Understanding COVID-19 through the Lens of Data Analytics

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Contributed by
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SEOUL NATIONAL UNIVERSITY

ARIC appreciates the medical staff, street bureaucrat, and citizen who never give up to COVID19 but demonstrate the power of our community.

00. ARIC COVID-19 Analytics Model

Colleting Data
KCDC, Johns Hopkins Univ, WHO
OPEN API
GOOGLE SHEET

Trend Analysis
Status quo
+
Age / Gender
Provinces / Imported

Visualization
Using SAS
: Visualization, GIS
Statistical Analysis

Tracking Policy
How Government Response to the pandemic?

Impact Analysis
Post- Coronavirus Impact Analysis
: Economy, Industry, Society

Lesson Sharing
Sharing the results and lessons from experiences of each nation

COVID-19_KO_Lab.html

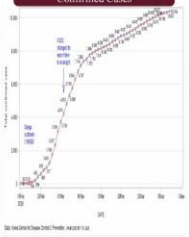
00. ARIC COVID-19 Factpaper

Coronavirus (COVID-19) outbreak in South Korea

Last update : 8 April 2020

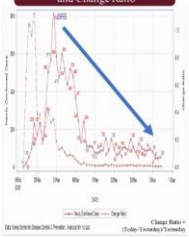
Question 1 "How Many People Have Been infected So Far?"

The Accumulated Number of Confirmed Cases



The accumulated number of confirmed cases in South Korea is 10,384 as of April 8. It used to be one of the top 3 countries that are heavily hit by the COVID-19, but now ranked 17th worldwide. Since mid of March compared to the previous period, the increasing trend is getting lowered. More than 400,000 cases of coronavirus have been confirmed in the US(precisely 434,114) and it is followed by Spain, Italy and Germany which recorded more than 100,000 confirmed cases.

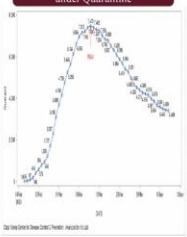
Additional Confirmed Cases and Change Ratio



Since its peak on 29 Feb, the number of additional confirmed cases has been continuously decreased and its trend is also heading downwards. Still, there are some ups and downs but the overall size of the newly confirmed cases is only 5~10% of the peak.

The change Ratio after mid of March also shows a very steady shape. Compared to the ratio in Feb, the ratio has been flattened and this trend would be maintained until the end of the epidemic.

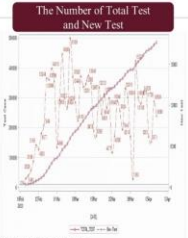
The Number of Patients under Quarantine



The number of patients under quarantine is a crucial figure to explain the upcoming situation. South Korea reached its peak on 12 March and ever since the number has decreased until now. In other words, the recovering patients are increasing and the spread of virus is getting lowered and lowered. This can be interpreted that South Korea is now entering the decrease phase of epidemic; however, the government should be vigilant for any unpredictable situations.

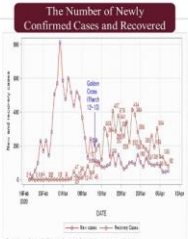
Question 2 "Will The Patients Immediately Die?"

The Number of Total Test and New Test



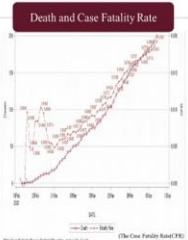
The number of total test in South Korea is reaching almost 500,000 and its positivity rate is 2.2% according to the official report. Positivity rate is calculated [positive tests / total number of tests concluded * 100%]. South Korea has tried various innovative testing method such as 'Drive-Through' to help diagnose patients and keep them from infecting others in hospital waiting rooms.

The Number of Newly Confirmed Cases and Recovered



The solid graph shows the number of newly confirmed case. It surged up to the 800 on Feb 29 and the showing a decreasing trend afterwards. The dotted line shows the number of recovered. Compared to early stage of the pandemic where there were only few of recovered, the number is drastically increasing up to hundreds since mid of March. This is also related to the 'Golden Cross'.

Death and Case Fatality Rate



The total number of death is reached 200 as of 8 April. While there are 17,669 death in Italy, 14,792 in Spain and 14,762 in the US, the total number of death in South Korea is relatively small compared to the level of its infection severity. CFR is continuously increasing and now it reached at 1.8% but still below 2%. While in Italy and France, it is higher than 10%. WHO roughly estimates the world CFR as 5.8%.

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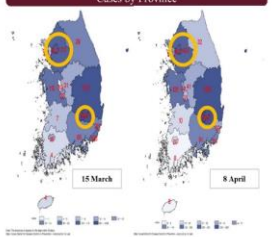
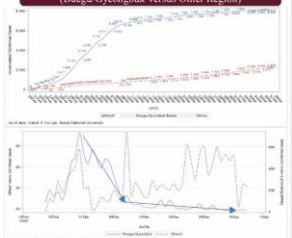
Question 3 "Which Region Is Heavily Hit By The Virus?"

Regional Map showing the Number of Confirmed Cases by Province



Seoul still has relatively fewer patients than Gyeongbuk/ Daegu area however, the number of patients in Seoul and Gyeonggi province is still increasing. Others than these regions show a very small change of the confirmed cases.

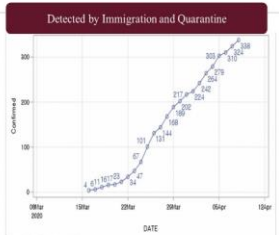
Confirmed Case Trend by Provinces (Daegu/Gyeongbuk versus Other Region)



Given that Daegu/Gyeongbuk/Busan are heavily hit by the COVID-19 as shown the above graph, the newly confirmed cases in those 3 regions has decreased since Feb 29. In the beginning stage of the COVID-19, Notably, South Korean government is mostly testing members of a religious group called Shincheonji, especially those who are residing near Daegu so that the result had surged up. However, other regions do not show a decreasing pattern but still show a fluctuating one until now. Government should pay more attention to the quarantine in those unstable regions.

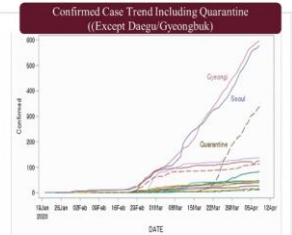
Question 4 "Are We Still At The Phase Of Increase??"

Detected by Immigration and Quarantine



As we have seen in the previous page, it is proven that South Korea is seeing a decline in its daily new coronavirus infections, but health authorities remain on high alert over imported cases. Due to the rise in imported coronavirus cases from mid of March, the government has required all arrivals to self-quarantine for two weeks to stop coronavirus cases coming from abroad. There were several terrible cases that people coming abroad did not keep the self-quarantine period and enjoyed their daily life, those are sued by the related local governments for their irresponsible actions.

Confirmed Case Trend Including Quarantine ((Except Daegu/Gyeongbuk)



The number of daily new cases in the metropolitan area has continued to increase mainly due to mass infection cases at major general hospitals and churches and imported cases. Despite a slowing but still continuing spread of cluster cases, the country on April 5 decided to extend its social distancing campaign for another two weeks until April 19. It prohibits mass gatherings while also advising people to voluntarily keep their distance from others.

This paper is based on the Statistics publicized at every midnight by KCDC *Data source : https://www.cdc.go.kr/board/board.es?mid=a20501000000&bid=0015*

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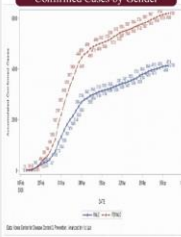
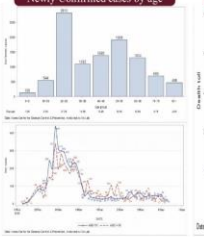
Question 5 "Does Gender and Age have a Correlation With?

The Number of Cumulative Confirmed Cases by Gender



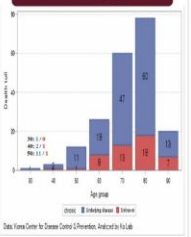
There was an allegation that male is more vulnerable to the COVID-19 based on Chinese data. However in Korea, the number of female patients is almost doubled to that of male patients. There are many reasons why the number of female cases is higher than that of male: religious activities, small group infections including Zumba dance seminar started from Cheonan area, Guro-gu Call center, several hospitals in Seoul/Gyeonggi province and etc.

The number of Confirmed cases Newly Confirmed cases by age



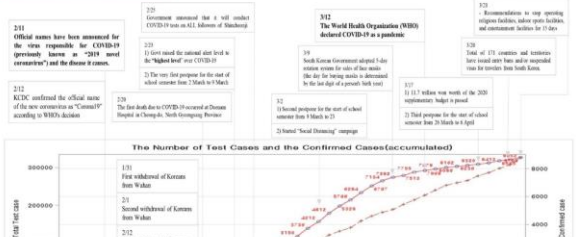
As shown in the upper panel, the most infected are 20s, which takes up almost 30% of the infected and the 50s is following next. On the below panel, the red graph which is age 20-59 takes up more than half of the confirmed cases and the downward pattern of both under and over 50s is fluctuated once on 11 March but quite consistent. We postulate the high infection of the 20s is related to their social activeness including religious activities.

Death toll by Age



The country's death toll rose to 200 and most fatality cases are concentrated to the old age group over 50s. This suggests that the fatality rate of COVID19 is still somewhat high to the aged but the risk to the young and/or having no underlying disease would be even far lower than that. However, we also have to focus that the cases of death without underlying disease has slightly increasing. Still the CFR in 20s is zero but it doesn't mean that the young are 100% safe to the virus.

Question 6 "Has The Government Responded Appropriately?"



Note: The anaylysis is based on the data within 30days.
Data: Korea Center for Disease Control & Prevention, analyzed by Ko Lab

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Government Responses to COVID-19 in South Korea

2/11
Official names have been announced for the virus responsible for COVID-19 (previously known as "2019 novel coronavirus") and the disease it causes.

