates of influenza activity for 25 countries based on Google Search queries. Based on about 40 keywords people used to search when infected with flu, the service attempted to map the outbreak and the spread of influenza. Google Flu Trends compared these findings to a historic baseline level of influenza activity for its corresponding region or country and then reported the activity level as minimal, low, moderate, high, or intense.

Soon after launching, Google Flu Trends received much attention due to its outstanding performance compared with the existing forecast system of the U.S. CDC. In 2009, Google announced through 'Nature', a renowned scientific journal, that if the data is synced to the flu tracking data of the CDC, Google Flu Trends can precisely predict the influenza activity 2 weeks faster than the CDC's system. In fact, in early February 2010, it came up with the prediction of an influenza outbreak that hit the central region along the Atlantic in the U.S, which was 2 weeks faster than the CDC.

However, in 2-3 years after the initial period, the accuracy of predictions by Google Flu Trends has sharply declined and ultimately recorded a lower accuracy level than the CDC. Eventually, Google Flu Trends stopped publishing estimates in 2015, and Google.org is only providing historical data.

FIGURE 14: Comparison of accuracy between Google Flu Trends and the U.S. CDC



Google estimates more than double CDC estimates

Google starts estimating high 100 out of 108 weeks

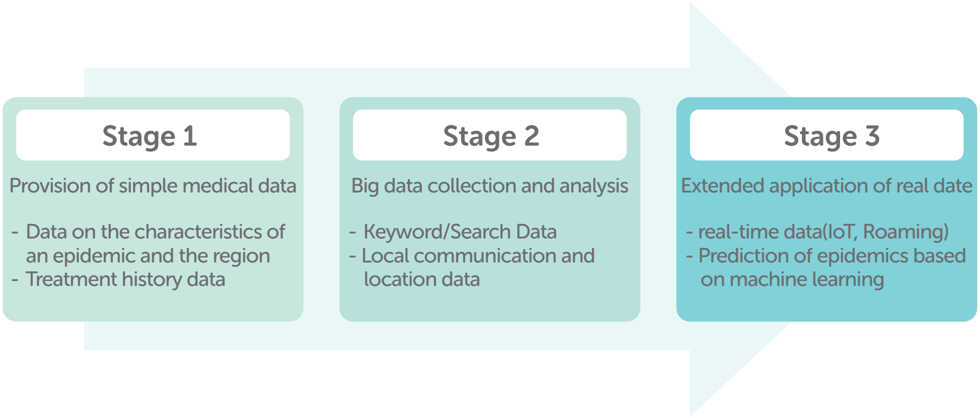
Source: Science

Of 108 weeks of influenza estimates from August 2011 to September 2013, Google Flu Trends recorded a high error rate[13] for 100 weeks by overestimating flu. In particular, over one interval in the 2012-2013 flu season, which hit the whole U.S., Google's estimates were more than double the estimates of the CDC, and its error rate was as high as 140%.

Experts pointed out that the principle behind the big data analysis of Google Flu Trends, which was highly dependent on search queries, was what created limitations of the service, and the 2012-2013 flu season in the United States was a decisive factor that led to the peak of the error rate. As the level of influenza outbreak was elevated to an emergency status, non-infectees made flu-related Google searches a lot, and Google Flu Trends was unable to differentiate Google search queries submitted by flu infectees from those submitted by non-infectees, thus overestimating flu prevalence. The case of Google Flu Trends demonstrates that dependency on a single source of data that has low credibility can increase the uncertainty of any analysis results and ultimately produce a far less accurate estimate than the actual prevalence and spread of an epidemic.

The problem exhibited by Google Flu Trends can be addressed by comprehensively applying various ICTs to the data gathering and analysis process and by lowering dependency on a single source of data. In particular, the convergence of roaming data, IoT, and AI technologies that are recently drawing much attention with big data is expected to rationalize the sources of data collection and significantly improve the effectiveness of data analysis.

FIGURE 15: Data Expansion for Effective Epidemic Response



Roaming data and IoT will contribute to sourcing data in real-time. While previous big data technology only focused on reconfiguring the courses and routes of potential infectees based on their historical data, the application of big data to roaming data and IoT will allow us to identify the outbreaks of an epidemic and its spread in real-time. AI will contribute to enhancing the accuracy and the prediction rate of big data analysis of epidemics. By making a step forward from the existing system which only identified the cause and effect relationship based on data, AI will enable us to consider a great number of variables that could cause the outbreaks of epidemics, thereby enabling more precise predictions of the outbreaks of epidemics and their spread in the future.

ICT's impact on the forecast, monitoring and management of infectious disease will only continue to grow

"ICT has been playing an essential role in preventing the spread of infectious diseases, and there are various examples that can prove this. Cases in point include the establishment of the Internet- based report network in the late 1990s and the identification of the course of epidemics spread by using big data and mobile devices during the SARS and the MERS outbreaks. In addition, while going through the era of the 4th industrial revolution, disease prediction using AI and algorithm, advancement of precision medicine, and epidemics forecast and management through genetic analysis will play bigger roles in the fight against epidemics."

Jong-Koo Lee (MD, MPH, PhD)
- Ex-Director of JW LEE Center for Global Medicine

2.3 Diversification of Big Data Based Epidemic Solutions

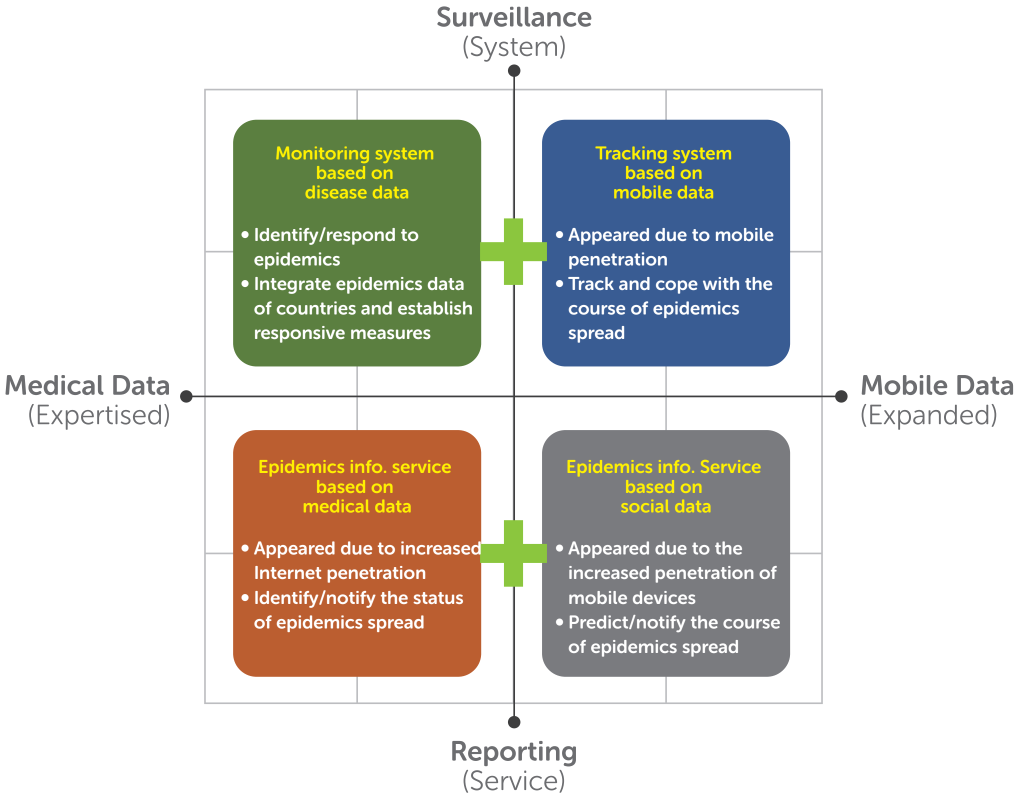
With the expansion of data usage in effectively responding to epidemics, various forms of big data based epidemics solutions have emerged. Currently, there are 4 main areas of big data based epidemics solutions depending on the 'source of data' and the 'provided functionalities'. Depending on the source of data, there are medical data and mobile data, and depending on the provided functionalities, the solutions can be divided into reporting or surveillance purposes. To sum up, ICT has greatly contributed to expanding the source of data to be used from medical to mobile, and to helping citizens not only enhance their awareness toward epidemics but also more proactively fight against the spread of epidemics.

Among the 5 data science technologies mentioned earlier, genetic data analysis, cell phone mobility data analysis and social media data analysis are the categorizes derived based on the source of data.[15] With explosive growth of mobile data usage resulting from the ever increasing diffusion of smart devices, there is an increasing effort to use not only medical data (epidemic data, genetic data) but also mobile data (cell phone mobility data, social media data) in the fight against epidemics. Medical data, which we can call small data rather than big data, is creating a synergistic effect by being combined with mobile data, thereby enabling us to take a full-fledged approach to fighting epidemics based on big data. Mobile data including call data and roaming data is currently being used in the areas that require a high level of instantaneity such as tracking of spread routes of epidemics and identifying potential regions of epidemics spread.

Categorization by the provided functionalities impacts the purpose of using epidemics solutions. Epidemics solutions that aim to provide information began to appear as various global private companies and research institutes started to offer 'open source epidemics information services' that individuals can easily use. Individual users access the service using their own computer (Web) or smartphone (App) and receive 'epidemics information' from the service. More recently, ICT is more actively utilized not only in providing epidemics information but also in directly responding to them. In other words, ICT is more than just a pipeline through which epidemics data is provided. It is playing a central role in monitoring and tracking global epidemics with an aim to 'identify current status of epidemics and establish ex post control measures'.

The categorization of big data based epidemics solutions based on the standards mentioned above looks as follows. The horizontal axis signifies the source of data, and data field tends to expand when moving from left (medical) to right (mobile). The vertical axis signifies the provided functionalities, and the functionalities that epidemics solutions provide tend to become more enhanced when moving from the bottom (reporting) to the top (surveillance).

FIGURE 16: Diversification of big data based epidemics solutions framework



① Monitoring system based on disease data

This system is to identify and respond to the trend of epidemics proliferation based on each country's national disease data. The main objective of this system is to establish a hotline among each nation's government ministry in charge of managing epidemics and international health authorities (or regional associations) through which epidemics data will be shared and coping methods will be established. Even though this is the most initial type of solution, this is still an important system considering that the very basic step of establishing an epidemics measure is to collect index-based data and to analyze the data in a comprehensive manner. For example, Southeast Asian countries near the Mekong River (Cambodia, Laos, China, etc.), have been continuously sharing epidemics data through the MBDS (Mekong B Disease System) which was established in 2001.

② Epidemics information service based on medical data

The high penetration of the Internet among households has given epidemics solutions new functions and helped expand the scope of data to be used. While the existing solutions focused on supporting the efforts to respond to epidemics at the national level, new epidemics solutions have added a new objective of directly notifying citizens of the status of epidemics spread. As for the data to be used, previous epidemics data were combined with medical data provided by various institutions, thereby evolving in a direction that has significantly enhanced the accuracy of epidemics spread trends. A case in point is 'ProMED'. In the initial stage, ProMED consolidated data from various research institutes and started an emailing service that provided basic epidemics information and the current status of epidemics spread to individual users. ProMED drew attention throughout the world during the outbreak of the SARS in 2003 as it notified the spread of the SARS faster than the WHO.

③ Tracking system based on mobile data

The penetration of mobile devices has contributed to enhancing instantaneity of epidemics solutions that are based on epidemics and medical data. For epidemics solutions based on medical data, which aim to establish ex post coping methods through identifying the spread of epidemics outbreaks, new solutions based on mobile data have been utilized in minimizing the gap between the outbreaks and the response by tracking the course of epidemics outbreaks. Huge volumes of data traffic such as call data and roaming data that are transmitted by based stations have been analyzed (large-scale simulation), and location-based information and the mashup of map platforms (location-based information mashup) have been used to track the course of epidemics outbreaks. So, this solution was first of its kind in terms of big data based epidemics solutions. The most representative solution is CDR (Call Detail Records), data platform established by the ITU in response to the 2014-2015 Ebola outbreak in West Africa. The solution established an integrated platform based on the CDR data provided by the telecom service providers in three West African countries (Guinea, Liberia, and Sierra Leone) and it can be used to track the course of an Ebola outbreak or other disease outbreaks.

④ Epidemics information service based on social data

The rapid distribution of smartphones has further enhanced the instantaneity of and access to big data based epidemics solutions. Social data has invited smartphone users around the world as the main player of data production, thereby further minimizing the gap between epidemics outbreak and the response. In addition, accumulated information has been provided as a form of mobile application, which enabled access to the latest epidemics information anytime, anywhere. In the meantime, social data has been contributing to improving the accuracy of epidemics spread forecast. The scope of data samples used for predicting the course of epidemics outbreaks has continuously expanded from medical data to communications data. Due to its borderless nature, the use of social data in responding to infectious diseases has made it so much easier to predict the course of modern epidemics, which also know no border. However, there are limitations as the use of social data is still in its infant stage. Social data is the best source among all the existing data in terms of speed; however, it is vulnerable compare to other medical and communications data in terms of credibility. Hence, in order to overcome such vulnerabilities, social data based solutions have been actively considering other methods such as combined applications using medical data. A case in point is the service named 'HealthMap'. HealthMap has contributed to giving various modern epidemics information to civilian users, and in particular in 2009, the service helped prevent the spread of H1N1 by promptly providing accurate information during the H1N1 (Pandemic Influenza A) outbreak.

What is noteworthy these days is that various solutions exchange their own data in an effort to effectively prevent the spread of epidemics. Not only HealthMap and ProMED mentioned as examples above but also other solutions in the field of epidemics monitoring are more increasingly doing so. Ever since the MERS outbreak in 2015, KT, Korean telecom service provider, has collaborated with KCDC (Korean Center for Disease Control) and mapped the roaming data of its subscribers to the epidemics data of the KCDC, thereby providing a solution that automatically sends text messages to citizens who have visited at-risk countries. The epidemics solutions and the cases mentioned in this chapter including ProMED, ITU, HealthMap and KT will be further detailed in Chapter 3.

Big Data will gain importance in fighting epidemics, and ICT will proactively change the way we respond to epidemics

"The epidemics monitoring system is a field of information activities which is based on the 'information cycle' encompassing data-information-knowledge. The system is at the core of the information network, the pillar of the overall epidemics management activities. Information will gain even more importance in the future. With the advancement of ICTs represented by AI and Big Data, a rather passive type of the epidemics monitoring system of the past where medial institutes reported the outbreak of epidemics will change to a more proactive monitoring system based on e-health records and big data collected from various sources. In addition, the RODS (Real-time Outbreak and Disease Surveillance System) will be established and be more actively utilized in fighting epidemics."

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Endnotes

[8] The ITU report categorizes indicators as Fixed-Telephone, Mobile-Cellular Telephone, Mobile-Broadband and Fixed- Broadband.

[9] According to the ITU's categorization, developing countries include top 5 nations in terms of the number of population including China, India, Indonesia and Brazil but excluding the U.S. More details can be found at https://www.itu.int/en/itu- d/statistics/pages/definitions/regions.aspx

[10] N. Madhav, "Five ways big data is transforming epidemics," AphA, 2017.

[11] Flowminder, a non-profit organization based in Sweden, provided to the healthcare authorities analysis results of travel routes of people based on the data collected from 150,000 cell phones, which was provided by a mobile carrier Orange Telecom, thus contributing to the establishment of measures.

[12] GSMA(2017), based on Unique mobile subscribers

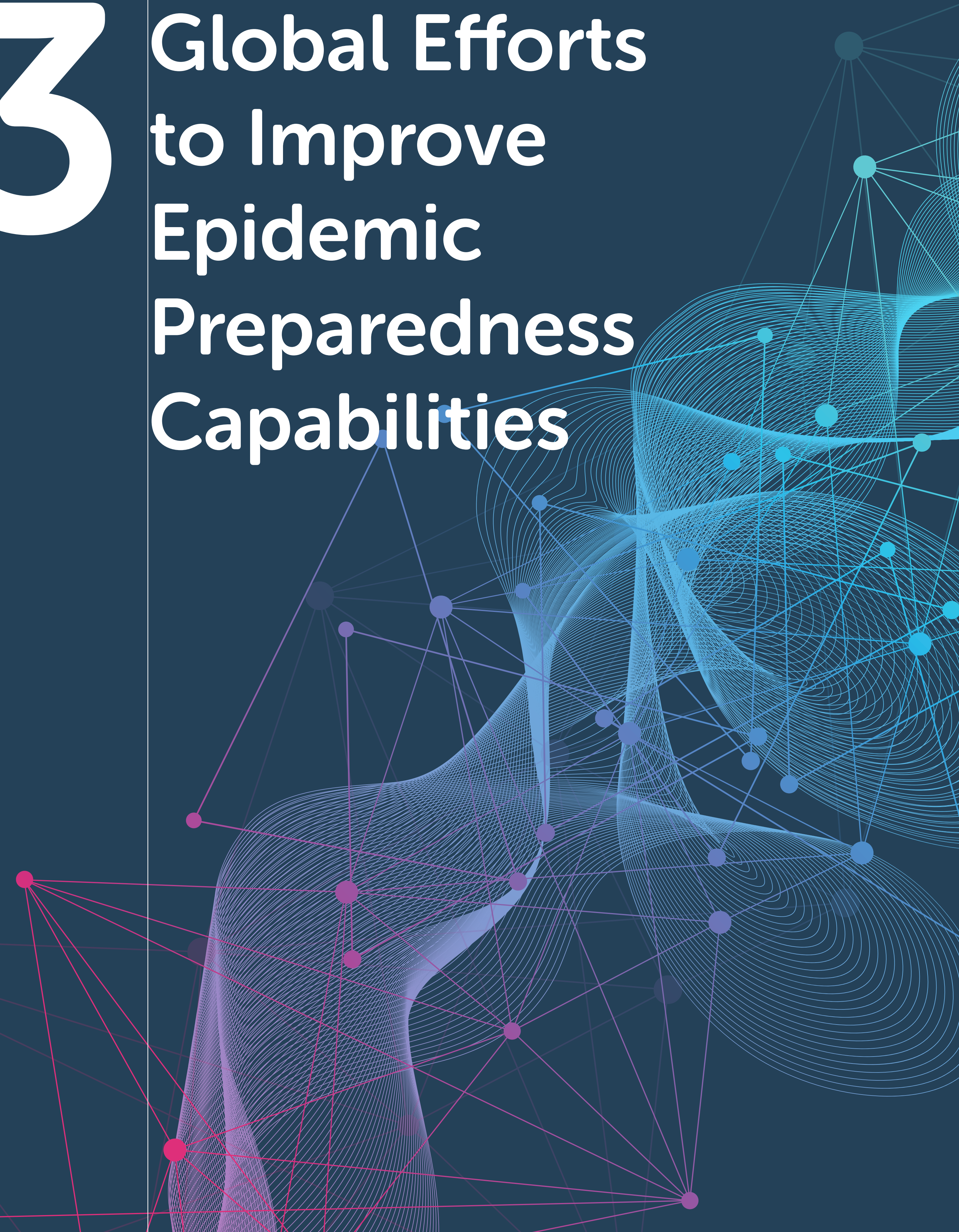
[13] CISCO, "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016-2021," 2017.

[14] Error rate: [(Non-CDC estimates)-(CDC estimates)]/(CDC estimates)

[15] Location-based information mash up and large-scale simulation mentioned here are the enabling technologies for the analysis of infectious disease big data. They are being also utilized in various data science based epidemics services and solutions being discussed in this chapter.