2/12
KCDC confirmed the official name of the new coronavirus as "Corona19" according to WHO's decision

2/20
The first death due to COVID-19 occurred at Daenam Hospital in Cheong-do, North Gyeongsang Province

2/23
1) Govt raised the national alert level to the **"highest level"** over COVID-19

2) The very first postpone for the start of school semester from 2 March to 9 March

2/25
Government announced that it will conduct COVID-19 tests on ALL followers of Shincheonji

3/2
1) Second postpone for the start of school semester from 9 March to 23

2) Started "Social Distancing" campaign

3/9
South Korean Government adopted 5-day rotation system for sales of face masks (the day for buying masks is determined by the last digit of a person's birth year)

3/12
The World Health Organization (WHO) declared COVID-19 as a pandemic

3/17
1) 11.7 trillion won worth of the 2020 supplementary budget is passed

2) Third postpone for the start of school semester from 26 March to 6 April

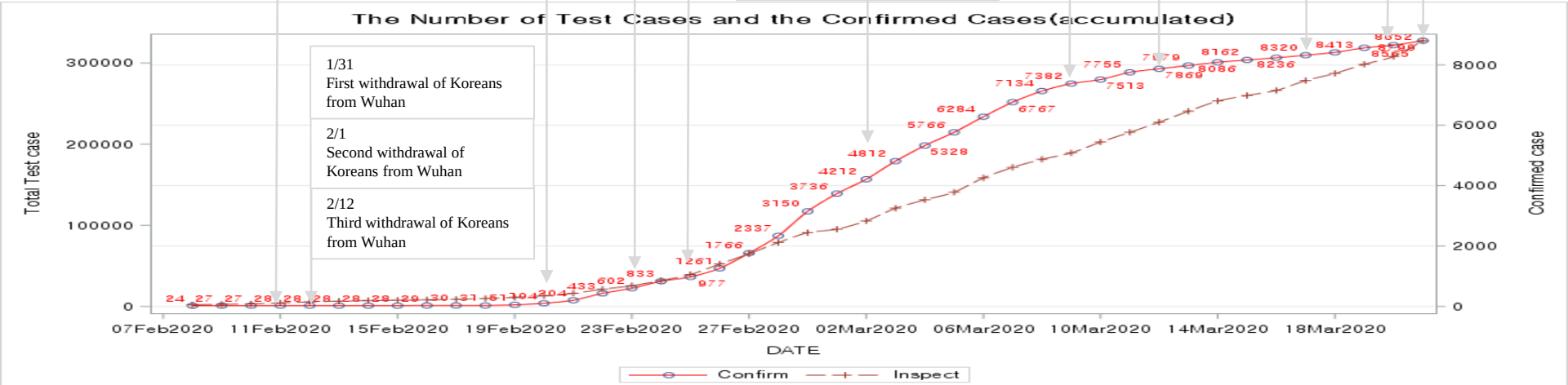
3/20
Total of 171 countries and territories have issued entry bans and/or suspended visas for travelers from South Korea.

3/21
- Recommendations to stop operating religious facilities, indoor sports facilities, and entertainment facilities for 15 days

1/31
First withdrawal of Koreans from Wuhan

2/1
Second withdrawal of Koreans from Wuhan

2/12
Third withdrawal of Koreans from Wuhan



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As of 21 MAR 2020

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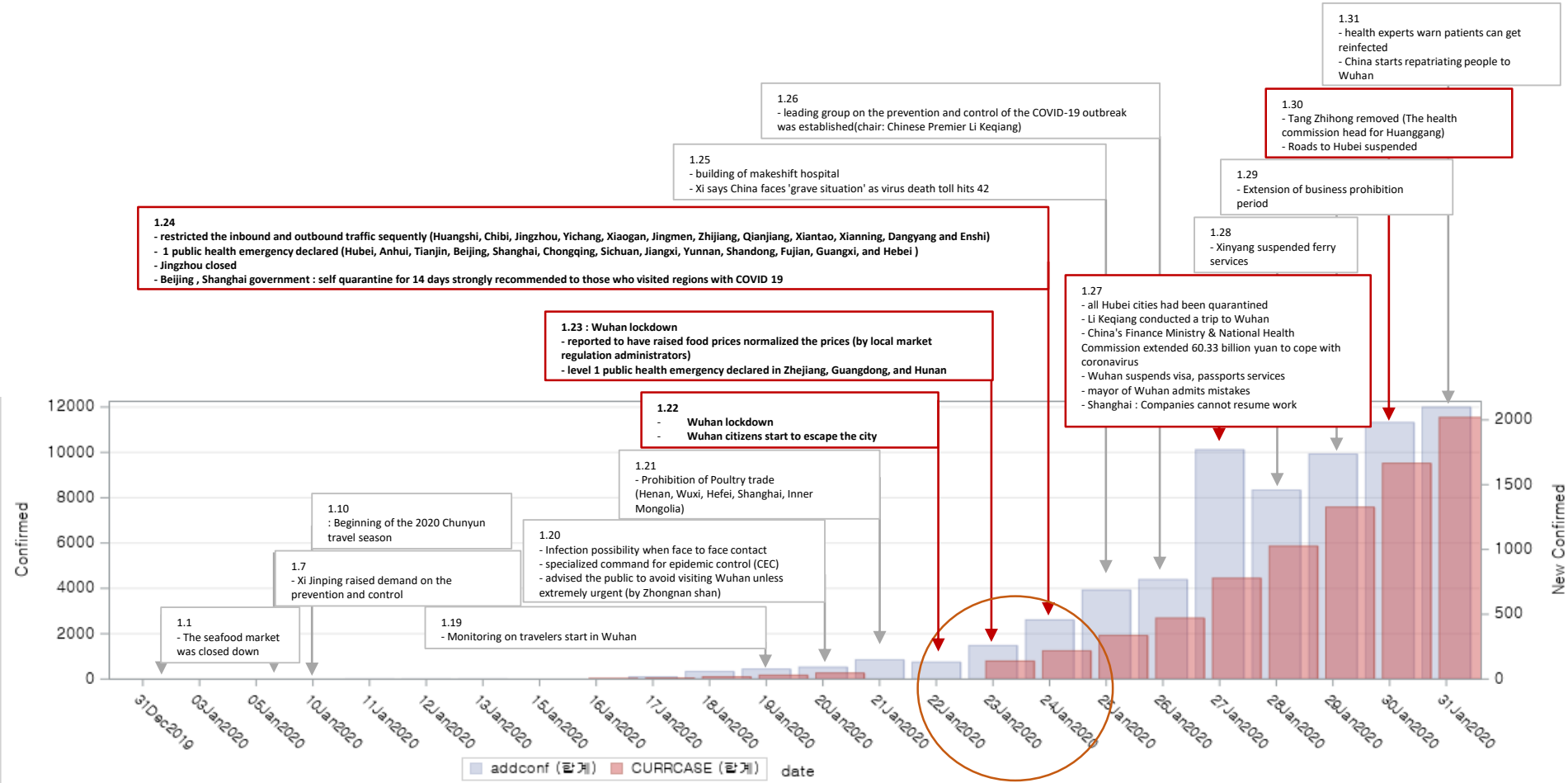
Government Responses to COVID-19 in China



Government Responses to COVID-19 in China

2.7
- 'One province for one city' declared
- Hangzhou : imposed a temporary ban on retail pharmacies selling fever and cough medicines

2.6
- Zhejiang, Jiangsu, Chongqing, Shanghai : school opening delayed
- Sichuan, Guangdong : rolled out measures to help SMEs.

2.5
- The National Health Commission releases the fifth diagnostic criteria
- Hubei : released an additional ¥200 million (US$28.56 million) as special subsidies

2.3
- control of the delivery of basic essentials to people living in the city
- 1,400 military doctors started to work in the Huoshenshan hospital

2.2
- Wenzhou, Zhejiang : every household may send one person every two days outside for purchases
allows imported and re-imported masks that are unlisted
- Wuhan : anyone suspected of being infected with the virus or having been in close contact with a confirmed case would be relocated to a dedicated quarantine centre
- asked the European Union to help

2.1
- Regulations on medical wastes released
- Huanggang(in Hubei) implements a stricter control
- Hunan, Tianjin : Business and school reopening delayed
- Hu pause the filming of all films and TV dramas in mainland China
- 310 Hubei citizens were repatriated

2.10
- Business has now resumed in all 30 mainland province-level divisions, apart from Hubei

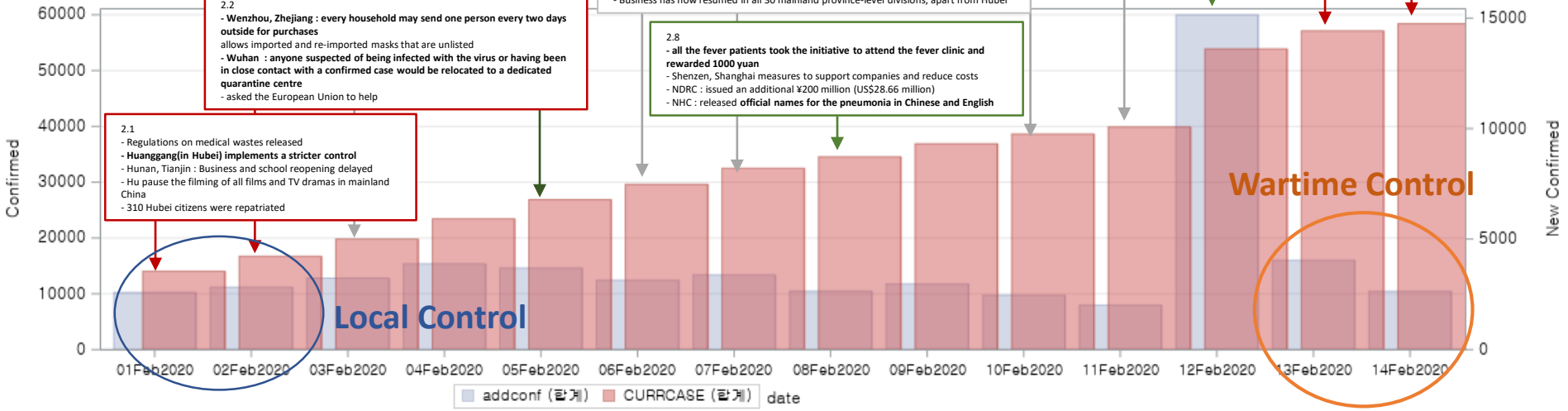
2.8
- all the fever patients took the initiative to attend the fever clinic and rewarded 1000 yuan
- Shenzen, Shanghai measures to support companies and reduce costs
- NDRC : issued an additional ¥200 million (US$28.66 million)
- NHC : released **official names for the pneumonia in Chinese and English**

2.11
- MOHRSS : expanded existing relief measures for micro, SMEs
- a notice to ensure security of living materials in key cities
- Guangdong : emergency legislation banning the trading and overeating of wildlife
- Guangzhou, Shenzhen : laws to requisition buildings and equipment to curb spread of disease
- numerous economic measures released

2.12
- Fifth version of COVID diagnosis criteria announced
- Zhejiang : decreased the price of enterprise utilities / Jiangsu : strengthen financial support / Shanghai : measures to support tech companies and exempt the rent of SMSEs
- Yunnan: mandatory QR code registration in all public places
- Honghu, Hubei : official investigation on medical item prices

2.13
- Foshan, Guangdong : require advance declaration for vehicles to enter the city
- Zhangjiawan District(Shiyan, Hubei), Dawu County in Xiaogan : wartime control, quarantine for 14 dyas
- Wuhan : not allowed to leave their neighborhoods

2.14
- Central districts of Yunmeng Country(Xiaogan) : wartime control
- Huanggang(Hubei) : lockdown
- Xiantao(Hubei) : price control for masks
- Beijing : self-quarantine for 14 days
- Shenzhen Metro : start using real-name system
- prohibited all after-school training institutions(The Office of the State Council Education Steering Committee)



Government Responses to COVID-19 in China

2.17
- Xiaogan now bans all its urban residents from leaving home, all its rural residents

2.16
- Hubei implements "hard quarantine" in units of natural villages; no outsiders are to be allowed in and each household is allowed one person every three days to go out for provisions and urgent agricultural material, on designated routes and in limited time.
- Guizhou resumes normal traffic, removing all temporary quarantine checkpoints
- Nanjing and Suzhou implements real-name system for public transit
- Huanggang announced that any person with fever or cough taking the initiative to see a doctor would receive a financial reward of ¥500

2.15
- Honghu, Hubei entered wartime control at 00:00
- Jingmen, Hubei escalated control, prohibiting outside vehicles and persons from entering its central districts and shutting down all business(except approved pharmacies, supermarkets, and hotels)

2.21
- Henan and Shandong removed all road quarantine measures.

2.20
- Wuhan requires residents to measure their temperature twice daily and report any measurements exceeding 37.3 °C.

2.19
- The NHC published the sixth pilot version of Diagnostic and Treatment Plan of the Novel Coronavirus Pneumonia, which removed the category of clinical diagnosis introduced in the previous edition for Hubei(as well as adjusted several descriptions, criteria, and treatment guideline)

2.18
- Hangzhou resumes normal traffic and public transport service.
- Tianjin now requires QR code scanning for entering public spaces and transport services.

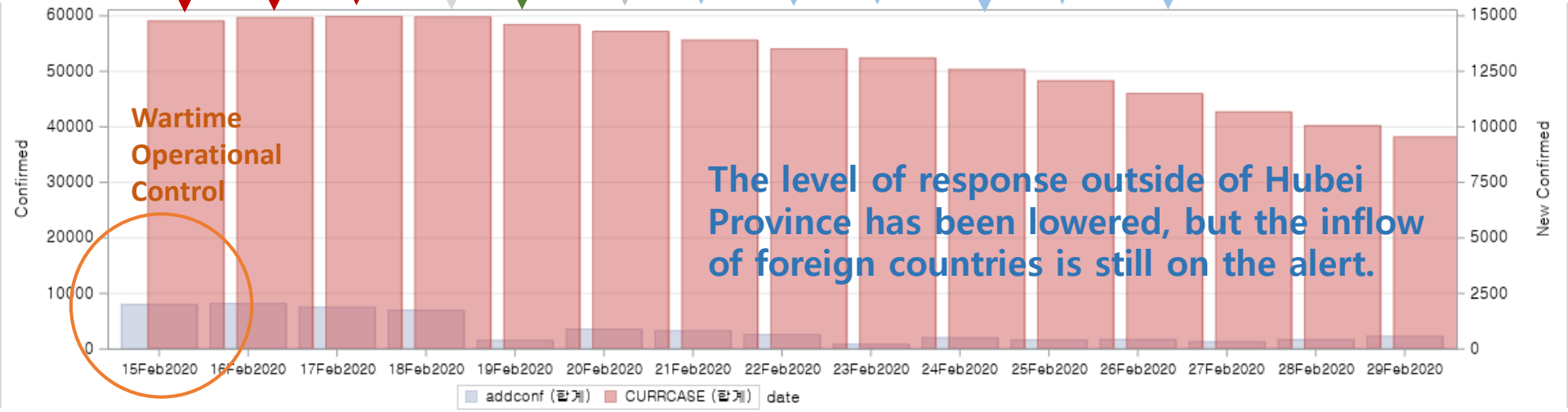
2.25
- Qingdao will now quarantine all persons entering with a travel history of areas with the epidemic.
- Weihai : Weihai will now quarantine all persons entering with a travel history of areas with the epidemic.

2.24
- Yunnan adjusts its emergency response level for COVID-19 from level 1 to level 3.
- Guangdong, shanxi and Jiangsu adjusts its emergency response level for COVID-19 to level 2.- -
- Jiangxi adjusted its levels to level 3 or level 2 depending on the risk of the county.

2.23
- Guizhou adjusts its emergency response level for COVID-19 from level 1 to level 3.
- Shanxi adjusts its emergency response level for COVID-19 from level 1 to level 2.

2.22
Liaoning adjusts its emergency response level for COVID-19 from level 1 to level 3.
- Wuhan requires a 14-day quarantine for patients discharged from COVID-19.

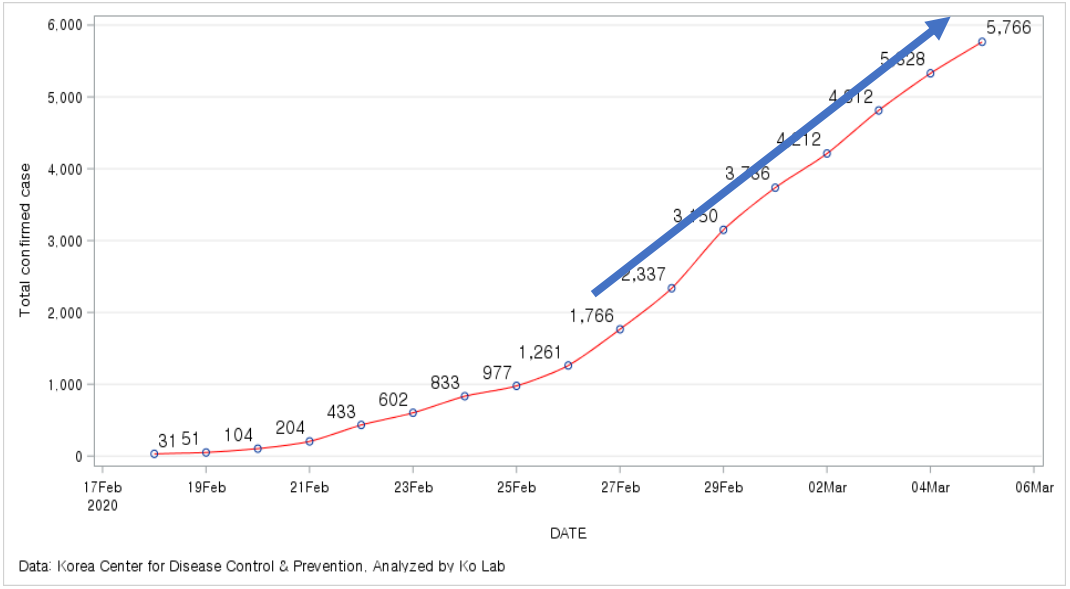
2.26
- Yantai(in Shandong) will test all persons entering China from the city for SARS-CoV-2 for free.
- Jilin adjusts its emergency response level for COVID-19 from level 1 to level 2.
- Hainan adjusts its emergency response level for COVID-19 from level 1 to level 3.
- Beijing orders quarantine for foreign arrivals from virus-hit areas



00. Do we know facts well?

- **The continuous increase of infection cases ??**

  : Different perspectives of time (long-sighted vs. short-sighted)