3

Global Efforts to Improve Epidemic Preparedness Capabilities



Cases of SARS, MERS, Ebola and other modern epidemics mentioned in Chapter 1 demonstrated the growing importance of systematic response to infectious diseases. But existing measures consisting of monitoring, warning, reporting, and tracking had many challenges, including low reporting rates due to data incompleteness, lack of standardization for disease diagnosis criteria, delayed reporting, lack of flexibility from information source limitations, and lack of expertise in interpreting surveillance data. Possible solutions to these challenges were discussed in Chapter 2, including real-time data collection from the source and real-time detection to monitor trends and anomalies in epidemics. Public health information is growingly becoming digitized and computerized, and real-time consolidation of such data and its utilization in surveillance has been a topic of discussion since the introduction of electronic medical records, with many projects still underway.

Before the widespread use of the internet, measures against infectious diseases were limited to regional and national efforts. But epidemic management systems grew rapidly during the three decades of internet and mobile revolution from the 1990s to the 2010s. Internet and mobile data not only supplement traditional public health infrastructure, but are also used as the hub of epidemic data and offer greater diversity in the methodology for early warning and data collection. With new types of data accumulating, such as internet search queries and social media, new efforts are being made to enhance surveillance efficiency by making direct use of this data or combining it with traditional data for analysis. Artificial intelligence, IoT, and other ICT convergence are expected to transform the current passive systems of surveillance into more proactive systems, and more real-time outbreak detecting systems (RODS) are forecast to be built in the future.

As we stand at the dawn of the fourth industrial revolution, many regions still have discoordinated surveillance systems between neighboring countries or completely lack even the most basic system for monitoring infectious diseases. It is time for us to re-examine our epidemic response strategies, to overcome the limitations of existing surveillance systems through technological convergence, to optimize real-time disease surveillance and reporting systems, and to explore other new ways to curb the spread of diseases based on the challenges we have identified and the lessons we have learned. As the key element to achieving such changes, ICT is being utilized in various areas of epidemic response, including monitoring, warning, reporting, and tracking.

Need to bridge the gap between developed countries and the LMICs in fighting epidemics and to extensively apply ICT to address this task

"Currently, there is a clear correlation around the world that is being exhibited between national capability in coping with infectious diseases and national competitiveness. Infectious diseases mostly occur in underdeveloped countries; however, they often lack the capability required to effectively respond to the outbreaks. Some developed countries in Europe, Asia and the US experience much less frequent outbreaks of epidemics, and they are capable of effectively coping with such outbreaks. While there is discrepancy in the capability of fighting epidemics, a globally coordinated effort is required in building the system and applying ICT to help underdeveloped countries not to be further alienated nor discriminated."

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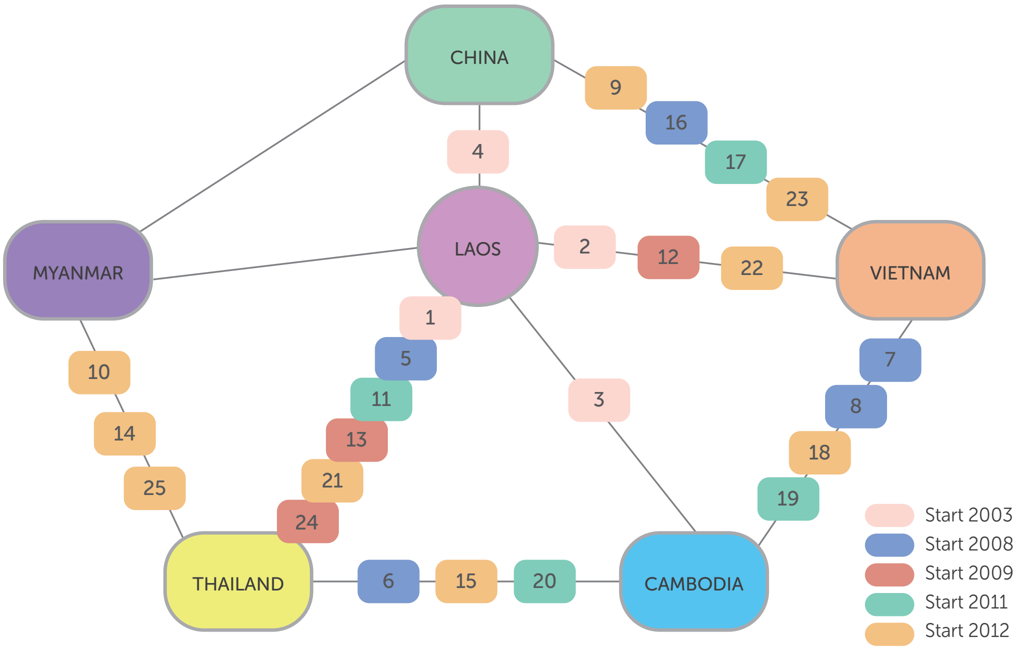
3.1 Disease Data Based Surveillance System

3.1.1 [Cambodia] Mekong Basin Disease Surveillance[16]

3.1.1.1 Background

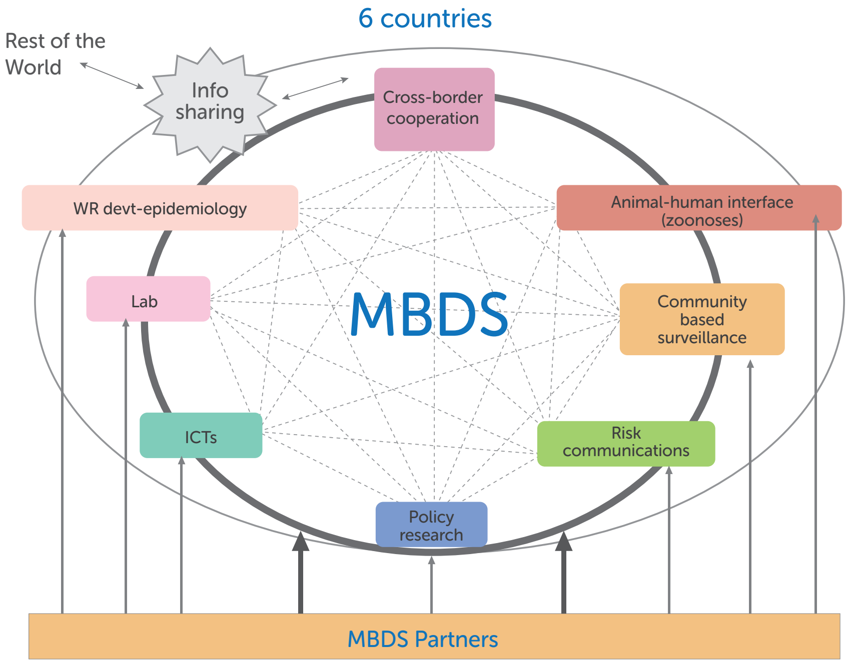
The MBDS(Mekong Basin Disease Surveillance) cooperation is a self-organized sub-regional network commenced in 2001 among six Mekong Basin countries and provinces of China, including Cambodia, Yunnan (and, since 2006, Guangxi) provinces of China, Laos, Myanmar, Thailand, Vietnam. It aims to strengthen national and sub-regional capabilities in epidemiology surveillance and outbreak response, especially on 18 currently designated priority diseases[17], to rapidly and effectively control them. The cooperation focuses on collaborative cross-border disease surveillance and response activities, through programming at approximately 25 designated 'cross-border sites'.

FIGURE 17: 25 designated cross-border sites of MBDS



And implementation of seven core strategies aimed at building capacity and advancing programming in the following areas: cross-border cooperation, animal-human interface and community surveillance, human resources in epidemiology, information and communications technologies, laboratory, risk communications, and policy research.

FIGURE 18: Seven core strategies of MBDS



The MBDS network operates based on its core values of mutual respect and trust. A new MOU signed by MBDS health ministers in May 2007 in Geneva renewed the formal cooperation for an indefinite period of time. MBDS leadership endorsed a new Master Plan for 2011-2016 which encompasses the seven core strategies. Moreover, MBDS leaders have also emphasized the need to align MBDS programming with requirements of the International Health Regulations (IHR 2005), to build core capacities to respond promptly and effectively to Public Health Emergencies of International Concern (PHEIC). The MBDS Network not only helps improve health outcomes and empowers health workers in the Mekong Region but it also provides a neutral mechanism for information-exchange and collaboration between countries that do not traditionally share information freely or work together easily.

3.1.1.2 Mekong Basin Disease Surveillance

MBDSNet is an open-source, Web-based application that serves as a data integration hub for the various surveillance systems used by the six participating MBDS countries. The website was developed after MBDS project coordinators and consultants traveled to each member country to review and collect information on the surveillance systems to ensure compatibility.

Data managers from each country submit surveillance data to their respective MBDS coordinator, who then collates the information within the regional database, making it available to other MBDS members. Each of the six participating countries has one information officer who is responsible for collecting, posting, and translating surveillance information. Currently, all data is posted in English. The next phase of work on the system will explore language translation software.

FIGURE 19: Key Technologies of MBDS

Core functions	1. Collect and upload data files from the different country systems 2. Consolidate parse data and covert to XML for data exchange 3. Generate content for website publishing and data visualization through graphics
Content management	MDBSNet features a content management system to enable country administrators to post news and articles on the website
System management	The MBDS project coordinator in each country is responsible for maintenance of the system

MBDS countries have piloted an integrated approach to disease surveillance and response across borders through the following activities.

① Cross-Border Information Exchange

Data from routine surveillance on priority diseases in each site are exchanged via e-mail or fax to national coordinators and the adjacent province's site coordinator using standard forms[18]. Reports of suspected outbreaks are also conveyed informally by phone. Information exchanges are carried out daily, weekly, monthly, or quarterly (depending on the disease) across border provinces. While country and site coordinators closely monitor these exchanges, the timely and relevant flow of information between surrounding communities, cross-border sites, and district and provincial levels remains a challenge.

FIGURE 20: Diseases Exchanged for MBDS Cross-border Project

Project sites	Daily report	Weekly report	Monthly report	Quarterly report
Savannakhet (Laos), Mukdahan (Thailand) and Quang Tri (Vietnam)	Acute Flaccid Paralysis (AFP) SARS Cholera Avian flu	DF/DHF/DSS Typhoid fever Measles	Malaria Pneumonia	HIV/AIDS Tuberculosis
Champassak (Laos) and Strung Treng (Cambodia)	AFP SARS Cholera Avian Flu	DF/DHF/DSS Measles AFP	Malaria	HIV/AIDS Tuberculosis
Luang Namtha (Laos) and Mengla County (China)	AFP Syndrome ARS Cholera Avian Flu	DF/DHF/DSS Dysentery Pneumonia Measles EID	Malaria	HIV/AIDS Tuberculosis

② Joint Outbreak Investigation and Response

After cross-border teams made up of health, customs, immigration, and border officials were established in 2006, three activities took place.

- Joint dengue fever investigation between the Laos and Thai provincial sites, enabling officials to effectively stamp out the cross-border outbreak:
- Joint typhoid investigation between the Laos and Vietnam provincial sites.
- Joint avian influenza investigation of cases in humans, triggered by the discovery of an infected Laos's citizen in Thailand. Within less than 24 hours of the initial report from the MBDS coordinator in Thailand to his counterpart in Laos, a team was dispatched from Thailand to Laos to support the Laos investigation.

③ Training of Healthcare Personnel

The joint Thai-U.S. CDC Field Epidemiology Program, Mahidol University, and SEAMEO-TropMed programs coordinate annual training for MBDS participants. Participants are selected from central surveillance offices, border provinces, and other peripheral areas essential to a coordinated regional response. As a result of these efforts, participants have enhanced their skills in research, outbreak investigation, and communication, as well as established friendships and mutual trust with officers from adjacent provinces across borders. Progress in 2006 and 2007 includes:

- 45 health workers from the region received training in field epidemiology, disease surveillance, and response.
- An additional 42 workers can now apply skills in geographic information systems and other analytic techniques.
- An additional 23 health workers have undergone in-depth training in the social, political and economic aspects of border health.

The MBDS Network serves the region both by empowering health workers and by preventing the spread of disease throughout the general population. Each implementation site features a border health team of between five to seven public health workers, border control and immigration officers, and community members.

The MBDS Network demonstrates and supports mechanisms for multi-country collaboration and response at two levels: sub-regional, and provincial/cross-border. Four demonstration sites comprise cross-border collaboration, with Laos at the geographic center of the region. While neither Thailand and Vietnam nor Cambodia and China share common borders, they do share information, strategies, and experiences through the national-level MBDS coordination mechanisms.

3.1.1.3 Impact and Achievement

The MBDS Network has given birth to new relationships that have influenced the way health officials in the region interact with each other and how much information they share. Additionally, the policy impact of the MBDS in terms of strengthening country-to-country ties and transparency is evident by the increase in the collaborative nature of each new disease detection and response activity and the willingness of each Ministry of Health to help its counterparts build capacity through training.

① A Policy Framework for Cross-Border Cooperation

During the 2003 SARS outbreak, the MBDS communications infrastructure and relationships between technical officers in each country's Ministry of Health proved essential to the subregion's coordinated response. The 2001 MBDS Memorandum of Understanding also served as a model for a subsequent collaborative agreement of ASEAN+3[19]. Additionally, the Thai Ministry of Public Health hosted an MBDS-facilitated meeting of ASEAN+3 to jointly develop a training plan for disease surveillance.

② A Proven Model for Collaboration, Growing in Strength and Capacity

The Asian Development Bank has committed $30 million to strengthen surveillance systems in Cambodia, Vietnam, Laos. The MBDS Network has also facilitated broad regional discussions with regional and international bodies, such as WHO, ASEAN, and PACNET[20]. Examples include:

- The MBDS Network helped establish a working relationship between WHO-SEARO and WPRO[21] in Asia.
- The MBDS Network demonstrates systems that facilitate compliance with International Health Regulations through development and testing of guidelines and protocols with multiple

sectors at border sites, including customs, immigration, transport, interior, and communities.

- Participating countries' Ministries of Health have allowed bilateral and multilateral investigations of disease outbreaks through MBDS. Efforts now focus on strengthening pandemic preparedness, with the regional simulation exercises that took place in Cambodia in March 2007.

The MBDS Network has held in-country exercises for over six years; in March 2007 participating countries joined forces to test their preparedness as a region. Senior government officials from the MBDS Network countries, as well as representatives from the UN, UNICEF, UNSIC, and UNOCHA[22], participated in the first-ever simulation exercise designed to test responses to a pandemic influenza emergency in the region. Using techniques similar to those in modern war-gaming, the tabletop exercise was designed to foster cooperation within the region seen as the most likely source of a potentially devastating pandemic, such as avian flu. The exercise also helped identify gaps and weaknesses in systems for detecting, monitoring, tracking, and containing the spread of disease.

Throughout the planning process, health officials from neighboring MBDS countries were invited to participate in national exercises, resulting in a rich informal exchange of strategies and approaches to rapid detection, response, and communication later adopted by other countries. This process—new to most countries—helped catalyze the testing of national pandemic preparedness and response plans in Cambodia, Laos, and Myanmar, and advanced ongoing efforts in China's Yunnan Province, Thailand, and Vietnam. The tabletop exercises also generated interest and support from additional sectors, including agriculture, foreign affairs, finance, defense, tourism, and trade. The ability of country delegations to bring in sectors other than health to participate in these tabletop exercises represents a significant change from only one year ago, when preparedness efforts largely took place within the domain of the health sector.

3.1.1.4 Challenges

① LanguageBarriers

The MBDS Network operates across multiple languages in the region(Thai, Laos, Vietnamese, Burmese, and Mandarin), which presents practical communication challenges—not only between MBDS partner agencies, but also with local communities.

② Information Security

Because public health information can be very sensitive—especially if that information carries potential economic ramifications—security concerns remain a significant barrier to effective data integration across borders. However, the trust and relationships that have developed through the MBDS Network now allow for much greater sharing of information.

③ Silos Between Animal and Human Health

MBDS participants recognize a need for closer communication between vertical programs within the health sector, and with other sectors such as veterinary public health. Integration of animal and human health sectors' surveillance and response is at a very early stage.

④ Infrastructure

MBDS participants continue to grapple with limitations in human resources and weak health systems. An additional hurdle includes unreliable communications technologies and systems, especially in rural areas.

3.1.1.5 Challenges Future Direction

① Health Situation Analysis

The MBDS Network is in the process of conducting a health situation analysis for each of its implementation sites. The analyses will become baselines for further monitoring of health development in selected provinces. In addition, the analyses create an opportunity to collect in-depth information about the surveillance structure within each province, as well as other tools for outbreak response. MBDS coordinators will communicate results of the analyses to each implementing site so that participants can identify approaches for more effective cooperation.

② Scale-Up Models

Effective collaborative cross-border and joint preparedness and planning models have become catalysts for scaled-up models in other border sites with the support of new donors. In order to support such efforts, MBDS participants will share lessons learned about effective regional collaboration with other regional surveillance networks in the Middle East and South Asia.

③ Network Expansion

The MBDS Network is evolving into a broader platform for regional coordination across sites and donors, and will continue to integrate additional technical aspects of data analysis, forecasting, and policy to assure the region's capacity to comply with International Health Regulations.

3.2. Medical Data Based Epidemic Information Service

3.2.1 [ProMED] Epidemic Notification Mailing Service

3.2.1.1 Background

ProMED (Program for Monitoring Emerging Diseases) is the biggest private, open system of unofficial disease surveillance and reporting in international health. The concept was initially proposed by Donald A. Henderson in 1989, and ProMED was founded jointly in 1994 by Dr. Stephen Morse of then Rockefeller University, Dr. Barbara Rosenberg of the State University of New York at Purchase, and Dr. Jack Woodall of the then New York State Department of Health. Although it was originally established as a communication channel for network of scientists, ProMED was later expanded to include physicians, veterinarians, epidemiologists, public health professionals, and others interested in infectious diseases.

This web and email based non-profit organization aims to continuously and rapidly monitor and report potential outbreaks of infectious diseases and exposures to toxins that could affect human or animal health. After its establishment in 1994 with the support of the Federation of American Scientists (FAS) and SATELLIFE, it was re-organized as an official program of the International Society for Infectious Diseases (ISID) in 1999 and currently has 60,000 members and 70,000 subscribers in 185 nations.

3.2.1.2 Significance and Implementation of ProMED

① Significance and Development of ProMED

The ultimate goal of ProMED is to prevent the spread of epidemics through proper surveillance, discovery, and reporting of existing or new infectious diseases and to protect humanity from potential diseases and dangerous substances. In line with globalization and other multi-faceted elements, ProMED's information has to reach affected and neighboring regions as well as health authorities and institutions around the world in a timely manner. In this context, the development of ICT offered an opportunity to build the most effective system of reporting with the least efforts. ICT also enabled

ProMED to quickly provide information on potential threats to human and animal health. AI, big data, blockchain, IoT and the continuous development of ICT are expected to bring new opportunities to develop more advanced systems of surveillance and reporting in the future.

② ProMED Mechanism

ProMED provides information on infectious diseases in near real-time to thousands of scientists, health professionals, journalists, and others interested in the topic. ProMED receives information from various unofficial channels, including media reports, official reports, online summaries, and local observers, as well as contributions by subscribers via email. A team of expert moderators, ProMED team members, and EpiCore members in 45 regions around the world review and analyze reports before they are posted. Based on their expertise of their given regions, the team investigates the accuracy and feasibility of the reports through screening and editing.

After the investigation, reports are distributed by email to subscribers, posted on the ProMED website, and even shared through social media channels like Twitter. All reports by ProMED are archived and made available to anyone through search. ProMED not only encourages subscribers to share information but also maintain a good relationship with subscribers by responding to their request for information and collaborating with them in outbreak investigations and prevention efforts. The services are provided 24/7 in eight languages to promote global coordination, including Spanish (ProMED-ESP) and Portuguese (ProMED-PORT). An average of 13 reports are posted to their website on a daily basis and shared via email to support the existing disease surveillance and reporting systems.