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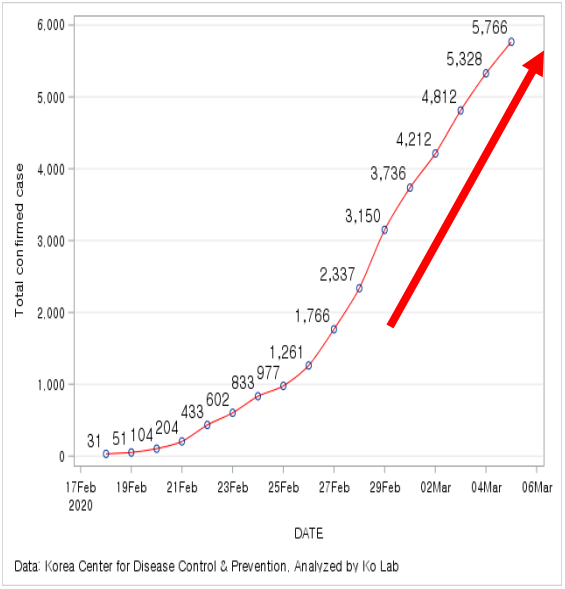
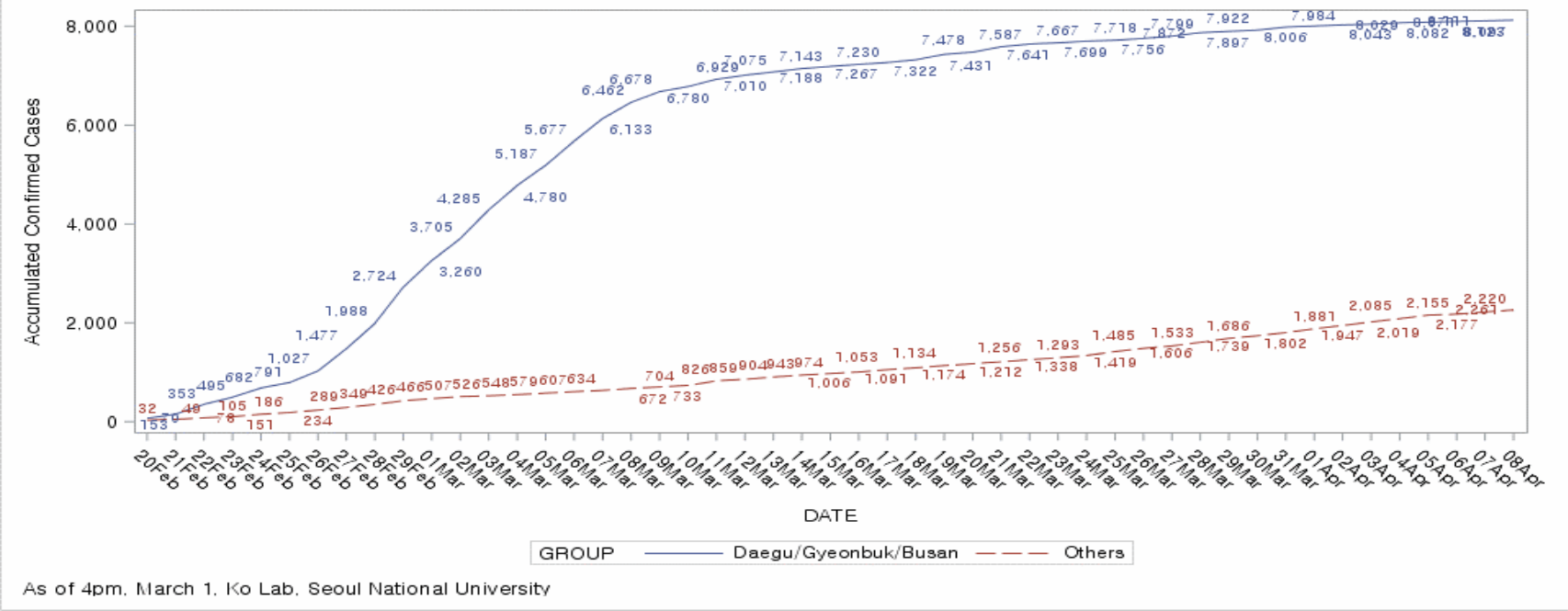


01. Community Infection

- Daegu-Gyeongbuk regions were heavily hit by community infection related to Shincheonji

81.9% of infections are community infection.



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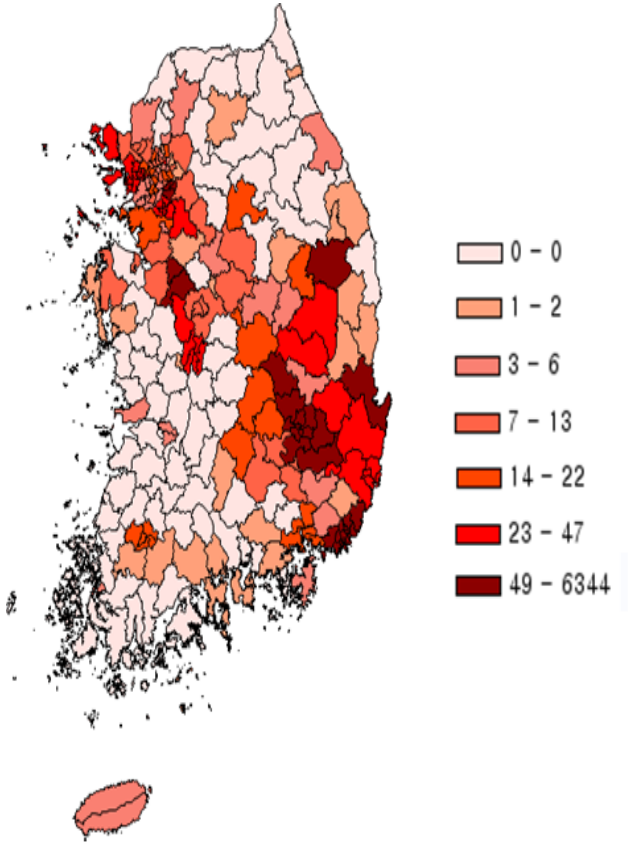
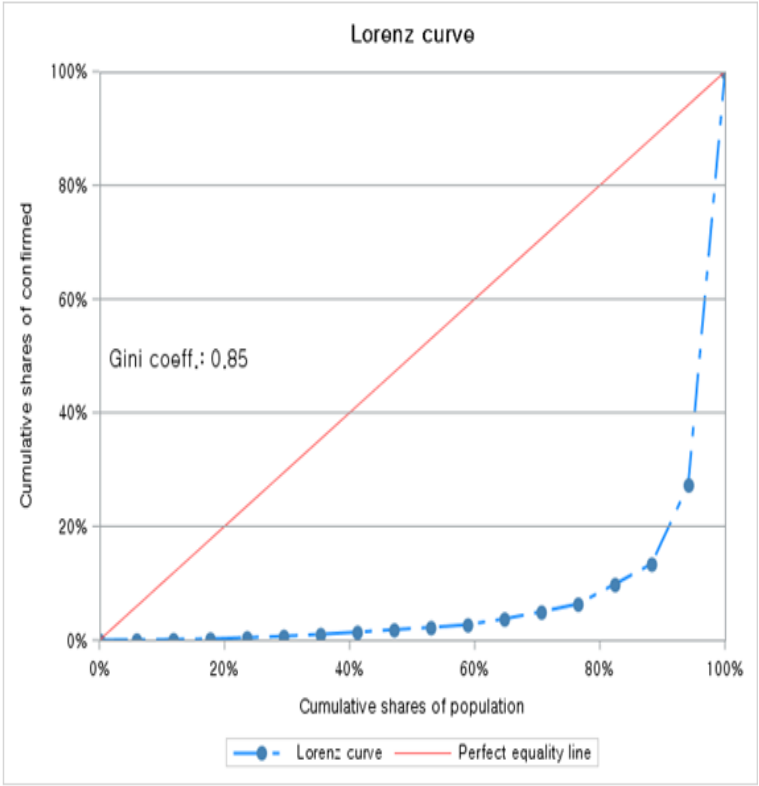
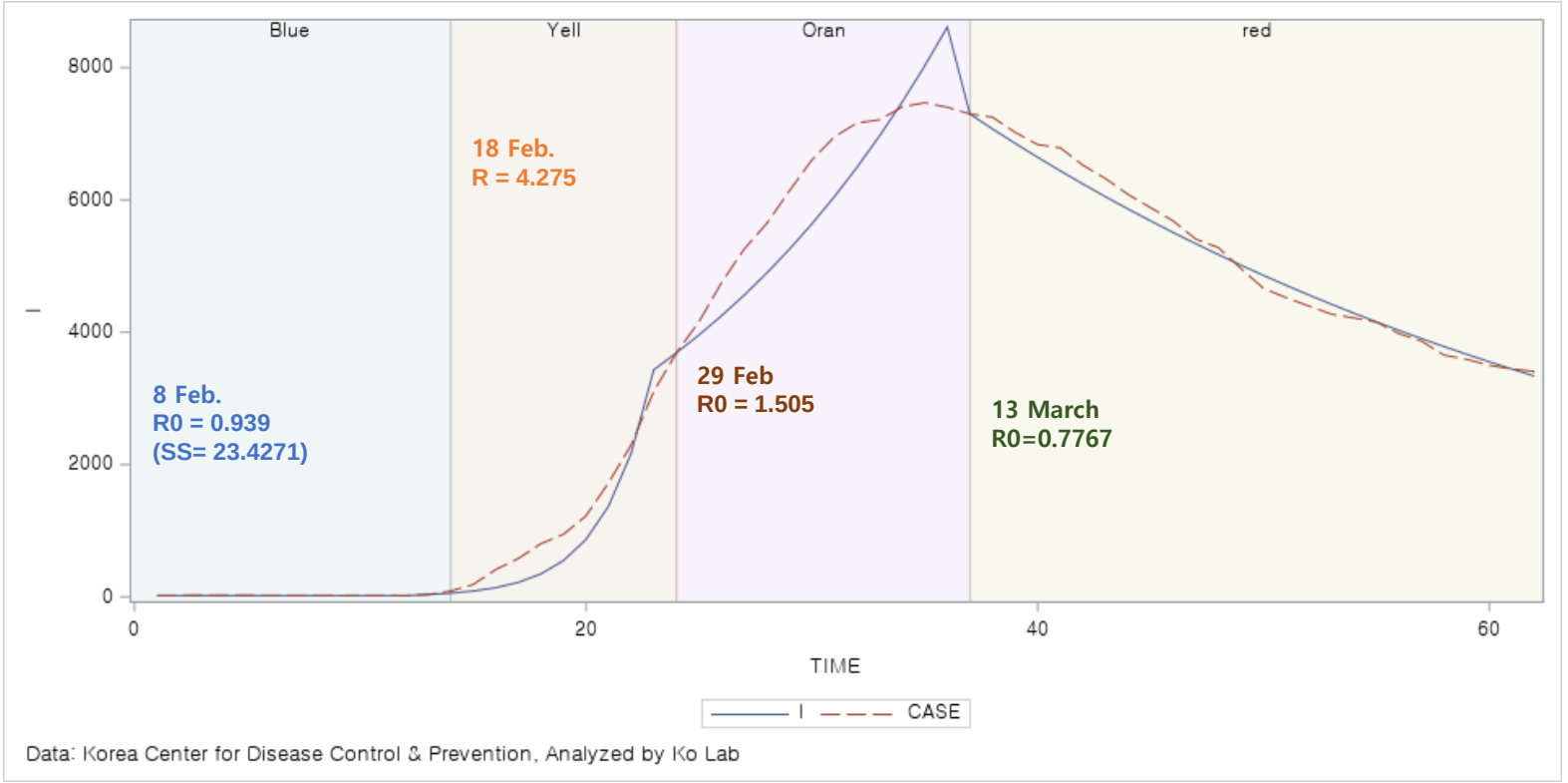