FIGURE 21: The Front Page of the ProMED's Website

Source: ProMED

3.2.1.3 ProMED's Pros. and Cons.

① Advantages of ProMED

- **Free of Political Constraints**

  It is not difficult to find historical records of governments postponing declaration of epidemics for political or economic reasons. One of the biggest advantages of ProMED is that it is an unofficial channel that is free of political constraints, and makes information available information even before official reports are released. During the Ebola outbreak in Gabon in October 1996, ProMED shared the news with its subscribers as soon as the WHO's Regional Office for Africa released the information. This was four days before the news reached the international society through WHO's internal system. Another example is the SARS outbreak in 2003 when ProMED launched an investigation 1-2 months ahead of time to confirm and report the outbreak of SARS, as well as the 2012 MERS outbreak when it announced the news to the international society one week ahead of time.

- **Availability to All without Cost**

  As a non-profit project, ProMED is operated with the support of the Wellcome Trust, Skoll Global Threats Fund, Google.org, the Gates Foundation, the Rockefeller Foundation, and other individual donors. Open to anyone at no cost, ProMED was built to urge international society to act quickly against infectious diseases through rapid information sharing and early warnings, and designed to be available to anyone with internet access throughout the world.

- **Commitment to One Health & Service to the Global Health Community**

  ProMED acts as a network and channel of communication for the international infectious disease community. Taking a multilateral approach to epidemic challenges for human, animal, and plant health alike, ISID has adopted the basic principle of "One Health" and continues its efforts to contribute to the international community. Since the launch of ProMED-EAFR (East Africa) in 2009, ProMED has conducted joint workshops with unofficial programs like HealthMap, including the Training Programs in Epidemiology and Public Health Interventions NETwork (TEPHINET) and the African Field Epidemiology Network (AFENET). Since then, ProMED has stressed the importance of unofficial systems of disease surveillance and reporting through continuous workshops, and has helped build a foundation of progress by bringing together the global health community.

② Limitations of ProMED

- **Imbalance in Information and Resource**

  Limitations of the global surveillance system are made more apparent in underdeveloped nations that lack the proper infrastructure to detect or treat infectious diseases. For instance, non-UN member countries are often left out of the information loop and lack a standardized system of reporting or have one that is not effectively implemented. This in turn exacerbates the imbalance in information resources. In the same context, such regions most likely lack proper medical services and face limitations in reporting and continuous surveillance even during an outbreak. This limitation is not unique to ProMED but to global surveillance systems overall, and thus requires coordination and resolution on a global scale.

- **Reliability**

  Analyzing and interpreting surveillance data in real-time to determine the onset of an epidemic is a difficult task even for skilled professionals. It becomes even more difficult to discern aberrations and noise inevitable in surveillance with a greater number of information sources. ProMED, GPHIN, MediSys, and other contributors to disease surveillance and reporting systems also face similar challenges. To this end, leveraging the strengths of different surveillance and reporting systems to build an organic network that will run as one big wheel would enable a more efficient and effective system of surveillance and monitoring for infectious diseases. EpiCore Program is one key example of such efforts by ISID since 2015.

<REFERENCE> EpiCore Program

EpiCore Program was launched in November 2015 to supplement and leverage existing disease surveillance and reporting systems under the partnership of SGTF, ProMED, HealthMap, and the Training Programs in Epidemiology and Public Health Interventions Network(TEPHINET). EpiCore aims to help existing surveillance systems verify the validity of outbreak information and issues surrounding public health. EpiCore network is comprised of experts in the field of human health, animal health, and sanitation, and has 1,817 members in 140 countries as of February 2017. EpiCore Program was able to expand its influence globally in just two and half years, and it continues to make efforts to build an efficient and effective surveillance system.

The Responders are EpiCore members who receive Requests for Information (RFIs) on possible outbreaks from Requesters (ProMED moderators) and other sources. The Responders review the shared information and verify its validity. The Requesters review the feedback from Responders and share this information through email, web, and social media, along with its implications.

As of 2017, Responders have answered 304 of the total 484 RFIs. Most of them answered within one day of the request, regardless of type of disease, but the response time varied by country of their location. Some of the RFIs had more than one answers. 127 of the RFIs were verified to be either health related (107 RFIs) or non-health related (20 RFIs). The below table is an analysis of the mean time to response and verification by region.

FIGURE 22: Mean time to response and verification by region, among RFIs with at least one response

	Men response time (days)	Total RFIs	Total verified		Public health event		No Public health event	
Region		N	N	%	N	%	N	%
Total	1.4	304	127	42%	107	35%	20	7%
Africa	1.6	38	24	63%	20	53%	4	11%
Eastern Mediterranean	0.9	87	36	41%	30	34%	6	7%
Europe	2.6	44	13	30%	9	20%	4	9%
North America	2.3	33	8	24%	8	24%	0	0%
South America	1.7	64	29	45%	25	38%	4	6%
South and Central America	1.0	12	5	42%	5	42%	0	0%
Unknown/Multiple	0	7	3	43%	2	29%	1	14%
Western Pacific	0.7	19	9	47%	8	42%	1	5%

** Percentage of total RFIs with at least one response.*
Note: WHO groups member states from North and South America into one reigion. However, Epo-Core member data distinguish North America from South and Central America the analysis included them as separate regions to capture any variations between thme
Source: EpiCore administrative data from Nov 15, 2015 through Feb 8, 2017

- **Manual Process**

Although ProMED shares information faster than official systems of disease surveillance and reporting and monitoring organizations, there is still room to improve as humanity prepares for the era of fourth industrial revolution. The current ICT-based ProMED system, using web, email, and social media, could expand into automation using new technologies like AI, IoT, or other core technologies of the fourth industrial revolution. And even though expert reviews could be conducted to check the facts of the reports, passive processing sometimes leads to a delay in reporting and creates risks where information cannot be checked in depth in real-time. There is also the challenge that epidemiologists can't immediately identify the type of information for the disease and health data provided ProMED.

3.2.1.4 Use cases – SARS in 2003 and MERS in 2012

The outbreaks of Ebola in 1996, SARS in 2003 and MERS in 2012 clearly demonstrated the importance and necessity of unofficial systems like ProMED. Both during the SARS outbreak in 2003 and MERS incident in 2012, physicians made use of ICT to call for rapid response through early warnings by sharing epidemic information with the international community prior to the declaration of official institutions.

SARS Outbreak in 2003

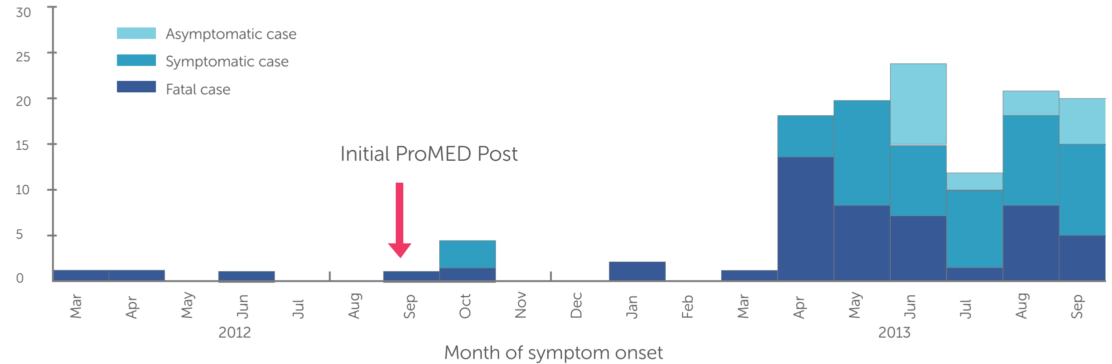
ProMED played an important role in identifying the SARS outbreak in 2003. Dr. Stephen O. Cunnion of Silver Spring, Maryland was the first to submit a report for SARS on the ProMED database in November 2002. Thanks to this report, ProMED team was able to launch an investigation into the SARS outbreak two months before the official declaration of the international community. In fact, the official declaration of the Chinese authorities for this outbreak came one month after the information was posted on ProMED in February 2003.

MERS Outbreak in 2012

In September 2012, ProMED user and Saudi Arabian microbiology professor Ali Mohamed Zaki found coronavirus in a pneumonia patient and passed this information immediately to ProMED. Similar to the previous outbreak of SARS, ProMED was able to identify an outbreak of MERS early on and shared it via web and email. It was eight days after the initial report that the Saudi Arabian health authorities officially announced the new type of coronavirus. Figure XX shows the monthly distribution of MERS coronavirus cases by symptom levels, and the arrow represents the timing of ProMED's initial post.

FIGURE 23: MERS Case distribution graphic

istribution of confirmed MERS coronavirus case by month of symptom onset, March 2012-24 September 2013(n=133)



ERS: Middle East respiratory syndrome.

here month of onset was not available, month of reporting was used.

Source: EuroSurveillance 2013 Volume 18, Issue 39, Article 3, annotated by ProMED

3.2.1.5 Fruition of ProMED

ProMED aims to support and supplement existing systems, not to compete with other global or national systems of disease surveillance and reporting or to make profits from its activities. ProMED's main objective is to spread disease information to as many people in the shortest time possible for continuous monitoring, early warning, and reporting, and to act as a supporter for a more proactive, rapid, effective response to infectious diseases compared to disease control systems like the National Tuberculosis Surveillance System (NTSS) and international and national institutions like WHO and CDC. Systems of disease surveillance and reporting like ProMED is a crucial source of disease information and plays an important role in identifying outbreaks. Countries that lack budget or resources could make use of ProMED and other internet-based systems of disease surveillance and reporting for bidirectional communication to take necessary measures to effectively curb the spread of infectious diseases.

ProMED's disease data is also used to measure mortality rates or demographic statistics for certain infectious diseases. As mentioned previously, effective use of unofficial information is gaining importance in national health monitoring. According to WHO Epidemic and Pandemic Alert & Response, more than 60% of early outbreak reports are from unofficial systems like ProMED. Unofficial disease surveillance service pioneered by ProMED, also known as "event-based surveillance" or "epidemic intelligence," has become an indispensable element to national response and efforts to curb infectious diseases.

3.3 Mobile Data Based Epidemic Tracking System

3.3.1 [ITU] CDR Based Ebola Outbreak Data Repository[23]

3.3.1.1 Background

Big data derived from the use of ICTs hold great promises to help address national development challenges in developing and developed nations. Digital footprints produced from using online services, phones and other digital transactions, can be gathered, analyzed and used to provide critical information to develop better policies and foster development, preparedness and response plans in case of emergencies.

3.3.1.2 ITU mandate

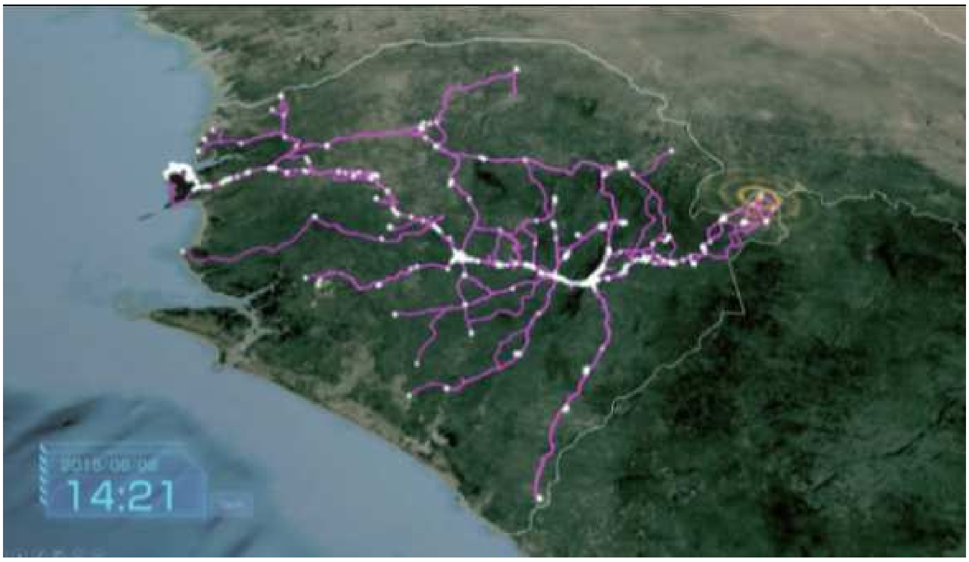
ITU data show that around 95 percent of the population in the world is covered by mobile-cellular networks and a growing number of people are using mobile phones. This makes data from mobile phone operators a particularly valuable source of information, including in the case of emergency situations. In 2014, ITU's Membership recognized that "The use of Information and Communication Technologies (ICTs) play an important role to break the chain of health-related emergencies such as Ebola virus transmission" (Resolution 202, PP-2014). In 2015, when 3 West African countries were hit by the Ebola virus, ITU initiated its first big data project. With the support from Ministry of Internal Affairs and Communications (MIC) of Japan, and in collaboration with the beneficiary member states of Guinea, Liberia and Sierra Leone, the project was able to showcase the potential of big data to facilitate the timely exchange of information to respond to epidemic outbreaks.

3.3.1.3 Potential use of Call Detail Records (CDRs)

In close cooperation with the national telecommunication regulatory agencies in Guinea, Liberia and Sierra Leone, and with all mobile network operators

(MNOs) operating in these countries, ITU conducted a preliminary study on sample Call Detail Records (CDR) data. CDR data includes information on the use of the mobile phone services, including the location of use, and time and length of the calls. Three separate country case studies for Guinea, Liberia, and Sierra Leone were published as a result of this preliminary study. The case studies include detailed information on the CDR data sets, analysis and results, as well as the anonymization process and limitations and challenges. These country case study reports demonstrate how the analyzed CDR data can provide information on human mobility, including cross-border movement, and the spatiotemporal distribution of people, while safeguarding individual privacy through an anonymization process of the CDR data (See Figure 24).

FIGURE 24: Tracking population movement to develop an epidemic outbreak model in Sierra Leone



Source: ITU. Note: This image shows how CDR data can be used to predict the outbreak of Ebola from one location (yellow circle), to other parts of the country, based on the movement of people.

As part of this project, a Secure CDR Data Repository was designed and implemented as a solution to assist each of the Member States to create a foundation for national big data initiatives. A national CDR data repository solution can provide governments, aid agencies, researchers, and others with free and open access to valuable data on the movement patterns of citizens. Combined, for example, with data on new epidemic outbreaks, this information can make huge impacts in improving and saving lives. In the case of a disease outbreak, information on the movement of citizens is critical for governments and humanitarian aid agencies for an effective intervention, and to tackle a specific outbreak. It can further be used to build models of population flow patterns over time, and at specific events, and to combine these data with other information for building prediction models of potential outbreaks.

While the analysis of anonymized Call Detail Record data can serve to address epidemic outbreaks, the same CDR data can also be used with other relevant data sets and deliver new use cases, including in the area of national planning and for the development of health, transportation and other policies. Infrastructure records, combined with mobility patterns could help optimize transportation routes and public service planning. Other valuable data that could eventually be included into this platform to foster development is information about roads, airports, schools, medical facilities and housing needs. The platform ITU has set up can effectively be used for decision making during times of uncertainty, but also for national development planning in various areas.

3.3.1.4 Limitations of CDR Data

Even though analyzing anonymized CDR data can provide many benefits in various sectors and applications, there are challenges that are faced when using CDR data:

① Privacy concerns

When mobile phones are used to make calls, browse internet or send short messages information such as time, location and other data is also stored in CDR data. Also user specific and personal information is linked to CDR data, including information on the identity of the user, contacts, etc, thus creating challenges in terms of the conflict between technology innovation and user data privacy.

② Accuracy

Limitation in the accuracy of the geolocation or estimated position or mobile devices can pose potential challenges. Almost all CDR data from telecommunication networks use the base tower location to infer the geographic location of the devices. In most cases, the accuracy from this method only varies from 50 to 300 meters in dense urban environments. To mitigate the accuracy issue, an estimation method based on the users idle time spent at specific locations and movement routes by using digital map data including POI (Point of Interest) and transportation network data was used.

③ Availability of data

In most countries, the research and study of mobile phone data is limited to the availability of data from operators. Datasets have become available in recent years and have opened the possibility for researchers to carry out large-scale urban and social impact analysis. Mobile operators can work with researchers to provide relevant and accurate data for analysis in a privacy-protective and collaborative way.

④ Data discontinuity

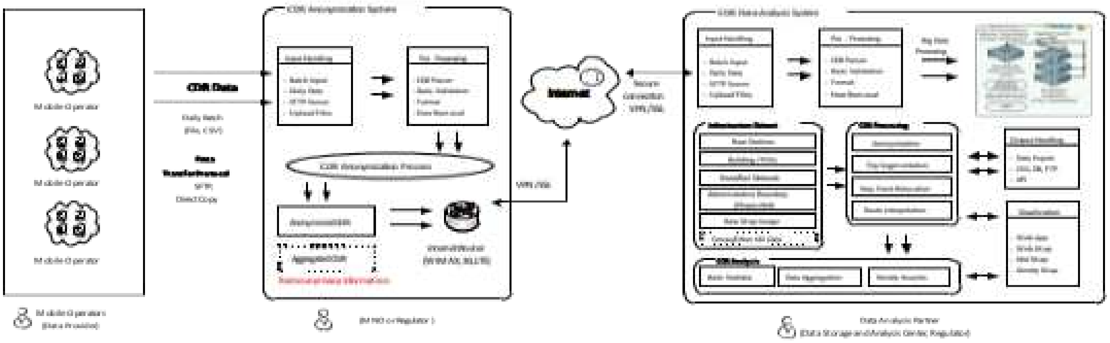
Call detail records are generated when people use their mobile phone, creating a lack of continuity in consecutive access points in CDRs, creating a core user location problem when analyzing the data. The discontinuity issue is addressed by using the estimation method based on the users' idle time spent at specific locations and movement routes, described above. In addition, and despite industry-wide formatting standards, the variation of data format requires much data pre-processing and cleaning before analysis.

3.3.1.5 Implementation of CDR Data Storage System Platform

For the beneficiary countries to be able to collect, store, and classify data and to link different data sets to each other so as to carry out big data analysis, ITU assisted in building a basic infrastructure (Figure 25). This included developing a data collection and storage platform that can be used by national and international third party organizations for research, analysis or to use and/or implement additional analytical solutions at the national level.

This system was designed to automate most of the processes from raw CDR data acquisition, anonymization, data import and storage of useful data into a Hadoop system for future analysis. During the initial setup there were some manual operations required to ensure the accuracy of information and proper configuration. This included input handling, pre-processing and data analysis configurations. Once the system is set up and configured to automatically carry out the procedures in collecting and pre-processing the data, little involvement from the mobile operators side is needed. In 2016/17, ITU conducted the training on the configuration and usage of the system for participants from all three countries involved in the project.

FIGURE 25: CDR Storage System Architecture



Source: ITU

3.3.1.6 A Promising Success Story

There are many ways to use CDR storage system for big data analysis. Currently, one of the countries that has implemented the above mentioned solution is discussing potential collaboration with an international data analytics company, in particular to develop health monitoring and disease outbreak models and information. While the country would share its CDR data, the analytics company would develop an analytical layer to combine different data sets, and produce new insights of relevance for their own purpose, as well as for policy making. In particular, this analytics platform promised to provide predictive information on mobility and disease outbreaks that was missing during the last Ebola crisis.

In addition to this information, the country would also benefit from the transfer of technology and knowledge since the analytics company would provide full access to the algorithms and train government employees on how to use and further develop these. This example shows the potential benefit of public-private partnerships in big data.

3.3.2 [KT] Roaming Data Based Smart Quarantine Solution

3.3.2.1 Background

The Center for Disease Control and Prevention has a monitoring system to identify history of visits to at-risk areas using passport information and the passenger name record (PNR)[24] of airlines, as well as a solution to send precautionary text messages when travelers return to Korea and to share travel records on the drug utilization review (DUR)[25] system of medical facilities for those that have traveled to at- risk areas. However, the system and solution have their limitations because personal information of travelers are often outdated due to the 10-year renewal period of passports or omitted from the PNR.

The biggest challenge is the fact that the current immigration control system does not provide information about stops made during the trip. It is difficult to track travelers who visit at-risk regions but return to Korea on a flight from a third, unaffected country. For example, during the Zika outbreak of 2016, the authorities failed to properly screen a passenger who had visited Brazil but returned to Korea on a flight from Germany, which was the first incidence of the disease in Korea. A big data consulting project in 2015 by Korea’s Ministry of Science and ICT and the National Information Society Agency found that the quarantine system worked only on passengers returning to Korea directly from contaminated countries, regardless of whether or not they have visited contaminated regions during the trip.

FIGURE 26: Result of Quarantine System Test

ACTION	Execution
Stopped at airport	○
Info. to medical facilities	○
SMS during incubation per.	○

ACTION	Execution
Stopped at airport	✕
Info. to medical facilities	✕
SMS during incubation per.	✕

The consulting project investigated local company's data that is used overseas to determine which could be used to track visits to certain countries, and learned that three types of data are available: (1) roaming data, (2) credit card payment data, and (3) hotel/flight/travel package reservation data. However, each type of data had their limitations.

FIGURE 27: Types of overseas data for quarantine solutions

Roaming Data	Unable to check non-roaming users (20% of population)
Card Data	Unable to check if credit card purchases are not made
Reservation Data	Difficult to collect/integrate data with so many players

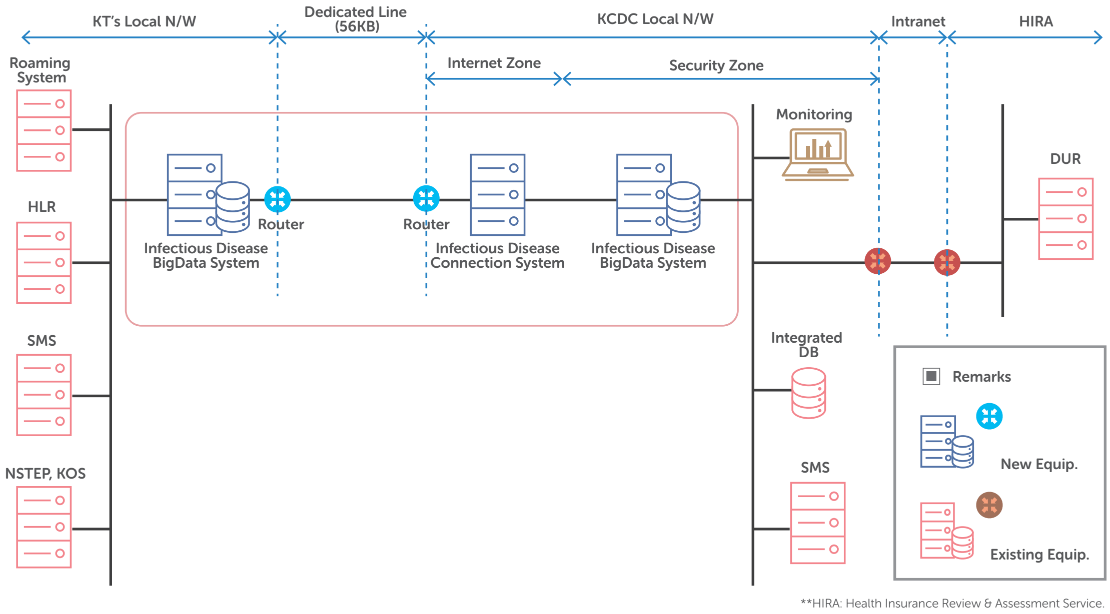
Roaming data provides credible information about countries of visit, but 20% of travelers do not use roaming while traveling. Credit card data may not be all inclusive because there is no guarantee that travelers will use credits card in all the countries they visit. In the end, KT decided to use roaming data for its Smart Quarantine solution with the focus of collecting maximum number of parameters with the available data.

After MERS was contained in Korea, KT joined hands with Korea Center for Disease Control and Prevention (KCDC) and the Ministry of Science and ICT. KT signed an MOU to develop a service to prevent the entry of epidemics across the border using roaming data as one of its leading pilot projects for big data. The system was built by KT and launched at the KCDC in November 2016, and it was later linked to data from other telecom companies.

3.3.2.2 Smart Quarantine Solution Using Roaming Data

KT's epidemic prevention solution consists of the following: (1) identification of at-risk travelers using roaming data, (2) text messaging service to provide information on epidemics and to manage infected patients, and (3) statistical data for future quarantine policies and measures. This new system of epidemic data, selected as one of KT's main areas of business, links big data from KT's roaming-based system and KCDC's epidemic data system.

FIGURE 28: Structure and scope of KT's epidemic prevention business using roaming data



**HIRA: Health Insurance Review & Assessment Service.

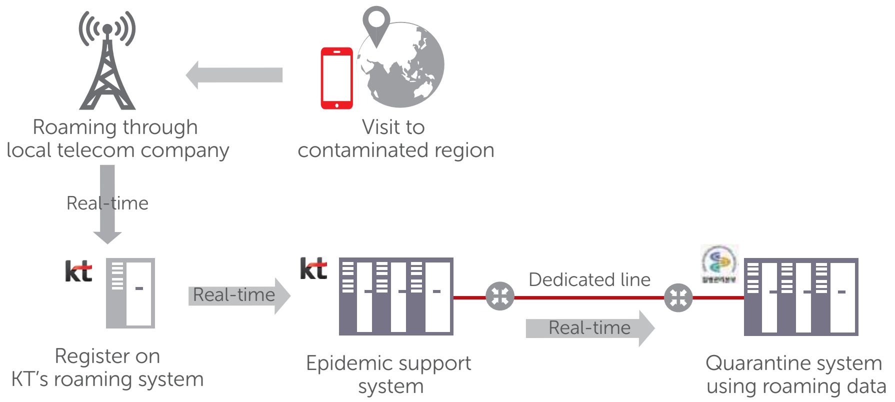
Source: KT

The solution has made it possible to verify whether a traveler has visited contaminated regions using their roaming data, to maintain communication with possible infection patients via text messages or DUR with the cooperation of KCDC, and to possibly build a total solution of epidemic prevention to establish measures before an outbreak.

① KT Big Data System: identification of at-risk travelers using roaming data

KT's Smart Quarantine solution using roaming data is comprised of two back-end processes that help travelers take measures before and after their arrival in Korea. Prior to their arrival, at-risk travelers are selected using roaming data. This process can identify at-risk travelers if they return to Korea via a third country, unlike the existing immigration system.

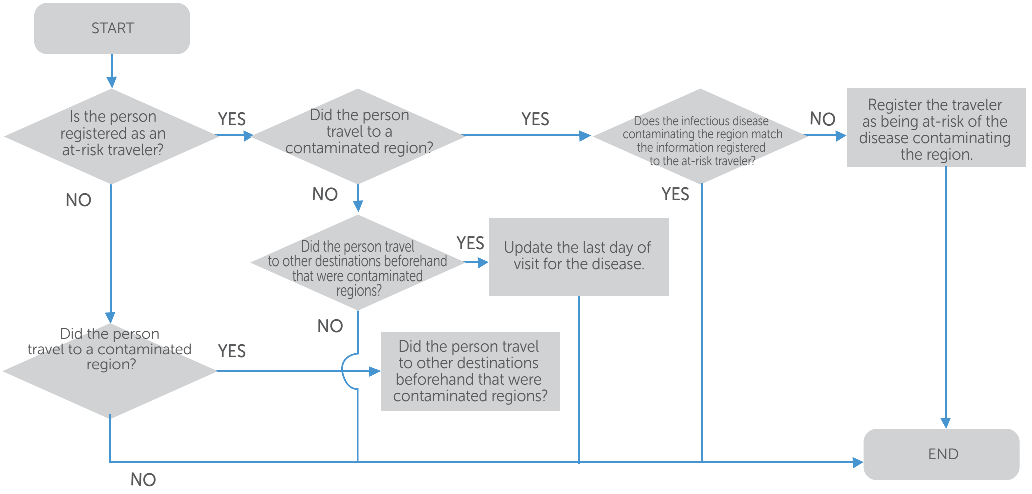
FIGURE 29: Process of identifying at-risk travelers prior to arrival



Source: KT

KT receives the traveler's roaming data in real-time, and KCDC's data on epidemics is used along with the below algorithm to determine whether the traveler has visited a contaminated area and whether they need to be registered as an at-risk traveler.

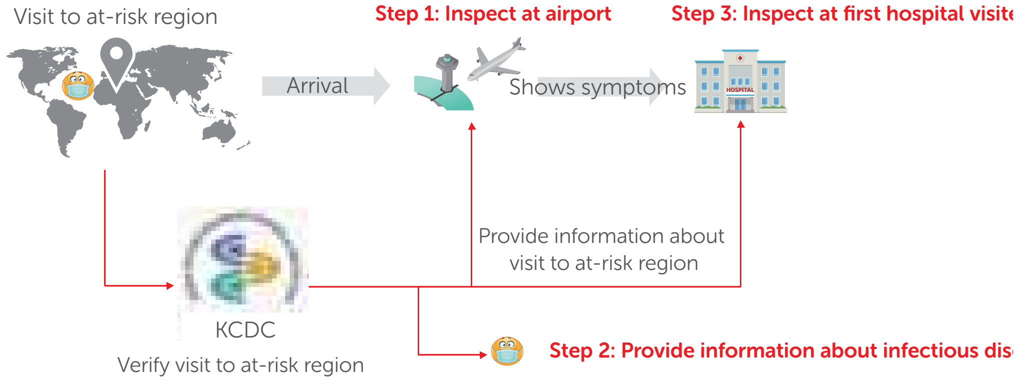
FIGURE 30: Algorithm to determine traveler's visit to contaminated regions and registration as at-risk traveler



Source: KT

When the traveler arrives in Korea, information about the at-risk traveler is provided to quarantine authorities and medical facilities so that the information is readily available on the quarantine system in real-time. When KCDC provides KT with data on epidemics, KT first verifies whether the traveler attempting to connect to roaming is a subscriber[26] and then provides their information to KCDC, while KCDC shares that information with other stakeholders like airports and medical facilities.

FIGURE 31: Process of sharing information about at-risk travelers after arrival



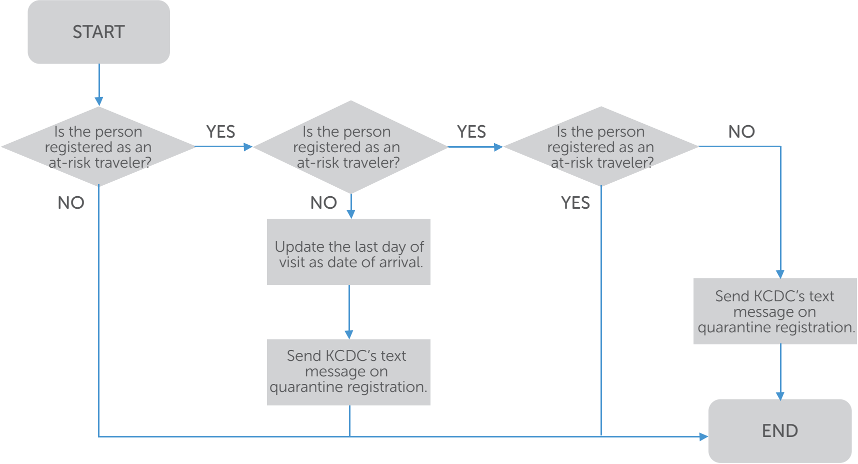
Source: KT

② Text messaging service for epidemic information and infection management

Once the two processes are running in the back-end, KCDC decides whether or not to send a text message to the traveler based on the process of handling the entry of travelers who have visited contaminated regions. If the person is an at-risk traveler, a text message is sent out with information about the infectious disease and precautions to take.

Roaming data also provides information about the arrival of an at-risk traveler, which is required as part of the process of handling the entry of travelers who have visited contaminated regions. When the KT subscriber returns and registers their location on the HLR[27], the roaming system signals the end of roaming service and confirms the return of the traveler. Once the traveler's return is confirmed, roaming data is used to determine whether the traveler has visited any contaminated countries during their trip and then processed according to the below algorithm.

FIGURE 32: Algorithm to determine text messaging when traveler returns after visiting contaminated region

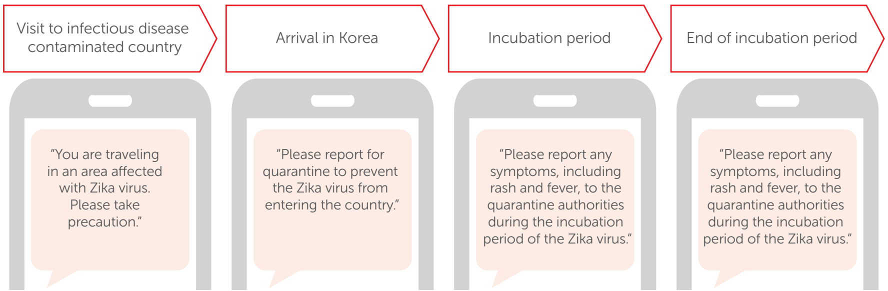


Source: KT

Travelers heading for at-risk regions will receive text messages containing information about infectious diseases, contaminated countries, and ways to prevent an infection, while those that return via a third country will receive information about infectious diseases and ways to report infections. Roaming information enables provision of information in all stages, from departure to arrival and from incubation to occurrence of the infectious disease.

It also allows us to specifically target travelers that have visited contaminated regions and encourage them to report infections[28] , which is one of the most important elements to curbing epidemics in the earlier stages. This unique case of mobile data use is made possible due to the permissions expressly granted by the 'Infections Disease Control and Prevention Act', ensuring data protection rights are not compromised.

FIGURE 33: Examples of text messages sent to at-risk travelers



"You are traveling in an area affected with Zika virus. Please take precaution."

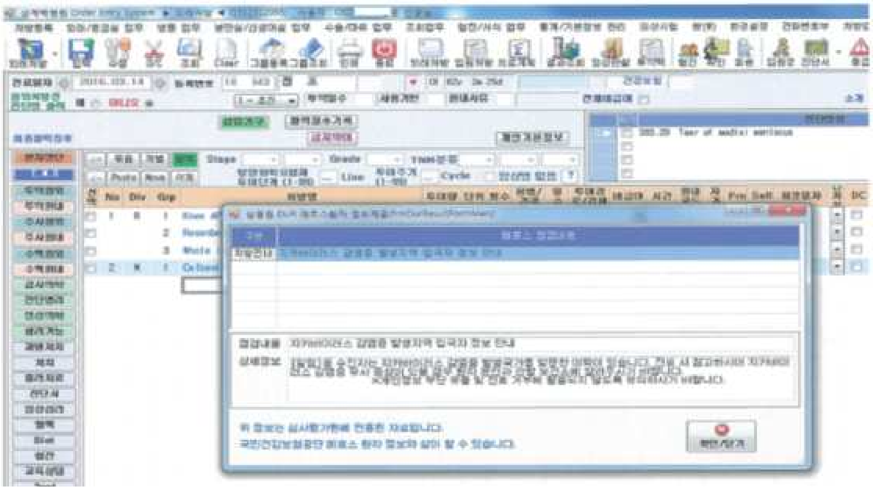
"Please report for quarantine to prevent the Zika virus from entering the country."

"Please report any symptoms, including rash and fever, to the quarantine authorities during the incubation period of the Zika virus."

"Please report any symptoms, including rash and fever, to the quarantine authorities during the incubation period of the Zika virus."

In addition to text messages, KCDC also uses DUR messages to share information about at-risk patients with medical facilities. This ensures that medical staff will be fully informed about the patient when they visit the facility for symptoms of infectious diseases, preventing any misdiagnosis with non- infectious diseases of similar symptoms due to the medical staff not having prior knowledge about the patient's at-risk status. The medical staff will be alerted via a pop-up message in the DUR system, which is run by the Health Insurance Review & Assessment Service.

FIGURE 34: Example of DUR pop-up with information about at-risk patients

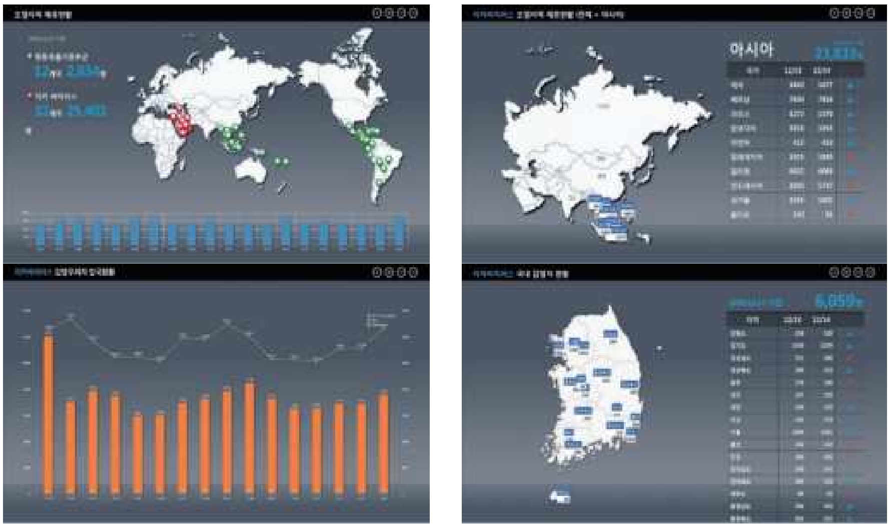


Whereas text messages use roaming data for identification, DUR messages depend on the resident registration number of patients. Resident registration numbers of at-risk patients are found using KCDC's at-risk traveler data, and the resident registration number and corresponding infectious disease are shown in the pop-up window on the DUR system.

③ Statistical dashboard for future quarantine policies and measures

To prevent infectious diseases from crossing the border and entering the country, it is important to identify the number of people who are at risk of infection. It is also important to plan and allocate the quarantine resources properly to have the right infrastructure and staff in place. KT manages the status of the number of Korean residents currently in infectious disease contaminated areas and the number of those that arrived in Korea during the incubation period. This information has been fed into statistical data to be used for future quarantine policies, and KT has also developed a dashboard for better visibility and utilization of the data.

FIGURE 35: KT's Dashboard for Epidemic Statistics



Source: KT

The dashboard has been provided to the Quarantine Support Team at KCDC to enhance their ability to handle infectious diseases such as the Zika virus and MERS, and is being widely utilized in the establishment of quarantine policies and measures in Korea.

3.3.2.3 Achievements

As demonstrated above, KT's Smart Quarantine solution has accomplished meaningful achievements in preventing the spread of infectious diseases in Korea. Smart Quarantine has made it possible to build a real-time monitoring system of those traveling to contaminated regions based on roaming data, and has brought a positive change to the actions and awareness of Korean people when it comes to prevention of infectious diseases and ways to handle infections. Moreover, unlike previous quarantine and prevention efforts against unspecified individuals, Smart Quarantine text messages manage only those who have traveled to affected areas for a more efficient use of disease prevention resources.

After the Smart Quarantine solution was introduced, the convergence of communication data with flight information enabled daily detection of travelers to 13 MERS affected countries and 62 Zika affected nations. The solution was later expanded to include cholera, plague, Ebola, Lassa fever, and Zika virus in the scope.