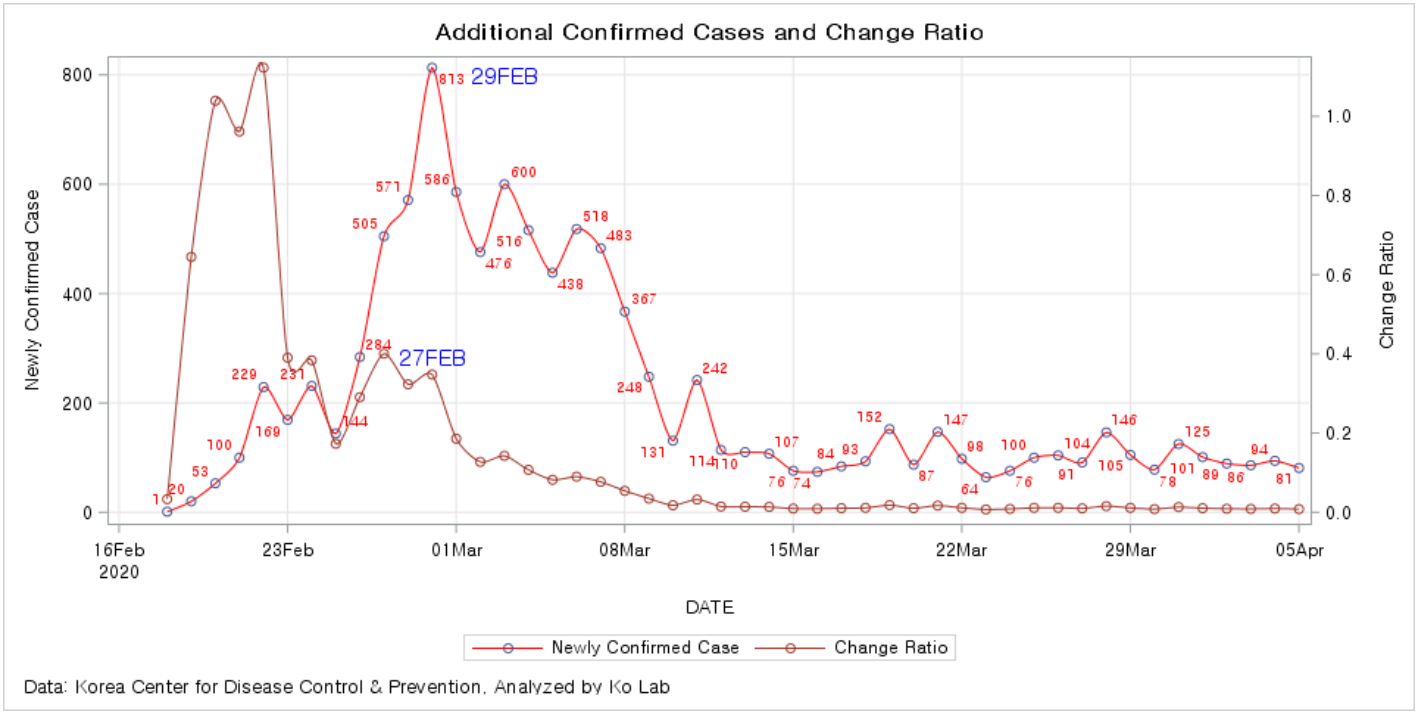
01. Community Infection

Estimation of reproduction rate (R0) by period (SIR model)



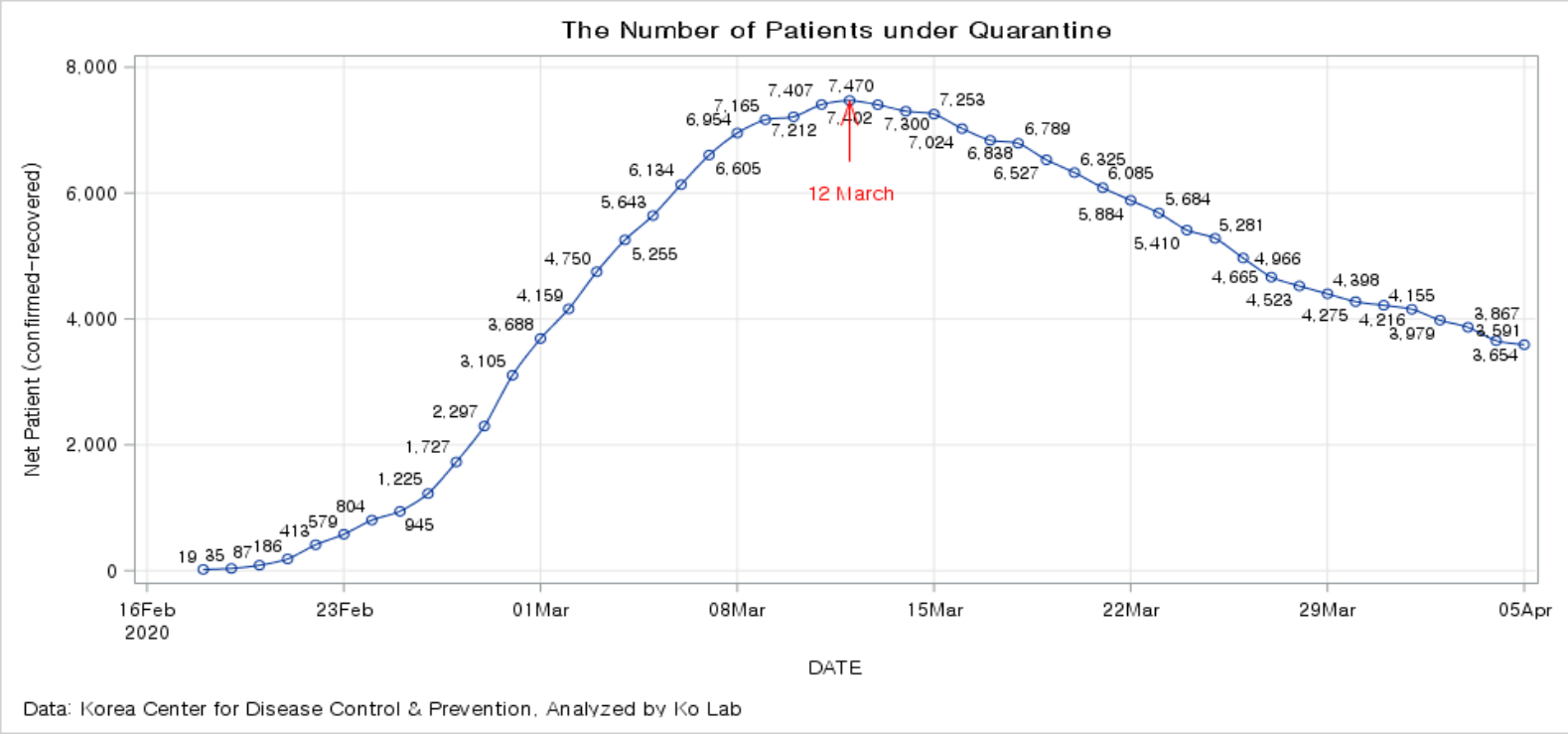
02. When is a turning point?