FIGURE 36: Text messages sent to at-risk travelers (Nov. 22-28, 2016)

	Nov. 22	Nov. 23	Nov. 24	Nov. 25	Nov. 26	Nov. 27	Nov. 28
Sent to those arriving in contaminated countries	5,045	4,623	5,129	5,011	4,489	4,636	4,751
Sent to those returning to Korea	3,458	3,363	3,336	4,312	4,326	4,927	4,740

Source: KT

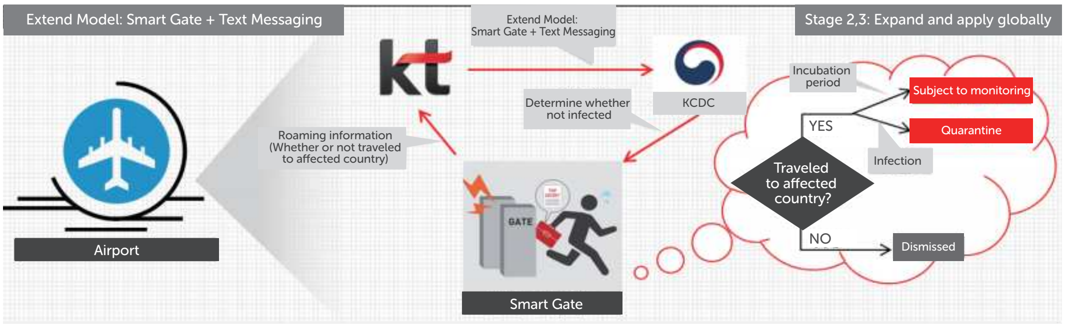
Over 10,000 text messages (5,000 for those arriving in contaminated countries, 5,000 to those returning to Korea) are sent daily to at-risk travelers. The number of messages per day reached nearly 20,000 during the time Zika virus was on the monitoring list until January 2018. Information on approximately 5,000 at-risk travelers is collected and provided each day for quarantine purposes, with Smart Quarantine service provided to a daily average of 245 travelers who return through third, unaffected countries after visits to contaminated regions

3.3.2.4 Future Plans: Applying Smart Gate

Although the Smart Quarantine system already sends out text messages, KT is currently reviewing a Smart Gate model as part of its efforts to build a more effective model to prevent epidemics. The existing model is limited by the fact that the necessary data can't be pulled if the traveler decides to use a local USIM card at the travel destination. Moreover, the number of non-roaming users is expected to increase from its current 20% due to the inexpensiveness of foreign USIM cards and growing use of portable Wi-Fi devices. Consequently, greater importance is being placed on the Smart Gate model.

Smart Gate is a solution that alerts quarantine authorities of phone calls or data usage from mobile phones used in contaminated areas when the traveler returns home and passes the gate with the phone in possession.

FIGURE 37: KT's Vision for Smart Gate + Text Messaging Model



Source: KT

Smart Gate uses handover technology that takes place when mobile devices move and switch base stations. A femtocell (a small base station) would be installed inside the gate, and the roaming data history will be collected from a returning traveler's phone as they pass the gate, as per the prior approval of the government. Based on the information collected, government authorities will be provided information about whether the traveler has visited an affected region, while the traveler will be sent precautions about infectious diseases. Since the model uses the transmission of 3G, LTE, or other cellular network already installed on the phone, rather than functions like Wi-Fi, Bluetooth, or NFC, mobile devices will be recognizable without any input from users as long as the power is on. This technology was demonstrated at the KT booth at MWC 2017.

3.4 Social Data Based Epidemic Information Service

3.4.1 [HealthMap] Real-Time Epidemic Information App

3.4.1.1 Background

Infectious diseases are spreading further than ever before in the modern era. Thus borderless disease response measures beyond existing surveillance systems are becoming necessary, and easy accessibility to disease information growing in importance to allow citizens to take part in awareness raising activities in addition to the efforts by the government. In this era when smartphones have become the most important source of information, disease information services have evolved into the form of mobile applications. Disease information apps have great accessibility, and app users around the world provide disease information and contribute to the globalization of disease information in real-time.

Many advanced nations are strengthening medical information based surveillance systems. But considering the cost and time it takes to build medical information infrastructure, many epidemic prone nations don't have the proper surveillance systems or data sharing hubs. Many expected the development of internet and mobile to correct such imbalances. Data pouring out of news feeds, social media, and online discussion forums are being shared through the immediate, voluntary participation of citizens, and enable faster identification of the latest disease status than official reports by public institutions in countries where public health infrastructure is limited.

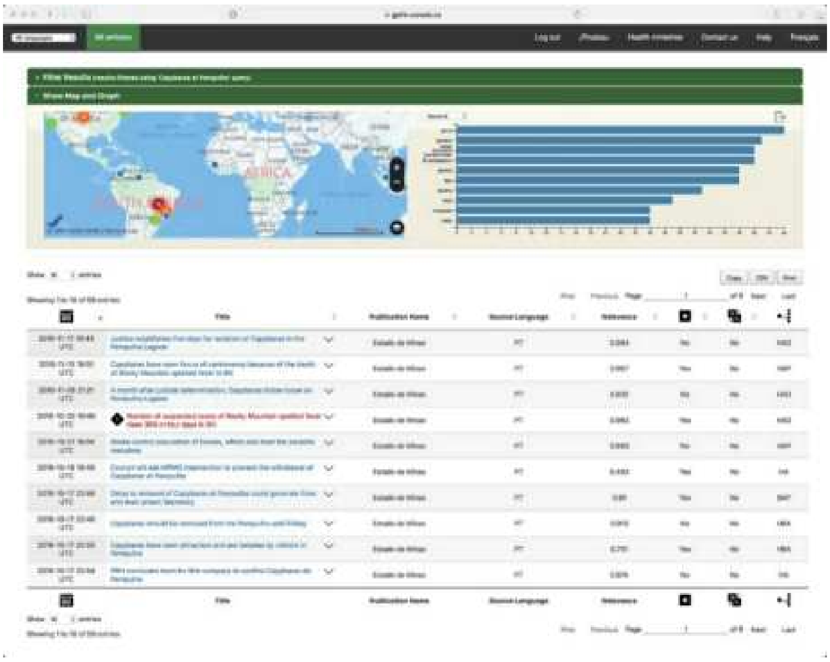
However, some voice their concerns that only data timeliness is increasing while the issue of data reliability remains unresolved. Since most social data is produced by non-experts, there is always the risk of putting citizens in greater danger by spreading information that is unfounded or has uncertain sources. As a result, there have been more examples of integrated disease information, where the timeliness of social data is leveraged by using it in combination with existing public health reports to resolve the sustained issue of data reliability. In fact, the first step to most confirmations of infectious diseases by WHO's Global Outbreak Alert and Response Network (GOARN) starts with social data.

3.4.1.2 Overview and Main System

HealthMap is an open service that aggregates and analyzes social data on infectious diseases and public health reports, and provides them free of charge to a diverse audience from public health workers to ordinary citizens. Disease information is available whenever, wherever through the very accessible mobile app. The primary objective of HealthMap is to provide disease information in real-time. The system monitors, organizes, aggregates, filters and visualizes online information about emerging diseases through an algorithm-based automated process to minimize the gap between timing of notification and the occurrence of disease to optimize real-time.

HealthMap has been in operation since September 2006. HealthMap isn't the first use of social media for disease surveillance. Canada's Global Public Health Intelligence Network (GPHIN) had attempted to detect infectious diseases through global news data.

FIGURE 38: Canada's Disease Surveillance System GPHINI



Projects like GPHIN had already been providing disease information to public health authorities, but not many services reached out to ordinary citizens. More services that enhance accessibility have emerged since ProMED began its web-based open information service. Among them, HealthMap used both web and app and received wide attention for combining automatic processing of extensive social data with abundant visual tools for users.

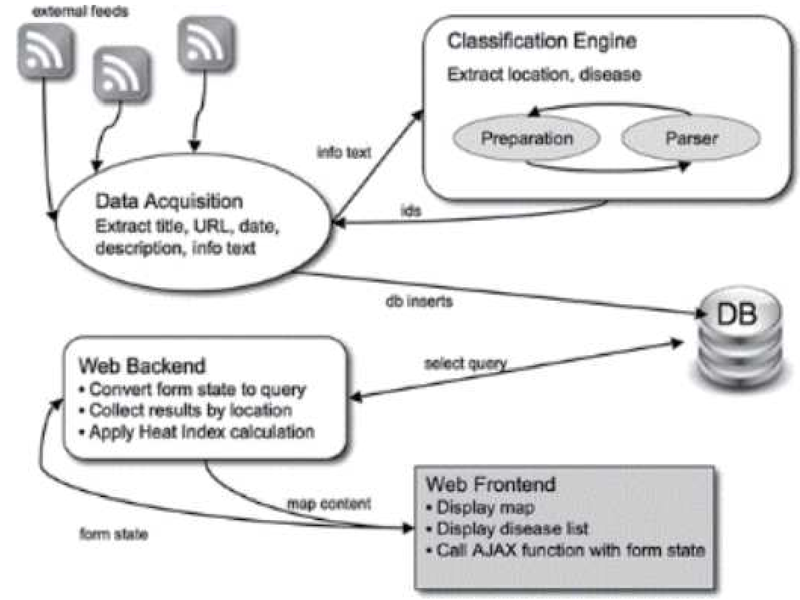
HealthMap focuses on facilitating the consumption of useful data from widespread regions without causing user fatigue through excessive information. To this end, the system should be able to collect disease data through an appropriate process, group the data properly, present the information through useful visualization tools, and handle high-usage situations.

① HealthMap's Data Collection and Filtering Process

HealthMap monitors global online news (i.e. Google News, Baidu) and reports by international health organizations (i.e. WHO) with the participation of 14 experts for more reliable data selection. Out of over 300 reports that HealthMap collects on an average day, news media makes up the highest percentage with 85.1%. In addition to English-language reports, HealthMap monitors reports from 15 language regions, including Spanish, Chinese, Hindi, French, Russian, Arabic, and Korean in an effort to ensure that disease information does not concentrate only on English-speaking regions but achieves geographical balance.

The collected data is filtered for validity through a series of automatic text processing algorithms. The following is the process through which data is filtered from the screen:

FIGURE 39: HealthMap's Data Filtering Process



The system groups the initial collected data based on location and disease type, and stores it into the database. The data is converted and stored in a form so that an appropriate value can be returned upon user's request, and geographic data and disease data are marked on the map solution to enable interaction with the user. HealthMap currently processes an average of 30 disease warning notifications per day, and over 1,000 per month.

② HealthMap's Map Based Visualization Function

HealthMap's visualization aims to optimize the balance between user interface and data collection in a flexible way. To this end, HealthMap allows users to customize the map and time series as they want to see them. The map-based interface allows users to intuitively identify disease outbreaks and status of dissemination around the world, unlike the quantitative data usually offered by public health authorities. The advanced search option includes filtering based on original report, date, disease type, and location, which makes it easy for users to visualize the disease information from different perspectives. The time-series view functionality displays the statistics for a specific disease in chronological order, which makes it easy for even non-experts to understand trends.

FIGURE 40: HealthMap Mobile App (left) and Website (right)

Users can create queries for frequently used searches on the map-based interface, leave comments on disease warnings, download research data, and receive updates on the latest warnings in a particular region. Users can also choose to receive only information from the query of their choice.

What makes HealthMap visualization more remarkable is the fact that it not only deals with human diseases but also animals, plants, insects, and other types of infectious diseases. HealthMap takes a multilateral approach to finding the cause of the diseases compared to existing surveillance systems, in line with the modern approach of One Health. This functionality allows users to identify any correlation between human diseases and animal or plant diseases by placing the information adjacently on the same map.

FIGURE 41: Animal Disease Information Displayed on HealthMap

As mentioned previously, HealthMap will leverage its internet and mobile based service to specialize in real-time disease service functionality. Public health experts and ordinary citizens alike can access the HealthMap website or the mobile app to submit real-time events for information missing from the HealthMap system, and the mobile app also accesses the user's location to display any nearby warnings or outbreak news.

3.4.1.3 Limitations: Data Bias

The very thing that sets apart HealthMap, its ability to scrap data from internet media, can sometimes act as a hurdle. As mentioned above, HealthMap combines social data with reports by public health authorities to enhance data reliability, but sometimes the social data itself can be biased in its quantity and quality.

In particular, news reports can lead to false conclusions when it comes to which diseases has spread the furthest or is the most dangerous. HealthMap looked at Google News for news articles on infectious diseases for 20 weeks (from October 1, 2006 to February 16, 2007) and a total 66 types of diseases were reported. It was found that the number of articles varied greatly for different types of diseases.

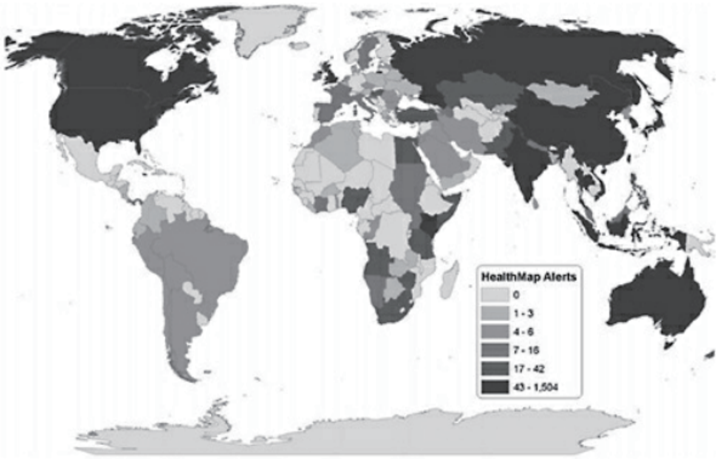
FIGURE 42: News Articles on Infectious Diseases for 20 Weeks ('06.10.01~'07.02.16)

Disease Type	Number of News Articles
Avian influenza	661
E. coli	492
Norwalk-like virus	242
Salmonellosis	217
Influenza	169
Dengue fever	133
Herpes	118
Cholera	81
…	…
Malaria	26

As demonstrated on the table above, news articles concentrated on avian influenza and norovirus. Such a skewed distribution can lead some to underestimate the dangers of lesser-reported diseases or vice versa. Such a quantitative bias can occur when media focuses on what the public wants to see, or reports on certain diseases are suppressed for social or political reasons. It is a phenomenon that takes place when interest on a certain disease escalates due to external factors, regardless of the actual risks or characteristics of the disease.

Data bias can also occur due to linguistic or demographic differences on social data. In fact, it was observed during a given period that HealthMap collected data from 88 nations, with most data coming from English-speaking countries such as the United States (1,346 cases), Canada (235 cases), and UK (226 cases). This can be attributed to the fact that HealthMap's early data source relied on Google News U.S. Data is biased not only in U.S., Canada, and U.K. but also in other English-speaking nations around the world. In addition to language, population (especially in China), diversity of media, and development of internet infrastructure can also have an impact on data bias.

FIGURE 43: Distribution of HealthMap Alerts by Country



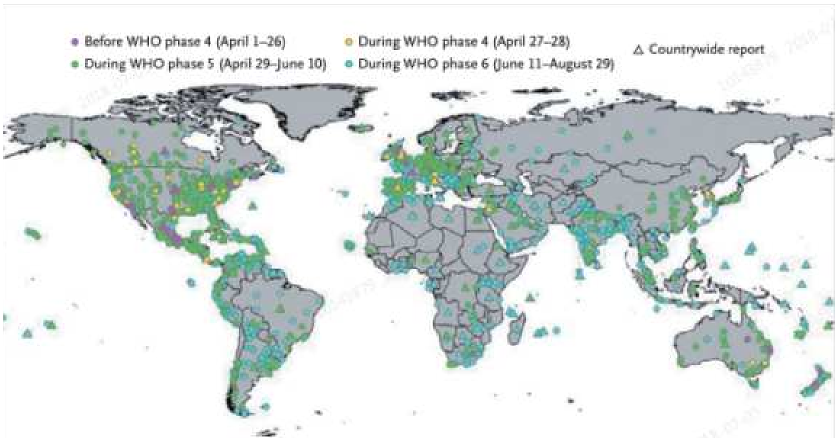
Data bias becomes a problem when we are unable to collect real data from the disease affected nations or regions. As seen in the figure above, warnings in the African and Latin American region were the least frequent on HealthMap. HealthMap continues to improve its service by collecting data not only from news sources but also social media, blogs, and online discussion forums, and adding more languages for data to be collected.

3.4.1.4 Accomplishments and Future Directions

As the hub of information on infectious diseases, HealthMap provides data to medical experts, regional health institutions, governments, and international organizations like the WHO. More than 1 million people visit the HealthMap website every year, and over 20,000 people (unique) visit on a monthly basis. Non-standardized data that were previously difficult to collect and analyze, combined with standardized data provided by public health institutions, is creating a synergy effect for HealthMap to contribute to the identification of disease spread status in real-time and the devising of response measures.

During the H1N1 influenza outbreak of 2009, HealthMap formed a partnership with the New England Journal of Medicine for real-time tracking and status alert of the disease and built an interactive H1N1 map in the system. Again leveraging its strength of the combination of social data with data by public health institutions like WHO and CDC (mostly relying on WHO), HealthMap focused on updating H1N1 information. While the disease was spreading[29], HealthMap collected and analyzed a total of 87,000 reports (43,700 during the 1st wave, 43,300 during the 2nd wave). As a result, the first suspicion of H1N1 took as little as 9 days to confirm, contributing to rapid measures to curb the spread of the disease.

FIGURE 44: Distribution of H1N1 Reports on HealthMap



For HealthMap to make further advances in the field of disease management, mid to long investments must be made in an area of machine learning that focuses on advanced text processing technology. A prime example is fuzzy matching technology that enhances matching results and filters collected data and natural language processing technology for data scraping. In the short term, HealthMap's data needs to be shared and integrated with other disease management systems. Such collaborations are already taking place with GPHIN, Argus, and ProMED, but multilateral cooperation is also needed to obtain data from LMIC.

3.5 Mobile Notification Infra Development

3.5.1 [Ericsson] Mobile Communication Support for Healthcare Personnel

3.5.1.1 Background

The application of smart phones and mobile technology in the health sector has the potential to improve the quality of healthcare as well as shift behavior to strengthen prevention, all of which can improve health outcomes over the long term.

Mobile technology has experienced rapid technical development, increasing network coverage, and an exponential increase of cell phone user rates all over the world. According to June's 2017 Ericsson Mobility Report, there are around 5.2 billion subscribers globally compared to 7.6 billion Mobile Subscriptions – growing at around 4% year-on-year.

Mobile networks have brought voice and internet services to billions of people over the last 25 years. At the current trajectory, mobile broadband will provide network coverage to around 95% of the world's population by 2022.

The mobile industry has a great potential to deliver life-saving information even in the most remote and resource poor areas in developing countries. Additionally, it offers an effective contribution to public health initiatives in support of achieving health outcomes related to the Sustainable Development Goals (SDGs) while being economical, effective, and sustainable.

The use of mobile technology creates points of contact between consumers, healthcare workers, health system administrators, and companies in supply chains for health commodities. The benefits of mobile technology, combined with the improvement in mobile phones features handling data privacy and data integrity, make mobile phones a feasible method of data collection that could result in enormous benefits as it is more widely deployed e.g. with Community Health Workers (CHWs) in Africa.

3.5.1.2 The Challenge

The Ebola outbreak in West Africa during 2014 was severe, both in the number of cases and human fatalities. The doctor to patient ratio, limited medical treatment facilities, and a lack of education on the preventative measures of this disease, contributed to the disease spreading at a fast pace.

3.5.1.3 The Solution

In the mobile industry, Ericsson and GSMA have engaged with the World Health Organization (WHO), World Bank, MNOs, and Jeffrey Sachs's Earth Institute of Columbia university to mobilize the required support of Mobile Network Operators in support of the outbreak of Ebola in Guinea, Liberia, Nigeria, and Sierra Leone, as well as Ghana, where the UN mission was established.