Optimistic policymaker: Trend of new case and/or change ratio



02. When is a turning point?

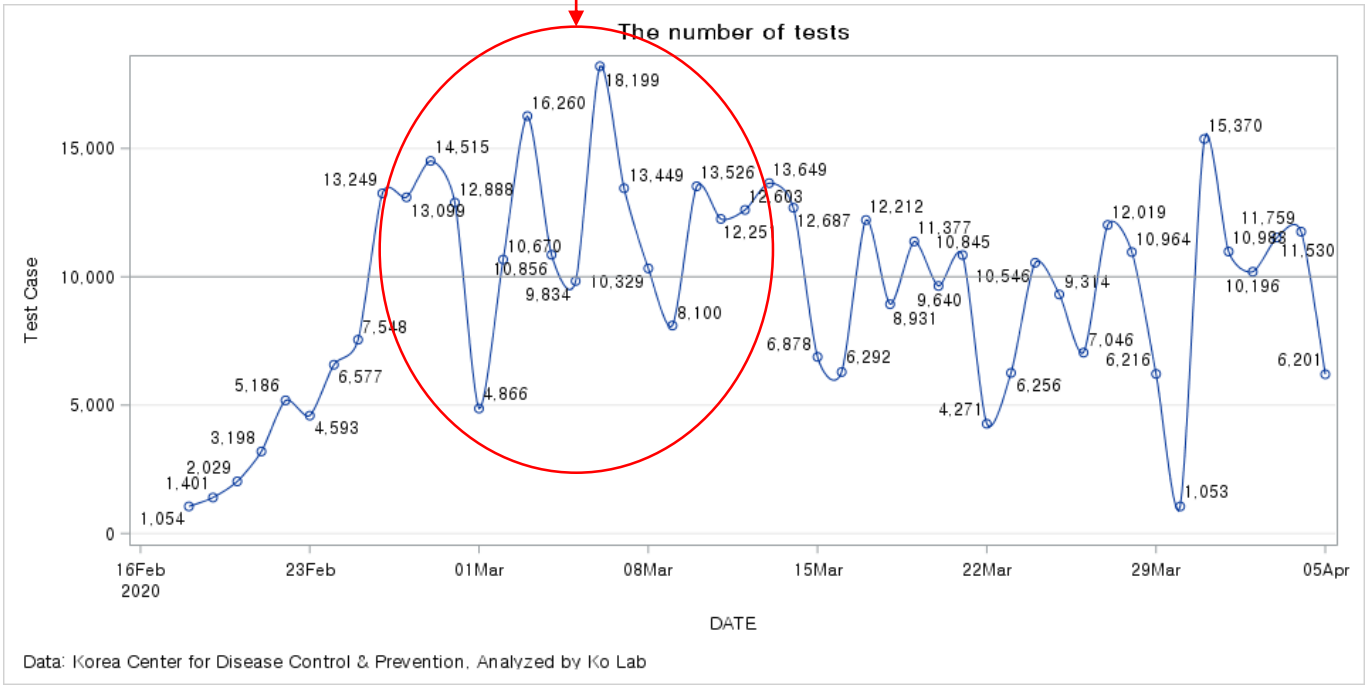
Conservative policymaker: Trend of net quarantine patients



03. Do not let your guard down

Successful preemptive test policy but...

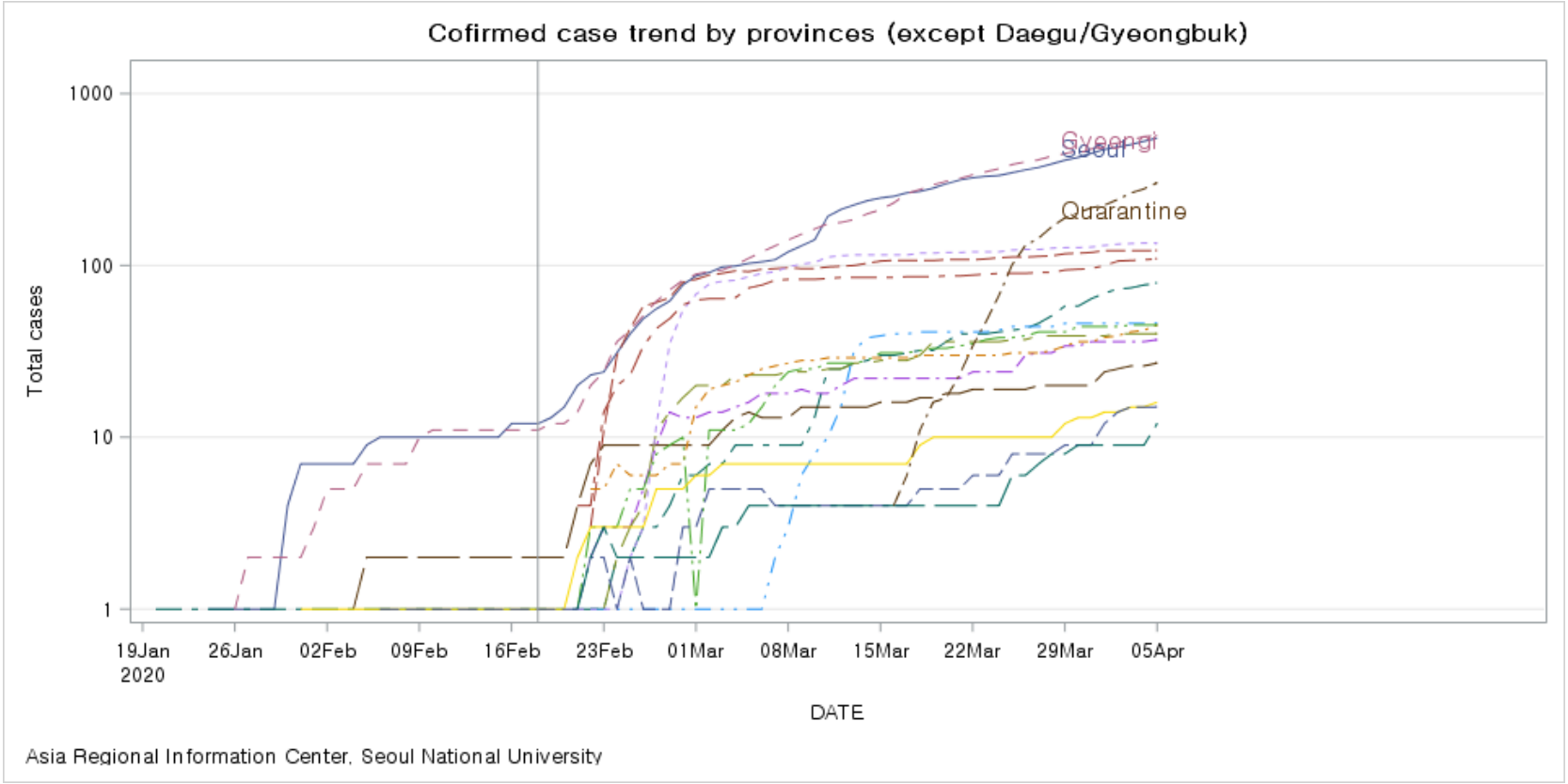
Note that the comprehensive tests were done almost a week later



KCDC ordered self-quarantine to Shincheonji Christians on Feb 25.

03. Do not let your guard down

Still, some provinces' trends are not flattened



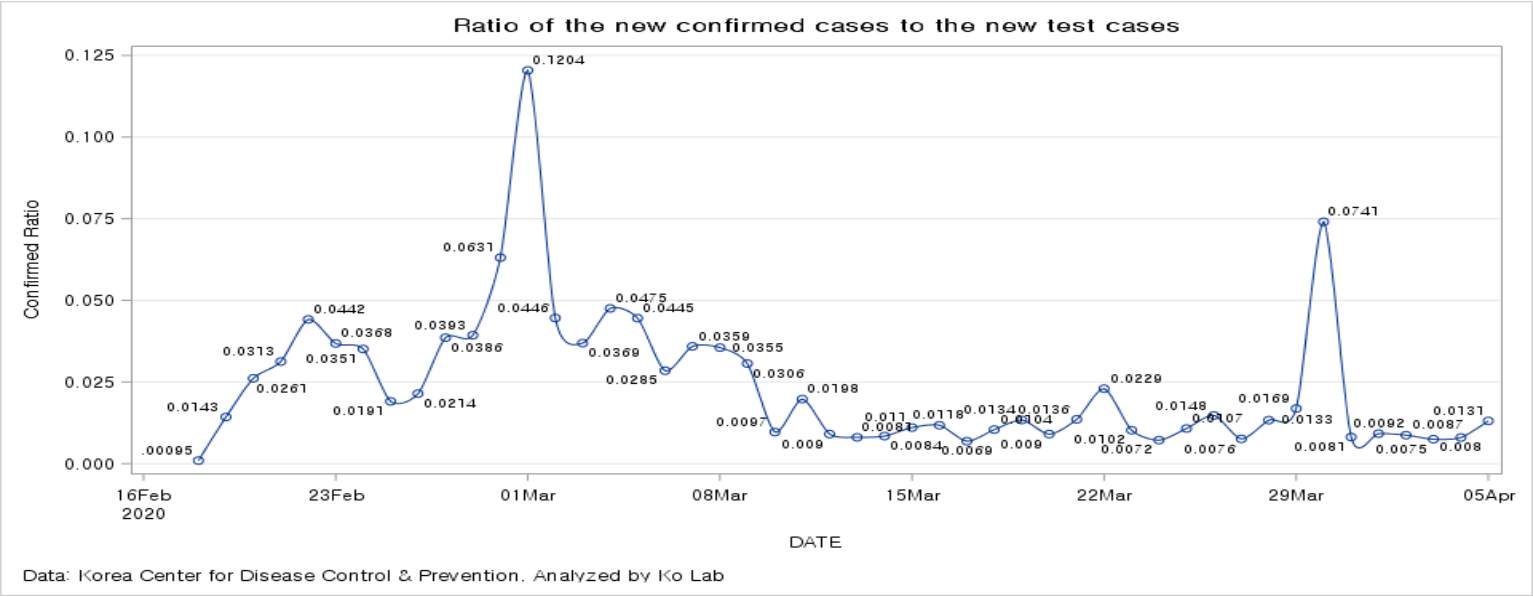
04. No free lunch: cost-effectiveness of the test

Cost-effectiveness

1) Cost per test: 150USD

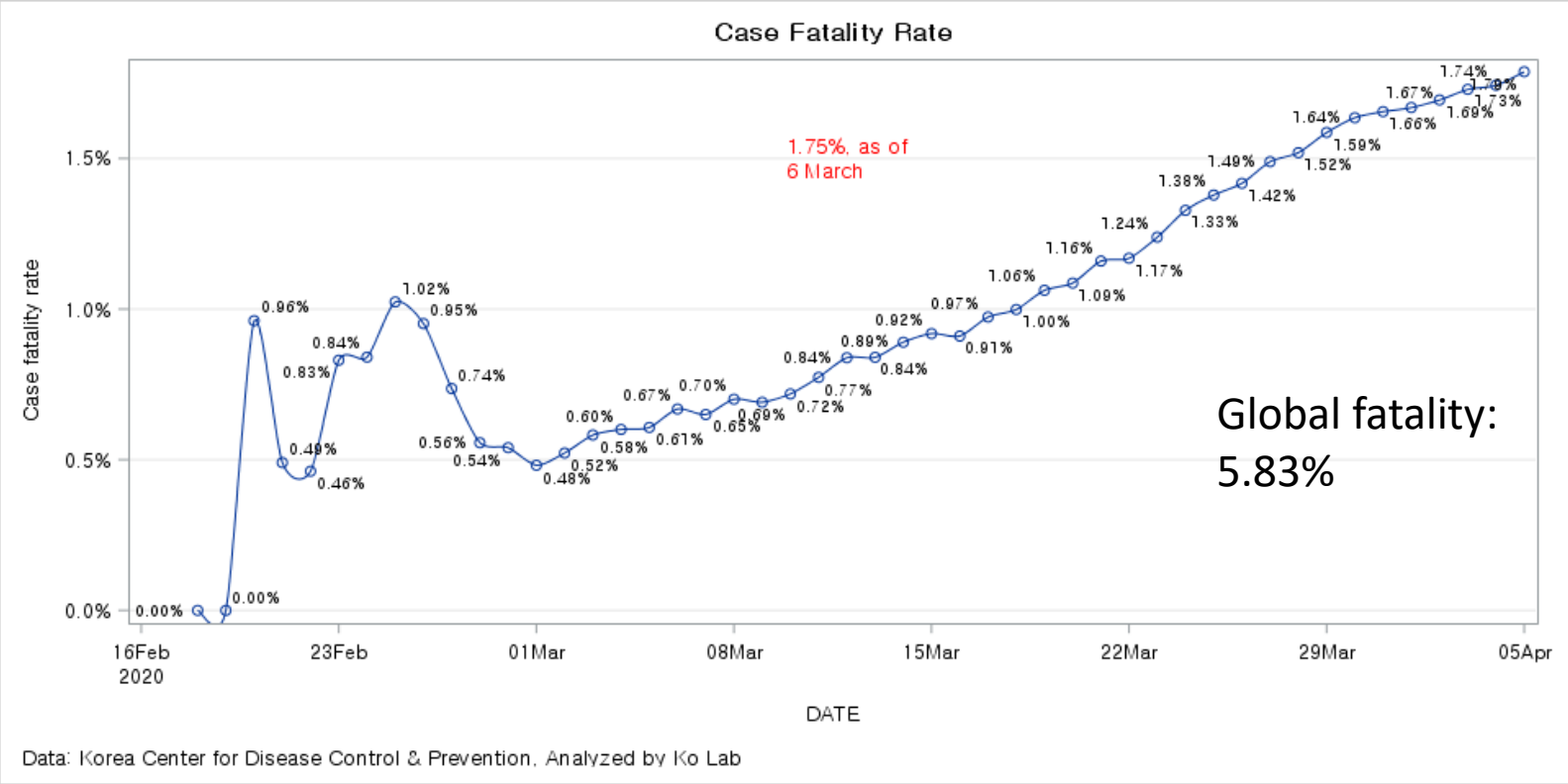
2) # of test per day: 10,000 → 1.5Mil. USD / Detection rate=1% -> 100 case

Therefore, are we willing to pay **15,000USD** for detecting additional patient?



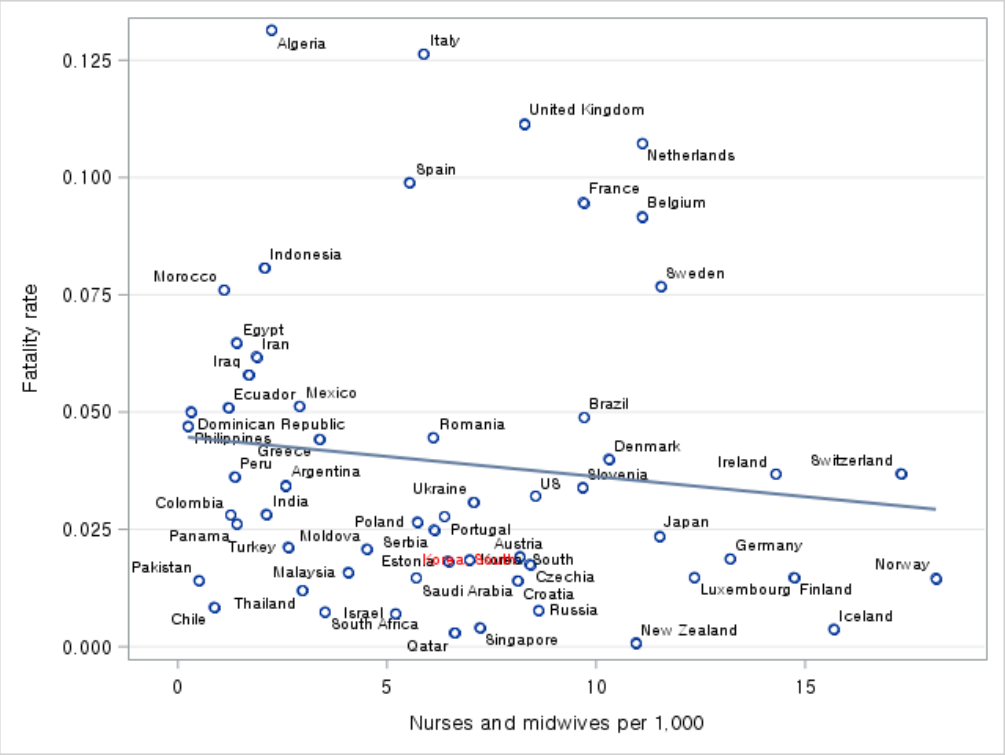
04. Effectiveness of medical staffs

Remarkably low fatality rate



04. Effectiveness of medical staffs

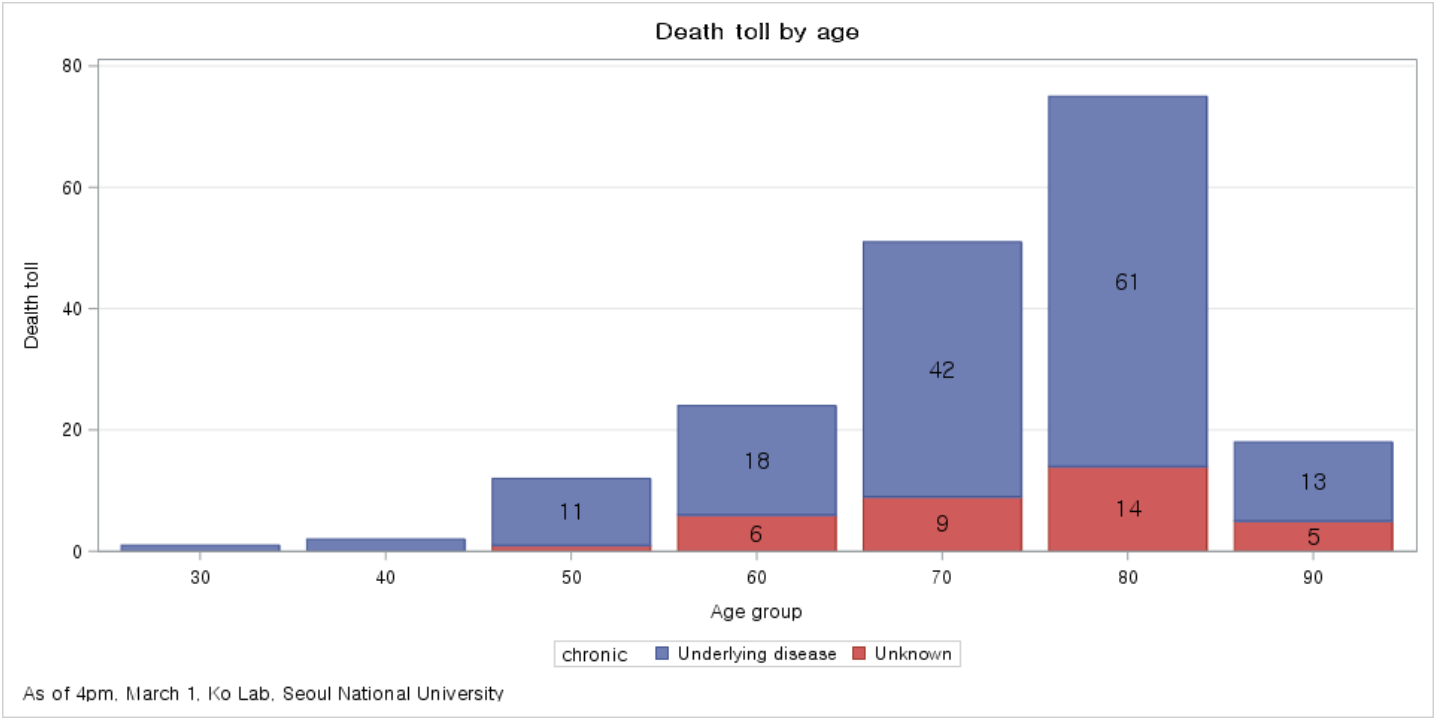
Low fatality rate despite small # of nurses per 1,000 people



Note that the regression model is not suitable yet because of large variation among countries and less stabilized fatality rate of each country