Ericsson has been a long-term partner to the Community Health Worker issue, supporting the Earth Institute and partners since 2007 launching the first ever mobile phones for health initiative in the Millennium Villages.

Ericsson Response is a global initiative that supports UN and humanitarian agencies with emergency telecoms support as a leading partner of the UN Emergency Telecom Cluster (ETC). During 2014, Ericsson Response volunteers continued to assist humanitarian agencies in missions including: the aftermath of the devastating typhoon in the Philippines; assisting aid workers in Internally Displaced Persons (IDP) settlements in both South Sudan and Iraq; as well as engaging in the Ebola response to help community health workers with ICT, often on the frontline during disease outbreaks, to do their job more effectively and link the rural poor to the broader healthcare system.

During the Ebola outbreak, one of the short-term deliverables was to support some 40,000 Community Health Workers (CHW) in the affected countries with mobile devices (smartphones), while at the same time supporting UN and humanitarian workers with emergency telecommunications support - the basis to build a real time information system for national and local response teams, one of the different ways how mobile technology can improve quality of healthcare.

A joint work was done with Sony to supply the devices and while Ericsson internal employees were volunteering to preload them with healthcare apps that were recommended by the Earth Institute like a survey management tool (FormHub formhub.org) and a patient record tracking tool (CommCare www.commcarehq.org).

3.5.1.4 The Result

① Guinea

Ericsson sent smartphones on request from the Earth Institute that was coordinating with the UNICEF on the ground. The preloading was done by Ericsson volunteers before shipment.

② Liberia

Ericsson sent smartphones on request from the International Rescue Committee (IRC). Apps were preloaded in all phones with FormHub, CommCare, as well as additional service apps that have been requested by IRC (i.e. Magpi).

③ Sierra Leone:

Additional smartphones were sent to IRC in Sierra Leone with the same configuration as in Liberia.

In total, Ericsson donated 2000 smartphones and configured them with healthcare apps at Ericsson premises before shipment to the UNICEF in order to be distributed to the community health workers in West Africa.

3.5.1.4 Emergency telecoms in West Africa with Ericsson Response:

To support Ebola relief efforts in West Africa, Ericsson Response has been requested to support the UN Emergency Telecommunications Cluster and their role in the UN mission in Ghana and Senegal, as well as support connectivity in common operational areas in Sierra Leone, Ghana and Guinea.

The deployment of Ericsson Response volunteers with some 15–20 of our WIDER (Wireless LAN in Disaster and Emergency Response) solutions have supported up to 65 sites in West Africa, including over 100 emergency treatment centers and connecting thousands of humanitarian workers to the Internet.

DHL has also offered to clear and transport the phones free of charge.

3.5.2 [GSMA] Mobile Information Notification System for Citizens

3.5.2.1 Background

Since the outbreak of Ebola, there has been an urgent need for a standardized and endorsed mobile response which will effectively address the requirements of governments and populations within all affected countries.

The GSMA, through its Mobile for Development mHealth and Disaster Response programs, has developed the Ebola Mobile Response, comprised of three phases and which is replicable across countries. This document sets out the response in the form of a blueprint for Phase 1. Guidance on the other phases will follow. Operators are encouraged to use this guidance for immediate activation of a response or to supplement work already started.

FIGURE 45: Three-phase approach

	Propsed activity
Phase I	Priovide a mibile based information product with credible, validated and endorsed local content, approved by WHO, that links to country specific response protocols
Phase II	Priovide anonymised data from mobile operator call data records (CDR) for disease tracking and respose
Phase III	Priovide Health worker mobile based services customised for each country needs

The GSMA seeks to assist Ministries of Health and other government agencies to activate the required support of mobile network operators in 5 countries, by providing their network platforms for a coordinated and effective response to the current Ebola outbreak. These countries are Guinea, Liberia, Nigeria, Senegal and Sierra Leone. This intervention is also extended to other West African countries along with high risk countries. This work is being facilitated by the GSMA with international support and public relations from the World Bank and the World Health Organization. The work of the Mobile for Development mHealth program and its Pan African mHealth Initiative (PAMI) has been funded by UK aid from the Department for International Development (DFID), and by the Norwegian Agency for Development Cooperation (Norad).

3.5.2.2 Guidelines for providing a mobile-based information product

Mobile technology provides several channels through which mass dissemination of information can flow. The technologies proposed below have the widest possible reach, as they are compatible with any GSM capable mobile handset, including all basic phones.

① Mobiletechnologychannels

- **SMS**

Short Message Service, restricted to 160 characters (reduced to 140 characters when a non-Latin character set is used). SMS has the ability to reach almost all subscribers and track the number of users that actually receive the message.

- **USSD**

Unstructured Supplementary Service Data, which allows for on-demand interaction with a mobile service, typically navigated through using on-screen menus. USSD allows a user to select and access information, which the system displays either on screen or via SMS. It can also be used to access a voice service.

- **IVR**

Interactive Voice Response, which is also a menu driven system like USSD, except that prompts and instructions are provided using recorded audio/voice clips. A user then responds as instructed in order to access further information. The final selection is either to listen to an audio recording or to receive an SMS.

FIGURE 46: Benefits and limitations of selected channels

Channel	Benefit	Limitation
SMS	- Fastest deployment - Low resource requirement - Common or widely used	- Visual impairment and/or literacy levels can be a hindracne - Limited to 140 characters
USSD	- Interactive and real time - Allows access to more information than SMS - Menu for choice of options	- Limited to 160 characters - Has a time limit of about 1 minute for response, and 3 minute per session (depending on network configuration)

IVR	- Natural interface (voice) - Highly customizable (accent, language, nuances) - Menu driven	- A user has to listen to the complete introduction to be aware of options available - Requires a human resource to create audio recordings - Hearing impairment is a challenge

② Non-technologicalconsiderations

- **Language and context:**

  in addition to the above limitations in technology, a mobile messaging response requires that messages be available in a language that is understandable. When targeting an entire population such as mobile operator subscribers or national population, it is important that messages be available in languages that can reach the widest population possible. As it is not always possible to translate to ALL local languages and contexts, the languages chosen should provide for the widest possible reach.

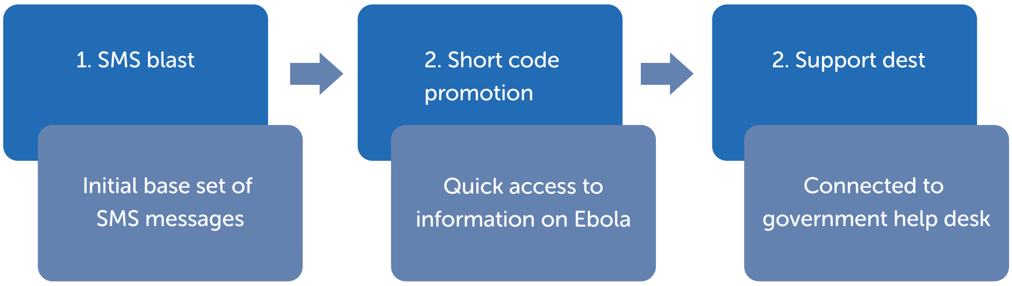
- **Response mechanism:**

  creating widespread awareness in a population may also require information on where to seek further guidance/assistance or report suspect cases of Ebola. Ministries of Health should consider setting up a call center/customer care desk at national, regional, district, or hospital level, in line with available resources.

- **Enabling quick and free access by all citizens:**

  the government's mobile industry regulator, in conjunction with the Ministry of Health and mobile operators, can enable the allocation of a national emergency zero-rated short code through which citizens in an affected country can access validated information, report suspected cases or seek treatment referrals.

FIGURE 47: Process of mobile-based information product



③ ProposedProductFeatures

The proposed emergency response initiative is designed to fulfil three functions:

- Facilitate countrywide dissemination of correct information on Ebola, by sending a set of relevant key messages to all mobile subscribers. This will help counter rumors and incomplete information, which currently result in irrational behavior and fear. Each country will identify the relevant key messages to be sent to the population.

- Provide access to further on-demand information on Ebola. USSD and IVR technologies will allow subscribers access additional information, beyond the standard set of text messages received via SMS blast. This will ensure that subscribers are not inundated with too much information via SMS, and provide a voice option via IVR.

- Provide a support desk. Where Ministries of Health have set up help desk facilities for Ebola management, mobile operators can provide access to these help desk facilities by patching through calls made to the allocated short code. This will allow users to enquire, report and or seek further assistance on Ebola.

FIGURE 48: Product illustration and user journey

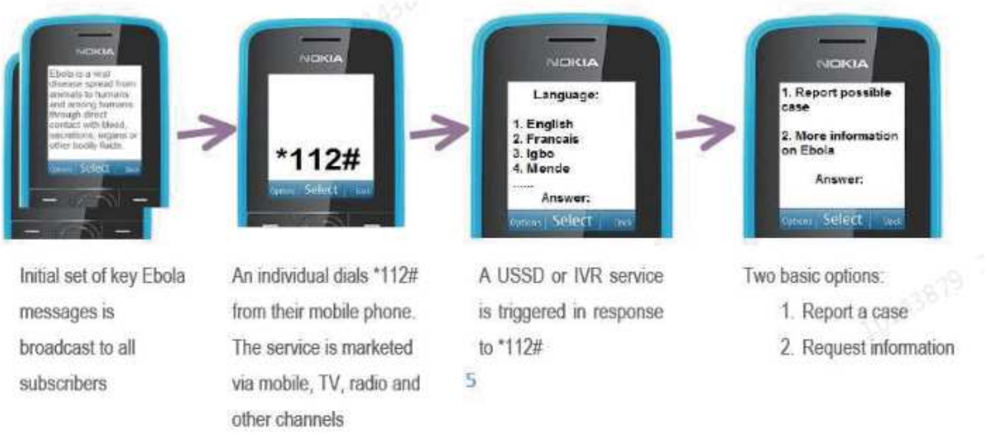
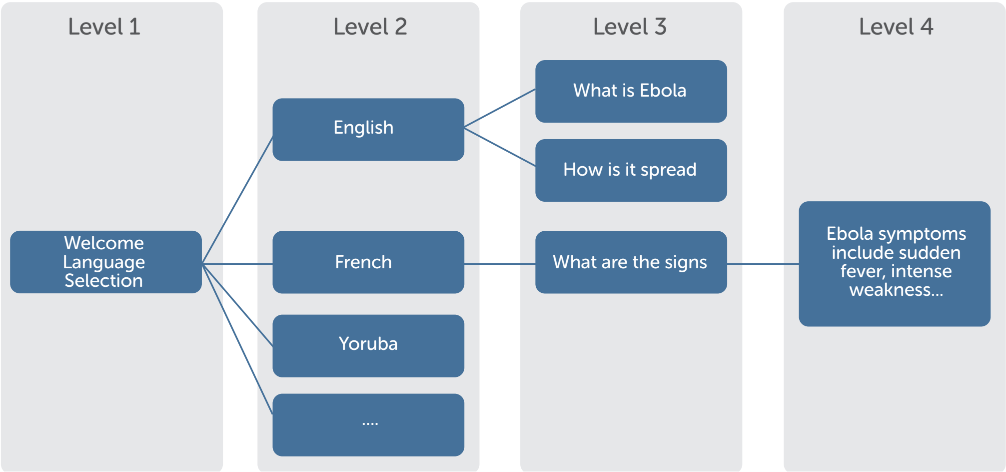


FIGURE 49: Suggested USSD/IVR service flow

USSD and IVR are both menu driven supplementary services available on GSM networks. A unified structure allows for consistent delivery of information via either channel. The following structure provides a template on which to base content for one or both channels.



3.5.2.3 Ebola content

The prevention and control of Ebola is very sensitive to the information provided about the disease. With the right information, citizens can help contain disease spread by avoiding risky behavior and identifying Ebola symptoms in time to seek medical support. Additionally citizens can engage in safe practices while handling Ebola suspects, thus further helping to reduce the spread within families and communities. While a lot of information is available in the public domain, on websites such as www.who.int and www.cdc.gov, much of the information reaching citizens is via newspapers, TV, radio, social media and SMS messages originating from other citizens, and can includes rumors, hear- say and outright myths and misinformation, which lead to the spreading of fear, stigmatization and risky practices. An example of a myth is bathing or soaking oneself in a tank of salt water to prevent Ebola infection. There is therefore a need for government approved messaging to counter misinformation and provide correct information on Ebola.

① Expected quality of Ebola key messages

Information available to populations must be:

- **Timely:**
  in countries already affected, messaging should be provided as soon as possible. In newly affected. Countries, this product can be launched within 48 hours of the detection of an Ebola case, to prevent further spread and dissemination of incorrect information.

- **Accurate and credible**:
  sourced from the WHO, and adapted for mobile messaging, language and context.

- **Approved by local authorities:**
  messages need be endorsed by local health authorities, as facilitated by the WHO as part of their effort to support government initiatives.

- **Reach critical mass of users in a short time:**
  use of mobile dissemination to reach a significant percentage of the population with consistent, correct information in the shortest time possible.

- **Be easy to understand and share:**
  WHO translation into local languages enables comprehension and mobile texts allow for recipients to share immediately.

② Expected quality of Ebola key messages

The following messages, adapted from the WHO's Frequently Asked Questions on Ebola and Ebola Fact Sheet, are formatted to fit within the 140 character limitations of SMS and USSD. Local languages may require more characters to communicate the same message, however as noted in the technology limitations 140 characters is the limit.

FIGURE 50: Adapted English messages on Ebola

	Type	Topic	Message	Character Count
1	Fact	What is Ebola?	Ebola is a viral disease spread from animals to humans and among humans through direct contact with blood, secretions or ohter body fluids	139
2	Fact	How is it spread?	Ebola is sored through direct contact with blood, secretions or other body fluids of infected animal or person or contaminated environment	139
3	Fact	How can I avoid it?	Avoid touching body fluids (blood, secrdtions) of any sickly person or contaminated items. If you suspect Ebola, seek medical help at once	139
4	Fact	What are the sings? *visible	Ebola symptoms include sudden fever, intense weakness, muscle pain, headache, sore throat followed by vomiting, diarrhoea and rashes	133
5	FAQ	Who is at risk?	Health worker and close family members are most at risk or infection. They must avoid contact with body fluids or secretions of sick person	140

	Type	Topic	Message	Character Count
6	FAQ	How ling dose it take?	Symptoms appear 2-21 days after infection. Anyone showing signs is contagious and should seek immediate medical assistance to avoid spread	140
7	FAQ	Is it airbome?	Ebola isnot air borne. It only spreads through contact with body fluids or secretions of sick person, or contaminated clothes, bed sheets etc	139
8	FAQ	Can you get it from clothes and utensils used by sick person?	Yes. Ebola viral disease can be spread through contaminated environment such as bed sheets, clothes and utensils	110
9	FAQ	Should I seek medical attention?	If you have been in an area or in contact with a person suspected to have Ebola, you must seek medical attention immediately	125
10	FAQ	Can it be treated?	Ebola currently has no known cure or treatment. With proper timely medical care, some people have recvered from illness	121
11	FAQ	Can it be controlled?	Ebola can be controlled by isolating those suspected or confirmed to have Ebola and using strict infection control precautions	127
12	FAQ	Where can I get help?	For help, please contact you nearest health facility. If you suspect you have been infected, alert health worker immediately	125

3.5.2.4 PR and marketing guidelines

In many scenarios, Ebola messaging will likely be launched on a humanitarian basis by government and concerned mobile operators. It may also be launched as a disaster response mechanism and thus while the term “marketing” is applied above, the context on the ground may be more of “dissemination” or “communication” guidelines and strategies.

If the messages sent are to have a real and swift impact on the spread of Ebola, it is of the utmost importance that those messages are trusted by subscribers. The promotional activities and channels chosen will depend on the availability of funding within government for crisis communication, as well as private sector budgets that can be availed to support the initiative.

① Communicationactivities

- **Launch:**

  a press statement or briefing by the Ministry of Health, together with partners (the WHO, mobile operators) should be arranged where possible, in order to give credibility to the information campaign. Alerting the market/consumers/citizens of the upcoming campaign, official short code being used and what to expect will create a trust relationship and an acceptance of the information. Example: “Ministry launched Ebola 112 information campaign” or “Ebola 112! Let us fight Ebola Together! Dial *112# for Free information”. Ministry of Health partners are also encouraged (funding allowing) to launch communication campaigns in support of the initiative. These could be through sponsored media spots, radio campaigns and even print media where possible. Mobile alerts should be limited to probably one prior to the messaging campaign commencing. This will reduce the sensation that too many messages are being sent to subscribers.

- **Supplementary messaging:**

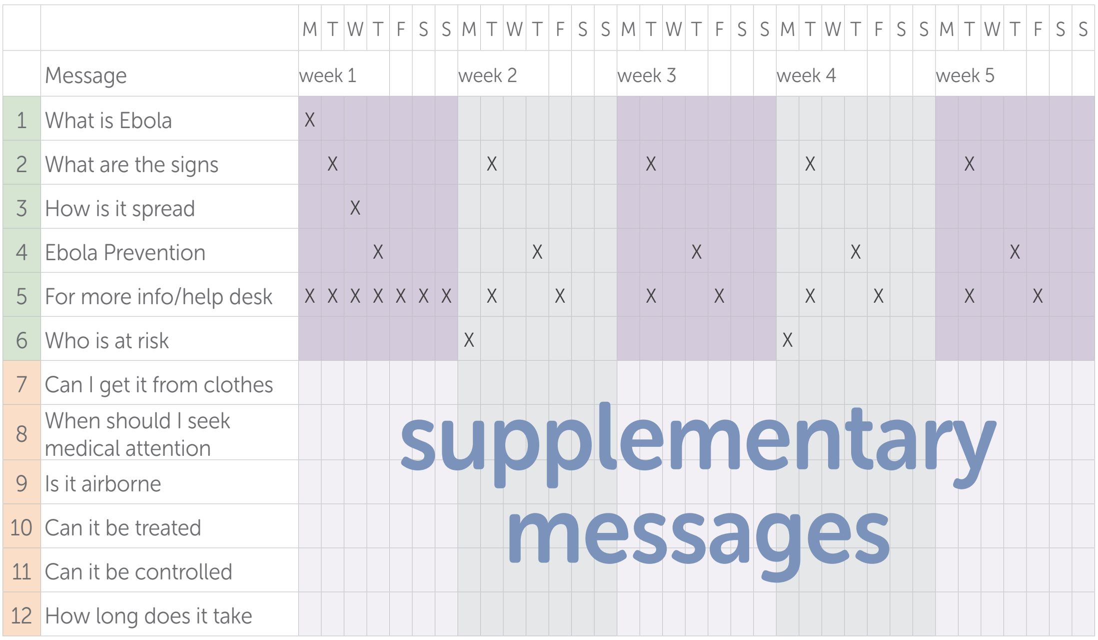
  for mobile operators and governments that have already been sending messages, promotion of the USSD/IVR service for users to access information is preferred. This avoids confusion between previous messages and new messages, and allows users to access the same and additional information on Ebola on demand. If any information gaps are identified between messages previously sent and the approved set of messages, operators are encouraged to send text messages with the additional key message. The rest should be made available through on demand channels.

- **Help line:**

  where in-country resources allow and a helpline desk exists, a common message should be broadcast at least once a week (resources permitting) detailing the number to call to get in touch with authorities. This will ensure that citizens know what steps to take should they come across a suspicious illness.

② MessagingFrequency

FIGURE 51: Suggested messaging frequency



		M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
	Message	week 1							week 2							week 3							week 4							week 5						
1	What is Ebola	X																																		
2	What are the signs		X							X							X							X							X					
3	How is it spread			X																																
4	Ebola Prevention				X							X							X							X							X			
5	For more info/help desk	X	X	X	X	X	X	X		X			X				X			X				X			X				X			X		
6	Who is at risk								X														X													
7	Can I get it from clothes																																			
8	When should I seek medical attention																																			
9	Is it airborne																																			
10	Can it be treated																																			
11	Can it be controlled																																			
12	How long does it take																																			

The proposed messaging frequency allows for an intense structured campaign within a limited time frame to avoid message fatigue or the reduction of impact. All messages should be available on a supplementary basis, and accessible through the advertised short code. Total messages per subscriber within 5 weeks is 29. The above is a suggested frequency. Based on impact and how affected a country is, the Ministry of Health and mobile operators can agree to have a more intense campaign or send less mandatory messages to subscribers.

Endnotes

[16] Information provided in this document is based on the information available at: http://www.pacifichealthsummit.org/downloads/HITCaseStudies/Functional/MBDS.pdf

[17] Daily(H1N1/H5N1, AFP, SARS, Cholera/Severe Diarrhea, Encephalitis, Tetanus, Meningitis, Diphtheria, PHEIC), Weekly(Leptospirosis, Chikungunya, Dengue Fever, Typhoid Fever, Measles Fever, Typhoid Fever, Measles), Monthly(Malaria, Pneumonia), Quarterly(HIV/AIDS, Tuberculos)

[18] The forms were developed through consensus by MBDS participants.

[19] ASEAN countries: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. Plus-3 countries: China, Japan, and South Korea.

[20] Pacific Disease Surveillance Network (PACNET).

[21] Regional Office for South-East Asia (SEARO) and Regional Office for the Western Pacific Region (WPRO)

[22] UN Children's Fund (UNICEF), UN System Influenza Coordinator (UNSIC), and UN Office for the Coordination of Humanitarian Assistance (UNOCHA).

[23] Information provided in this document is based on the information available at: https://www.itu.int/en/ITU-D/Emergency- Telecommunications/Pages/BigData/default.aspx and the project information at: https://www.itu.int/net4/ITU-D/CDS/projects/display.asp?ProjectNo=7RAF15087

[24] PNR(Passenger Name Record): Flight information record that includes passenger name, airline or travel agent, ticketing details, ticket number, expiration date, etc.

[25] DUR(Drug Utilization Review): A system to support prescribing and dispensing of medicine. Provides real-time information to healthcare provider and pharmacist via a computer screen on safety-related matters, such as medicine that could cause side-effects when taken together, etc. to prevent improper use of medication.

[26] Verification of personal information takes places within the scope of the Infectious Disease Control and Prevention Act

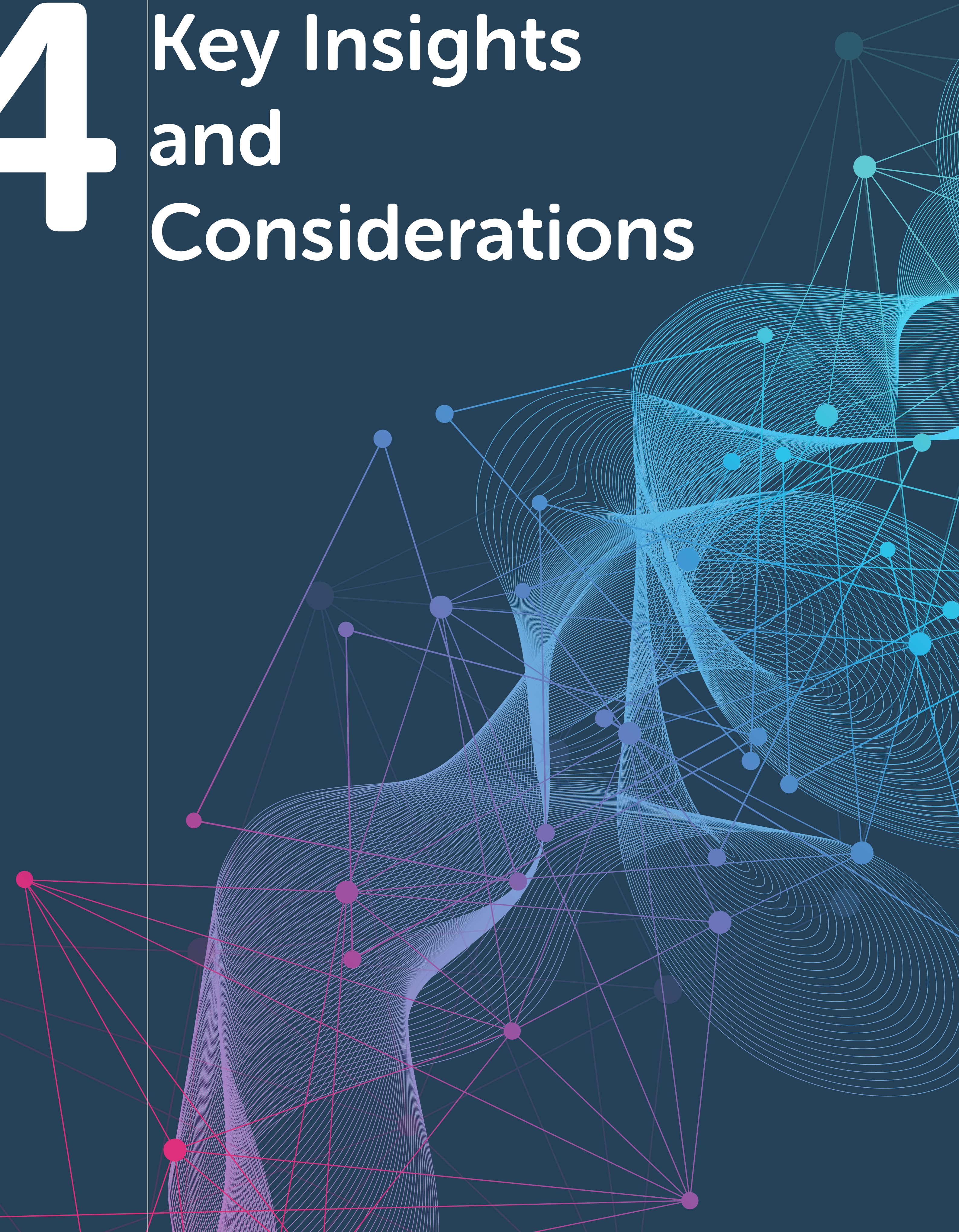
[27] HLR (Home Location Register) is a database that receives the real-time location information of subscribers.

[28] The Quarantine Act stipulates that anyone who travels to a country contaminated by an infectious disease is obligated to report the visit. In accordance with Infectious Disease Control and Prevention Act, quarantine authorities have the right to receive personal data of anyone who travels to a contaminated region without their consent on use of personal data. Therefore, KT's solution does not violate privacy and the system targeting travelers to contaminated regions using communication data is deemed lawful. However, for the sake of transparency in the use of personal data, notifications will be provided to all persons when quarantine authorities collect their personal data.

[29] 1st wave of H1N1 is April 1 – Aug. 29 of 2009; 2nd wave is Aug. 30 – Dec, 31 of 2009.

4

Key Insights and Considerations



4.1 Personal Information and Privacy

As previously discussed in detail, ICT solutions based on big data are drawing much attention as the most promising technology in fighting epidemics. Big data is already contributing to preventing the spread of epidemics as well as treating various diseases. For instance, a big data analysis was carried out in Japan for an accurate diagnosis of a patient who had been failing to recover for several months by combining 20 million cases of medical journals and the patient's genetic data. The analysis led to finding a new method of diagnosis and made critical contributions to the complete cure of the patient.

Despite such positive effect of big data, however, there are also risks of privacy violations in the process of data collection and utilization due to the related 'digital footprint'. For example, the use of roaming data, which is being actively discussed as a means to fight epidemics, could disclose private information such as nations or regions visited, schedules, and even personal tastes which people might not like to be disclosed to others.

In order to allay concerns over the use of personal information regarding the collection and utilization of roaming data, the exact scope and purpose of use, which in this case is the tracking and prediction of epidemics, should be informed and in accordance with relevant laws and regulations. In addition, concerns about data collection should be resolved by informing that there will be a clear storage period, after which the data will be discarded, for example, at the end of a disease incubation period and that the collected data will be safely stored and managed. In Korea, the authorities send an SMS to inform the information providers with the guidelines on the use of personal information and the legal grounds for data collection.

<REFERENCE> Example of an SMS sent to the visitors to countries affected with epidemics outbreaks

Hello, this is the Korea Centers for Disease Control and Prevention (KCDC).

This text message will be sent three times in the next 14 days to those who have recently visited Middle Eastern countries. **If you develop a fever or respiratory symptoms within 14 days of entry to Korea, please call 1339 (KCDC call center) or report to a close public health center** for more guidelines instead of visiting a medial institution. We sincerely ask for your active participation. Thank you.

※ According to Article 76(2) Paragraph 5 of the 'Epidemics Prevention and Management Act', **your record of overseas travel will be shared with medical institutions as a reference for treatment. Relevant information will be used for epidemics prevention purposes only and be discarded immediately after the disease incubation period (14 days).**

※ Source: Press release material by the Korea Centers for Disease Control and Prevention under the Ministry of Health and Welfare (Apr. 20, 2017)

More recently, due to the increasing speed and scope of the spread of epidemics, a greater volume of personal information is required to enhance the effectiveness of response. As discussed in the case of Google in Chapter 2.3, the more types and volumes of data we have to be analyzed, the higher the chances become to prevent epidemics in advance. However, the need for a greater volume of personal information means that there could be greater concerns over privacy violations.

For example, it is possible to manage data if a traveler uses roaming data, but it is hard to check relevant information if he or she uses a local USIM card or rents a Wi-Fi roaming device. To address this issue, expanding the scope of data collection and analysis from the roaming data of a cell phone to the IMEI (International Mobile Equipment Identity) is being considered because, even without using roaming data, using one's own cell phone overseas will allow the authorities to check whether the traveler stayed in a country infected with epidemics. Also, to be prepared for the case where a traveler chooses not to use a cell phone at all, there is a need to use additional data such as credit card usage in overseas countries for analysis.

However, IMEI data or credit card usage information is considered to be sensitive personal data, so the collection and utilization of such data should be handled responsibly only to prevent and respond to epidemics while also sustaining user trust. The data to be used should also be limited to activities that occurred in an area with an active outbreak. In addition, the information to be collected should be limited to only the country information, and not include records of calls and mobile data usage, the amount of credit card purchases, or the items purchased, so as to strictly protect personal information. Furthermore, to remove the possibility of information leakage, measures to reassure data providers need to established, just as KT is using the latest, highly secure technology for personal data storage such as Block Chain, and such technological security needs to be informed to those who provide personal information.

At a time when annual damages resulting from global epidemics amount to 60 billion US dollars[30], identifying all the countries visited by travelers to allow prompt response through big data analysis will be the smartest and most innovative way to utilize ICT in safeguarding public interests.

4.2 Sharing Data to Fight Epidemics

Nowadays, epidemics extend beyond the efforts of a single country. We are now witnessing much more severe damages resulting from the fast speed and increasing scope of the spread of epidemics, which ultimately threatens every country around the world. For instance, at the time of the MERS outbreak in 2015, the country that had the second largest number of MERS infectees after Saudi Arabia, the origin country, was not one of the nearby Middle Eastern countries but Korea, which is located in Northeast Asia, far away from the origin. Even though the MERS outbreak occurred in Korea 3 years after the first outbreak in Saudi Arabia in 2012, Korea suffered from huge damages with a death toll of 186.

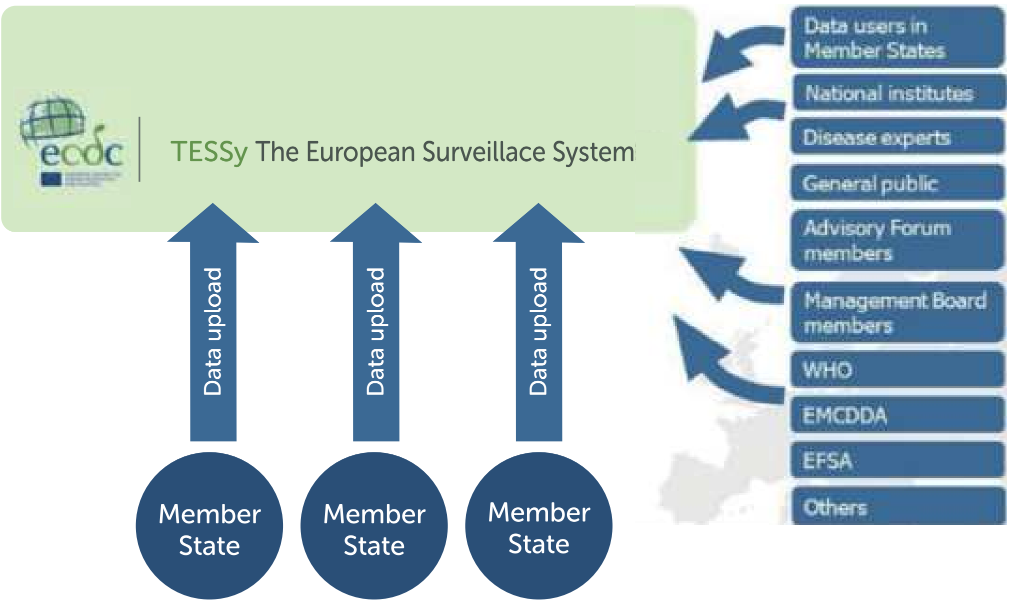
Amidst these circumstances, it is becoming increasingly important for countries to share data with an aim for fighting epidemics. Some countries which fast realized the need for cooperation on data sharing have continuously expressed that there is a need for the opening and sharing of epidemics-related data and the surveillance and response system to the extent that does not threaten national security of respective countries, and are actively joining hands to eradicate epidemics.

But there are not many zones of countries around the globe which have successfully built a data sharing and joint response system optimized for the current patterns of epidemic spread. The European Centre for Disease Prevention and Control (ECDC) of the European Union is a great example of building a cross-border data sharing and surveillance system and successfully coping with epidemics.

The EU zone is characterized by the fact that many countries are located in the region. Therefore, the EU historically had a high level of awareness toward cross-border cooperation when it comes to the issues of epidemics, and nowadays, the ECDC[31] is leading the efforts to fight epidemics by establishing mid-to-long term strategies for joint surveillance. After establishing the first mid-to-long term surveillance strategies in 2005 when the organization was created, the ECDC is carrying out its third surveillance strategies for 2014-2020 with an ultimate goal of strengthening its data-based surveillance system. 6 major tasks to achieve the goal are as follows: ①Develop surveillance standards, ②Improve data quality, ③Enhance surveillance capabilities, ④Secure access through practical use of surveillance data, ⑤Reduce the cost and time of data processing, and ⑥Provide scientific grounds for timely judgement of a situation.

The ECDC has the "Surveillance Atlas of Infectious Disease", a web-based surveillance data tool that allows EU member states to visualize epidemics data in various manners such as map, diagram, trends by time, dispersion, and table based on surveillance data of 25 types of epidemics. Based on the tool, the ECDC is operating the European Surveillance System (TESSy), an epidemics surveillance system based on data indicators. The TESSy is a 'One-Stop Shop'[32], through which EU members can access and upload information on 52 types of epidemics, playing a pivotal role as an integrated data system in monitoring the outbreaks of epidemics in the region and responding to the spread.

FIGURE 52: One Stop Shop structure of TESSy as an epidemics surveillance system



Source: ECDC

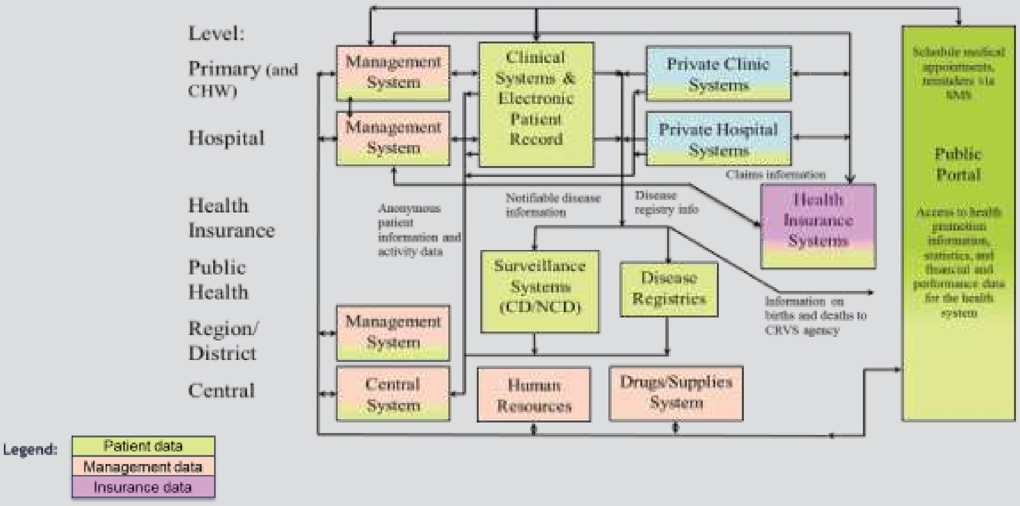
More insight from an external expert: a key success factor at this level of care is a standardized platform

A key success factor at this level of care is that the technologies and platforms used for epidemic

detection should essentially be the same with those being used for regular clinical work. This means that a standard platform should be used, which incorporates the electronic patient/health record (EHR), clinical decision support system, and laboratory order entry functions. However, if a notifiable disease is indicated, the platform must include the capability to immediately send a notification to the appropriate agency responsible for disease surveillance, and to refer the blood or tissue samples to the appropriate reference laboratory for confirmation. This notification should include the location of the facility, the home location of the patient (including GPS coordinates for each if possible), plus identifying information for the patient (ideally with biometric ID), and details of the suspected case, including case notes from the HER.

At the level of the disease surveillance agency, the systems and platforms need to be able to accept disease notifications from a variety of clinical locations (both public and private), track those that are yet to be confirmed (including tracking the relevant laboratory confirmation process), and collate the data from these different sources to determine where disease patterns exist. This process would determine whether cases are just isolated incidents or the beginning of an actual epidemics, and will likely require effective AI systems to analyze the patterns of disease (including geographic locations).

The schematic below shows how these processes fit into an overall digital health ecosystem.



A critical success factor from a data management perspective is the existence of a unique patient identifier, including biometric ID if possible. This will ensure that any notifiable cases can be appropriately tracked and monitored. It also means that the messaging between the systems at the clinic level, the surveillance agency level, as well as the reference laboratory level, should all be consistent, so that it is possible to exchange relevant information quickly and easily. While most information sent from health facilities would likely be anonymized statistical information (see above), it is important that patient identification information can be shared for notifiable diseases to facilitate subsequent monitoring and follow-up in terms of survival and/or long-term adverse impact. The inclusion of geographic coordinates is also a critical piece of information for assessing whether an emerging epidemic is in progress.

An important implication and success factor arising out of the requirement for patient identification information is the need for the inclusion of robust data privacy and confidentiality controls in the access and transfer of notifiable disease information. This would include the need for data encryption and appropriate data access controls at both the health facility and the surveillance agency level.