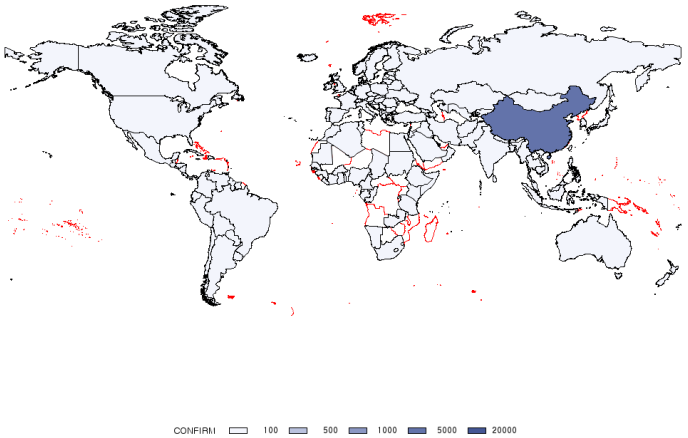
04. The cause of the 3rd factor

▶ Majority of people who died in South Korea had underlying disease

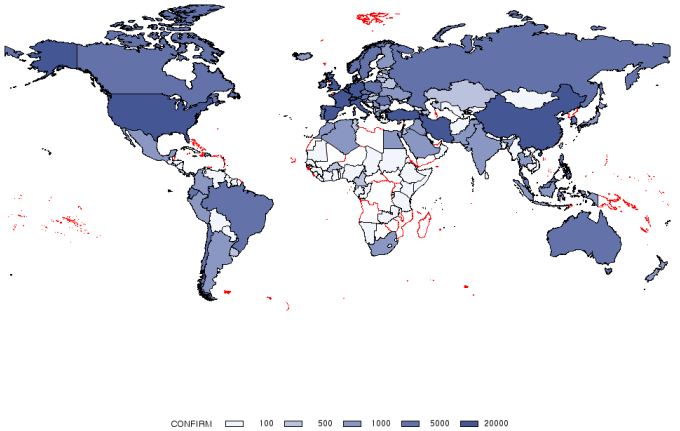


05. Global Trends

Feb 1, 2020



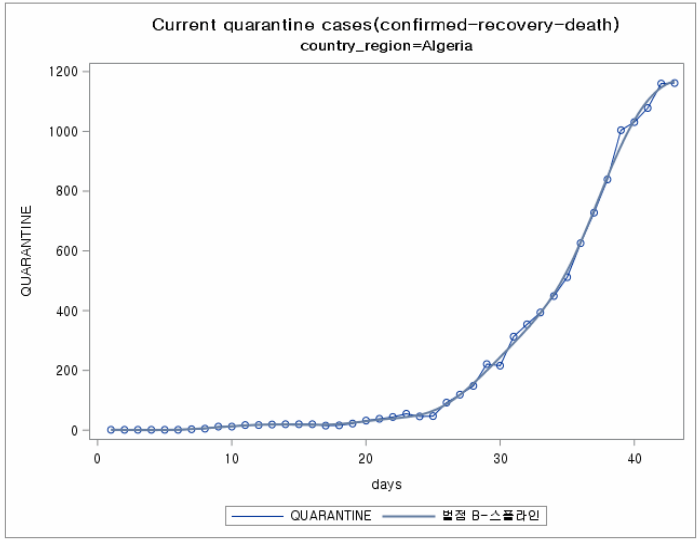
April 5 2020

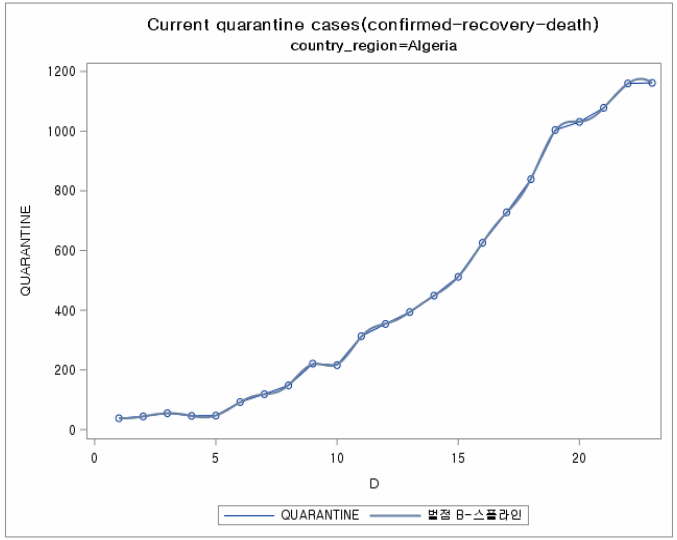


Is the global society well prepared even after the COVID-19 outbreak in China?

05. Global Trends

▶ No hope of the spring to come??



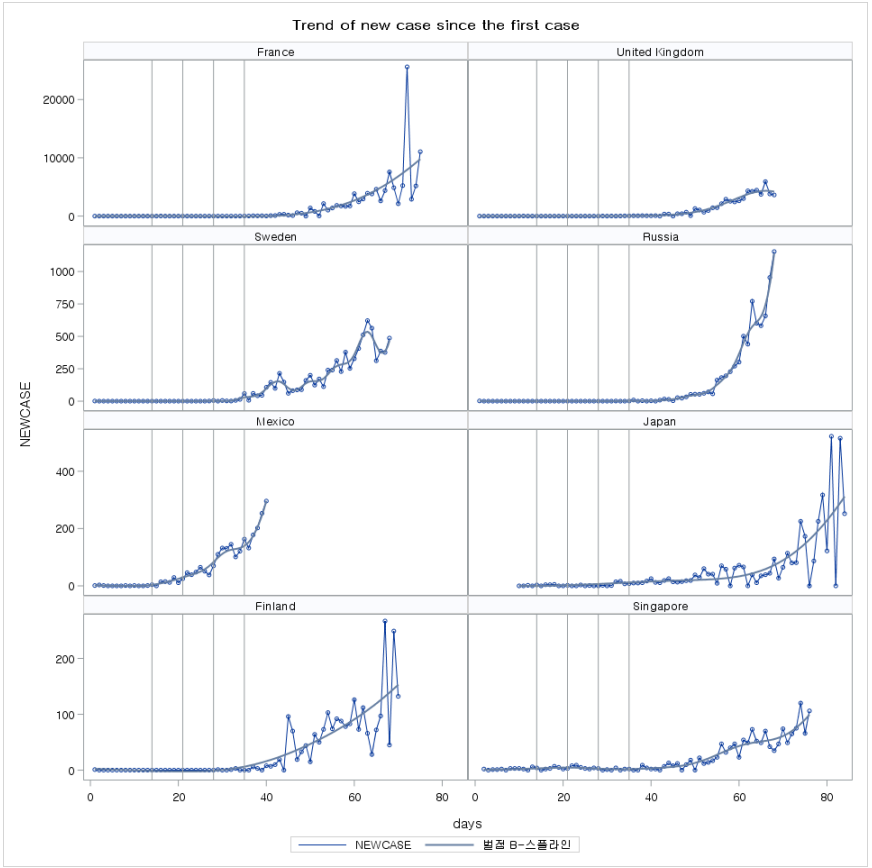


- Long left tails→ Unpreparedness

- Many countries are in hockey stick shape,
  but **some countries (Italy, US, Swiss, etc)** begin to follow **inversed U-shape**.

05. Global Trends

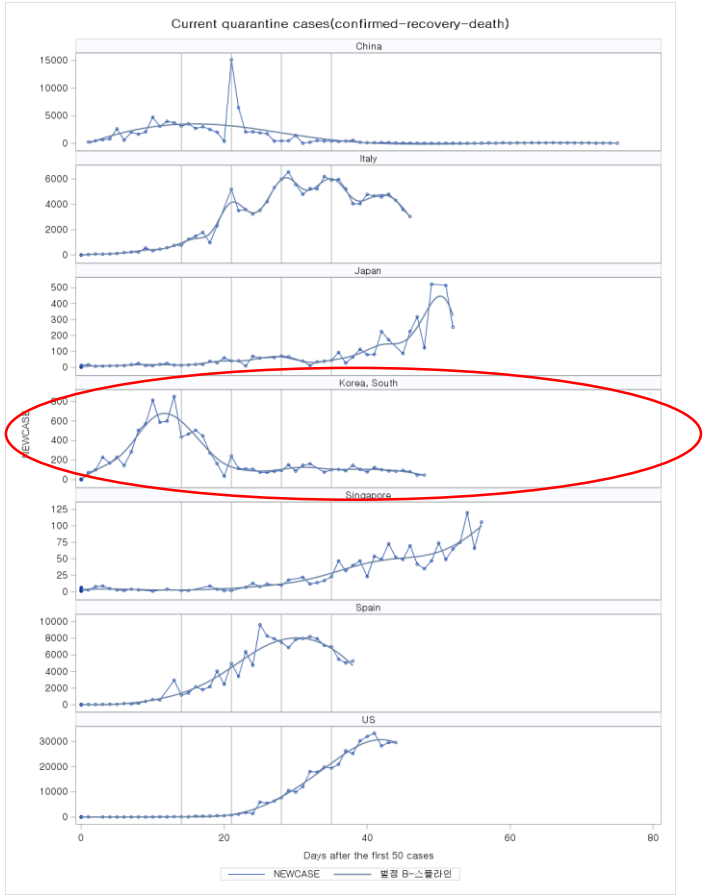
- **Winter is not over yet in some countries**



05. Global Trend

Does the Korean trend differ from that of other countries?

- Most countries' trend are hokey stick shape or premature inversed-U shape.
- However, Korea only took two weeks for arriving a plateau of new case trend and shows inversed-U shape now.



06. Implications

<Fact 1>

While there was unsatisfactory responses in preventing community infection in some regions, Korea successfully control COVID-19 considering the low fatality rate, quick control, and the flattened curve.

<Fact 2>

Draconian international and domestic travel ban would not be a mandatory and cost-effective policy.

<Fact 3>

Who knows the best timing?

<Fact 4>

As different infection and fatality risk by age is real, government's policy should be implemented accordingly.

06. Implications

<Fact 5>

The world should prepare the post-COVID19 era as more countries will approach to the golden-cross stage soon.

<Fact 6>

We need to deliver accurate information. Some make people too scared, others make too optimistic.

<Fact 7>

Sharing the experiences in a global context with international cooperation on data collection, analysis, and policy for better preparedness in future

06. Implications

ARIC's next agenda:

- DB and analysis of the impacts of COVID19 to socio-economic system
- Developing the better pandemic tracking platform (e.g. SNU CRN, WHO, etc.)
- Nurturing the next generation of policy analytics experts

ARIC is open to all for collaboration !!!

THANK YOU