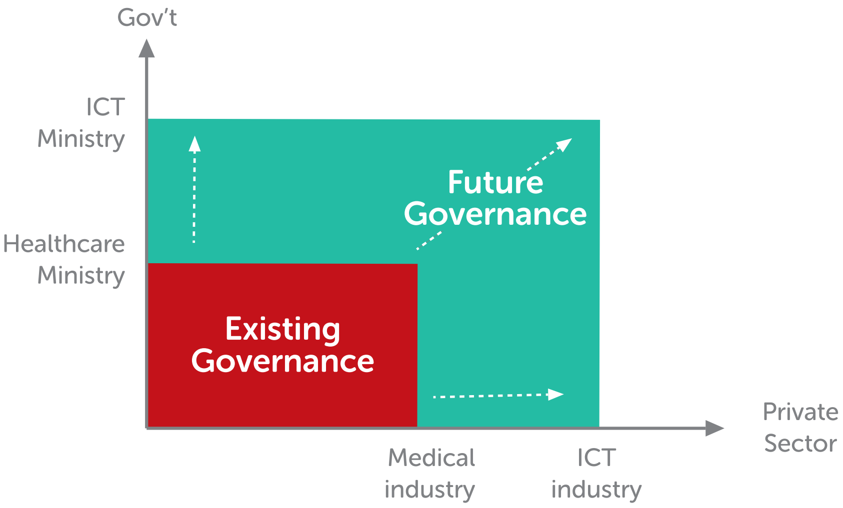
Dominic S. Haazen
- Lead Health Policy Specialist, The World Bank

4.3 Public-Private Partnerships for Smart Health

As the use and importance of ICT increases in the field of healthcare and medicine, the importance of cooperation is extending beyond public-private partnerships in healthcare. Now, the cooperation among Ministries and public-private partnerships to cover multiple fields such as ICT and healthcare are becoming increasingly important. ICT-enabled medical innovation is a newly emerging industry of ICT convergence, and pursuits by a single company or a government ministry to develop the industry takes time and could face limitations. In other words, to strengthen the governance that combines ICT with healthcare, the government needs to provide stronger policy support to achieve ICT and healthcare convergence, and companies need to provide relevant technologies and solutions to enhance social benefits.

The same goes to the application of ICT such as big data to the field of epidemic prevention. As previously discussed with Korea's example, establishing the world's first 'Smart Surveillance System' through cooperation between mobile operators including KT and the government represented by the KCDC is a case in point.

FIGURE 53: Ways to expand governance for the prevention of epidemic spread based on ICT convergence



In conclusion, in order for the two industries, ICT and medicine·healthcare, to converge with each other and transform into smart health services that provide greater benefits to the public, pan-government cooperation including the ICT Ministry and the Ministry of Health is a must. In addition, in the private sector, ICT companies and medicine·healthcare companies should pursue active collaboration to offset their respective weaknesses through the exchange of ideas and joint technical tests, to commercialize new ICT medical technologies. Ultimately, it is necessary to build governance based on public-private cooperation where all relevant ICT and healthcare players from the government and the private sector participate. The government should be responsible for building mobile networks, promoting cooperation among stakeholders to further develop new smart health businesses, enhancing its policy support and seeking cooperation in this field with other nations. And as for the private sector, companies should increase investment in new medical technologies and services and seek stronger collaboration with government entities and other relevant companies so as to prevent outbreaks of epidemics through the use of ICT, thereby making a big step toward tackling a longstanding challenge faced by mankind.

Successful establishment of smart health governance starts from breaking down the barrier between medical services and ICT. However, what is more important than the convergence between industries is the convergence between government departments.

"As explained in FIGURE 53, effectively responding to infectious diseases desperately needs chemical convergence of medical services and ICT. However, while there are many cases where private companies cooperate with each other for the purpose of achieving smart health, this is not the case for government departments. Currently, many countries are setting up a TF with the health department at the center when any infectious disease breaks out, and the health department is also playing a central role in sharing information related to infectious diseases among countries. It is true that technology-driven approach led by private companies is important. Nevertheless, for solutions to address infectious diseases based on advanced ICT to be further developed, making necessary policies and creating a national consensus are prerequisites. As a starter, it is necessary to consider the cooperation between the health authorities and departments related to ICT more importantly to effectively respond to infectious diseases."

Sok Puthyvuth
- Under Secretary of State in Cambodia MPTC (Ministry of Posts and TeleCommunications)

Endnotes

[30] The Commission on a Global Health Risk Framework for the Future (2016)

[31] The European Centre for Disease Prevention and Control of the European Union established in 2005

[32] A system that works as a single platform providing access to all of data and functions

5

Recommendations

5.1 Regulatory Approach: Public Health's Perspective

Considering that the damages resulting from epidemics can affect not only individuals but also a country as a whole, we should establish a policy and regulatory framework that allows for the collection and utilization of personal information, while respecting and protecting individual's privacy and so as to prevent epidemic emergencies.

A case in point can be found in Korea.

Korea is one of the countries that have the strongest regulations regarding privacy protection[33]. However, after the MERS outbreak, Korea revised relevant laws to enable the use of personal information only when necessary for the purpose of public healthcare. With the revision of 'the Epidemics Prevention and Management Act' in 2016, which added a new paragraph relating to the 'Request to Provide Information, etc.', it became legally possible to use roaming data to identify people who had visited the infected countries before entering Korea and to monitor them during the potential disease incubation period.

<REFERENCE> 'Infectious Disease Control and Prevention Act'[34] in Korea

Article 76-2 (Request to Provide Information, etc.) (1) If necessary to prevent infectious diseases and block the spread of infection, the Minister of Health and Welfare or the Director of the Korea Centers for Disease Control and Prevention may request the heads of relevant central administrative agencies (including affiliated agencies and responsible administrative agencies thereof), the heads of local governments (including superintendents of education prescribed in Article 18 of the Local Education Autonomy Act), public institutions designated under Article 4 of the Act on the Management of Public Institutions, medical institutions, pharmacies, corporations, organizations, and individuals to provide the following information concerning patients, etc. with infectious diseases and persons likely to be infected by infectious diseases, and persons in receipt of such request shall comply therewith:

1. Personal information, such as names, resident registration numbers prescribed in Article 7-2 (1) of the Resident Registration Act, addresses, and telephone numbers (including cell phone numbers);

2. Prescriptions prescribed in Article 17 of the Medical Service Act, records of medical treatment prescribed in Article 22 of the same Act, etc.;

3. Records of immigration control during the period determined by the Minister of Health and Welfare;

4. Other information prescribed by Presidential Decree for monitoring the movement paths of patients with infectious diseases.

(2) If necessary to prevent infectious diseases and block the spread of infection, the Minister of Health and Welfare may request the relevant head of the National Police Agency, regional police agency, and police station established under Article

2 of the Police Act (hereafter in this Article, referred to as “police agency”) to provide location information of patients, etc. with an infectious disease and persons likely to be infected by an infectious disease. In such cases, notwithstanding Article 15 of the Act on the Protection, Use, etc. of Location Information and Article 3 of the Protection of Communications Secrets Act, the relevant head of a police agency, upon request by the Minister of Health and Welfare, may request any location information provider defined in Article 5 (7) of the Act on the Protection, Use, etc. of Location Information and any telecommunications business operator defined in subparagraph 8 of Article 2 of the Telecommunications Business Act, to provide location information of patients, etc. with an infectious disease and persons likely to be infected by an infectious disease; and the location information provider and the telecommunications business operator in receipt of such request shall comply therewith, except in extenuating circumstances.

(3) The Minister of Health and Welfare may provide information collected pursuant to paragraphs (1) and (2) to the heads of the relevant central administrative agencies, the heads of local governments, the chairperson of the National Health Insurance Corporation, the president of the Health Insurance Review and Assessment Service, and such medical personnel, medical institutions, and other organizations as are performing tasks related to infectious diseases. In such cases, information provided shall be limited to information related to the tasks of the relevant agencies, etc., for preventing infectious diseases and blocking the spread of infection.

(4) No person provided with information pursuant to paragraph (3) shall use such information for any purpose, other than conducting tasks related to infectious diseases under this Act, and shall, without delay, destroy all information when the relevant tasks are completed and inform the Minister of Health and Welfare thereof.

(5) The Minister of Health and Welfare shall notify the relevant party as the principal owning information collected pursuant to paragraphs (1) and (2), of the following:

1. The fact that information necessary for preventing infectious diseases and blocking the spread of infection has been collected;
2. Where information prescribed in subparagraph 1 has been provided to another agency, such fact;
3. The fact that, even in cases prescribed in subparagraph 2, no information shall be used for any purpose, other than conducting tasks related to infectious diseases under this Act, and all the information shall be destroyed without delay when the relevant tasks are completed.

(6) Where a person provided with information pursuant to paragraph (3) process the relevant information, in violation of this Act, such person shall be governed by the Personal Information Protection Act.

(7) Necessary matters concerning the target and scope of information provided under paragraph (3) and methods of notification under paragraph (5), shall be prescribed by Ordinance of the Ministry of Health and Welfare

Source: National Law Information Center

Not only Korea but many other countries around the globe have privacy protection laws in place. However, this should not lead to the loss of opportunities to prevent the spread of epidemics in an early manner. To this end, we could consider implementation of laws that temporarily allow for the collection and utilization of personal information, which must only be used for health purposes and applied during epidemiological emergencies (e.g. Ebola, Zika, MERS, etc.).

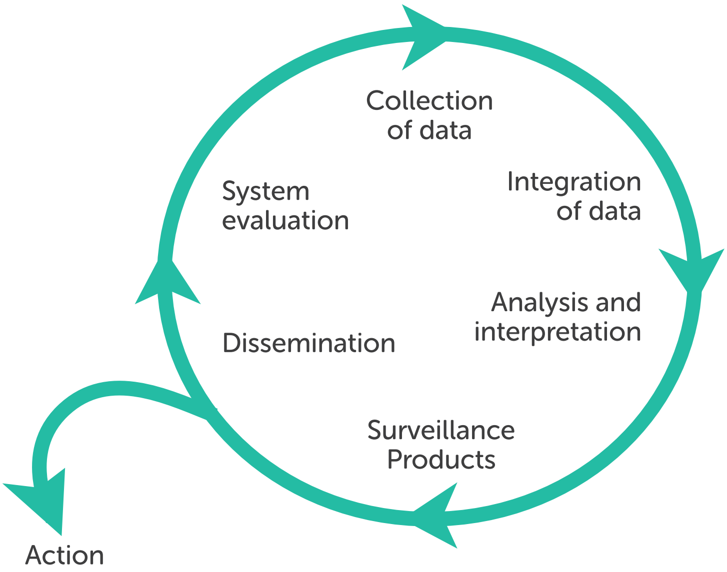
In order to make this approach a more viable proposition, the governmental body in charge must clearly notify the purpose of personal information usage to the public and to obtain prior consent, which could potentially be done on a single mobile app. In addition, it is also necessary to establish measures to allay concerns about the use of personal information by applying latest security technologies such as Block chain for the storage of personal information and by imposing stronger penalties for illegal use. Through these efforts, we will be able to utilize personal information in a way that enhances public interests and creates an environment where the use of personal information takes place in a safe and reliable manner.

5.2 Integrated System: Data Sharing and Surveillance Platform

The 4th industrial revolution is expected to lead to breakthroughs in the field of public health, in particular, in the prevention and management of infectious diseases. The reason is because at the core of epidemics management is the management of data and information. As Chapter 4.2 discussed the insights into the necessity of data sharing, what will become equally important in the future fight against epidemics, along with data sharing, will be the standardized integrated epidemics monitoring system.

The public health monitoring system of the modern era can be redefined as systematically and continuously analyzing and interpreting data to perform a given task as well as distributing the result in a timely manner to people in need, therefore it can help prevent and manage diseases. This definition implies more than a monitoring system that performs simple data collection. Rather, it means that the system needs to become an information cycle system where data develops into information and knowledge.

FIGURE 54: Information cycle of public health monitoring



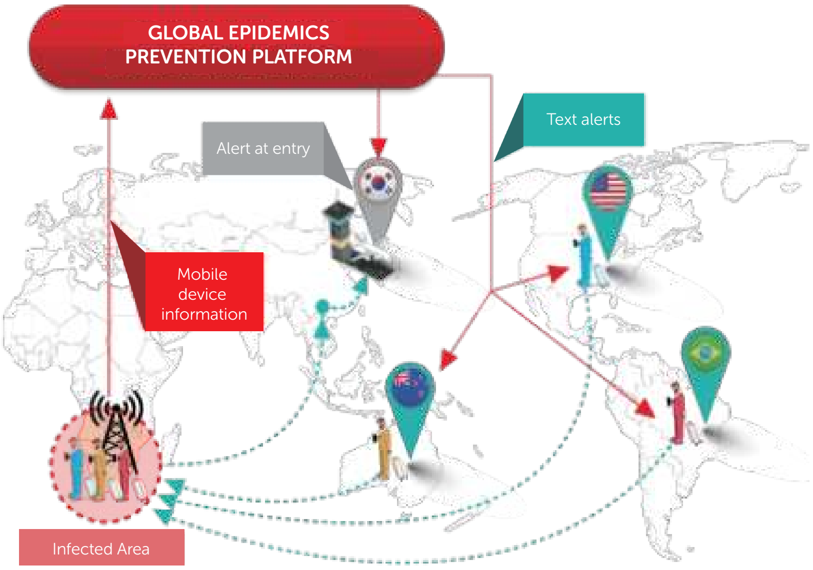
Source: Pan-Canadian Public Health Network

At a time when the outbreaks and spread of epidemics know no borders, the effective use of data sharing in the information cycle system is drawing more attention. In order for data sharing to be performed in a safe and effective manner and to be well utilized in effectively fighting the existing and new epidemics, there is a need to build a new type of integrated platform that goes beyond the traditional monitoring system that is currently in place.

So far, there have been various information systems and platforms which have been developed for epidemics management; however, not all of them considered interoperability or information standardization at the time of establishment. Most of them are application systems to add convenience to everyday work, which are far from the integrated monitoring system or big data that we actually need nowadays.[35]

The establishment of the TESSy mentioned in Chapter 4.2 was possible because EU member states have actively shared their data under a unified goal of epidemics eradication. In the same vein, governments around the world have to change their perceptions toward the sharing of epidemics data and make active efforts to build a common system. The Global Epidemics Prevention Platform (GEPP) suggested by KT at the World Economic Forum held in January 2018 can be an ideal objective to consider.

FIGURE 55: KT's Global Epidemics Prevention Platform (GEPP)



Source: KT

We particularly need active participation from Asian and African countries where the outbreaks of epidemics often occur. Some countries in these regions, however, do not have a proper epidemics response system due to lack of resources, information systems and delivery systems. Hence, it is the responsibility of the whole international community to provide economic and technical support to help establish epidemics surveillance systems in underdeveloped regions.

A remaining challenge regarding data collection (or access), management and analysis levels

"We know data exists and is collected by the operators. However, the format in which data is collected and stored may vary between companies, anonymizing that data implies extra layers of work which might not be automated yet and disclosure agreements between analytical partners or collaborators might also differ. To facilitate this process, ideally there should be common standards to be followed by operators and arranged under the umbrella of an international group or organization. Collected data would be organized in standardized formats that could be matched or paired to enable and facilitate analysis by partners. Cloud storage and access grating to such information should also be clearly defined and agreed between parties."

Dr. Ana Rivière Cinnamond
- Specialist of PAHO(Pan American Health Organization)

5.3 Global Governance: The Role of International Organizations

With the pressing need for international cooperation in fighting epidemics, expanding global governance led by various international organizations including the UN, the ITU, and the WHO is gaining importance. The suggestions made in this report (regulatory improvements in the use of personal information from the perspective of public interests, and establishment of a global epidemics data sharing and surveillance system) can then be put into operation under the leadership of international organizations. Remaining tasks for international organizations include the establishment of epidemics-related regulations and policy guidelines that governments around the world can refer to and the promotion of the private-public-international community participation to expand an integrated system.

The regulatory framework regarding the use of big data to respond to the spread of epidemics urgently needs new guidelines. While the use of big data is expanding rapidly in developing solutions to fight epidemics, there is a substantial disparity in national capabilities in responding to epidemics due to the difference in big data and personal information regulations. Furthermore, if the current situation where there are no cross-border guidelines persists, it could pose a serious challenge in building an integrated global platform required to stop the spread of epidemics.

Effective governance control in matters relating to epidemics preparedness is a key success factor

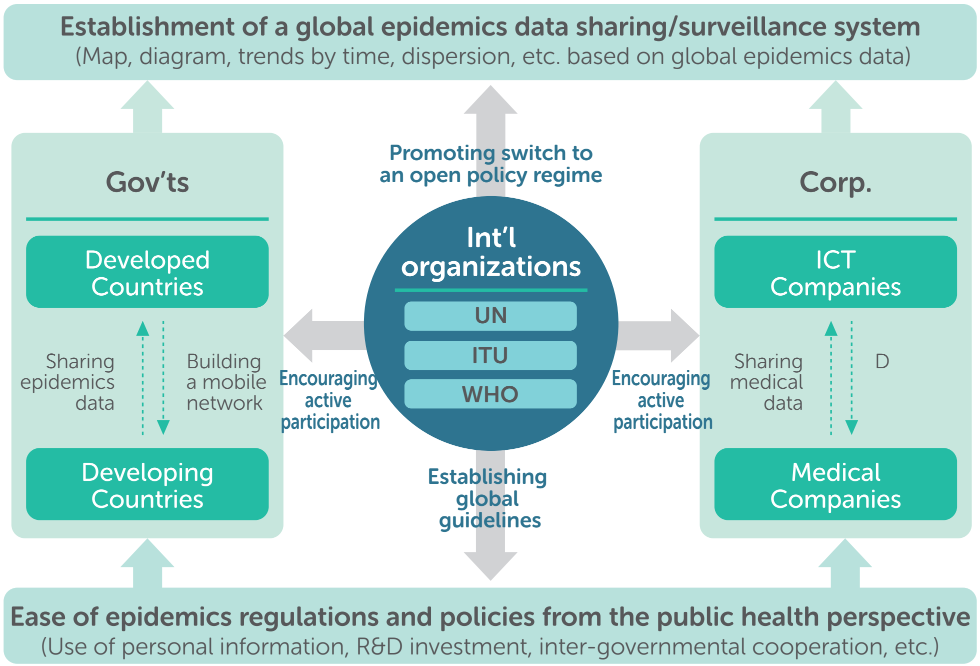
"A key success factor for the public health and surveillance agency is that it needs to have effective governance control in matters relating to epidemic prevention and response. This means that they need to have the requisite authority to compel necessary information and it needs to be able to communicate quickly

> *and easily with all parts of the health system (including both the public and private sectors), providing relevant directives and guidance; as well as to receive communications from all parts of the system. To the extent possible, this communication should be electronic and in real time, so that it can be acted on immediately if needed."*
>
> Dominic S. Haazen
> - Lead Health Policy Specialist, The World Bank

Fortunately, thanks to achievements in recent years, the epidemics response system built based on roaming data has emerged as a new solution for epidemics eradication, hopefully leading to a gradual deregulation on the use of big data in the future. The tasks ahead include the setting up of big data regulations and policy standards led by international organizations and the efforts of countries to effectively carry them out.

Promotion of the participation of the private sector, governments, and the international community for the establishment of a unified system is a challenging task that requires a paradigm shift of the members. To this end, private enterprises will have to disclose their own information and communication technologies and data, and governments will have to make a shift toward a more open policy framework to allow the sharing of the data and solutions of private enterprises on a single global platform. To make this happen, international organizations will need to take the lead in expanding global governance for fighting epidemics with an emphasis on the protection of public health.

FIGURE 56: Global governance structure led by international organizations to fight epidemics



An important remaining goal for us is to promote the efforts of the international community to transform every member in our society into an active participant in the new cross-border epidemics response system. The efforts to continue exchanging capabilities and active communication among the members will usher in a new era where everyone can live a healthy and safe life without the threat of epidemics.

Endnotes

[33] In Korea, under privacy protection laws such as the Personal Information Protection Act and the Information and Communications Act (the Act on the Promotion of Information and Communications Network Utilization and Information Protection, Etc.), the use of personal information is only allowed when it was notified in advance and explicit consent has been obtained.

[34] http://www.law.go.kr/eng/engLsSc.do?menuId=1&query=epidemic&x=31&y=10#liBgcolor4

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4. Key Insight and Considerations

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