SARS CoV-2 Testing Strategy in Korea

Jae-Seok Kim, M.D., Ph.D.

Department of Laboratory Medicine, Hallym University College of Medicine, Seoul, Korea
Situation in Korea

• Real time RT-PCR tests: >600,000

Coronavirus Disease-19, Republic of Korea

Cases in Korea  (as of 12am on April 26, 2020, data aggregated from January 3)

- Confirmed Cases (accumulation): 10,728
- Released from isolation (Released from Quarantine): 8,717
- Isolated: 1,769
- Deceased: 242

Testing in Korea (as of 12am on April 26, 2020, data aggregated from January 3)

- Tests Performed: 598,285
- Tests Concluded: 589,286
- * Positivity Rate: 1.8%

How Korea responded to a pandemic using ICT

Flattening the curve on COVID-19

April 15, 2020

Table 1  Companies that obtained emergency use approval

<table>
<thead>
<tr>
<th>Company</th>
<th>(Date of Approval for Emergency Use)</th>
<th>Company Information</th>
</tr>
</thead>
</table>
| KogeneBiotech | (Feb.4)                                | - Established in Mar. 2000 / SME  
  - (Business area) Diagnostic reagent development and genome analysis service |
| Seegene  | (Feb.12)                              | - Established in Sep. 2000/ SME (listed on KOSDAQ market)  
  - (Business area) Development of diagnostic reagents and automated software |
| Solgent  | (Feb.27)                              | - Established in Aug. 2000 / SME  
  - (Business area) Diagnostic reagent development and genome analysis service |
| SD Bio-sensor | (Feb.27)                            | - Established in Dec. 2010 / SME  
  - (Business area) Development of diagnostic reagents and in vitro diagnosis system |
| Biosewoom | (Mar.13)                              | - Established in Sep. 1997 / SME  
  - (Business area) Development of clinical diagnostic drugs including diagnostic reagents |
H1N1 Epidemic in 2009; Multiplex PCR, real-time PCR

Real time PCR machines

Real time PCR tests were allowed (2009, just few months before the epidemic)

Multiplex reverse-transcriptase PCRs for respiratory viruses (2009)

<table>
<thead>
<tr>
<th>Assay/Pathogen</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>C204</td>
<td>M. influenza A &amp; B [Interspecies Combined PCR Positive]</td>
</tr>
<tr>
<td>C205</td>
<td>M. parainfluenza 1,2,3 [Interspecies Combined PCR Positive]</td>
</tr>
<tr>
<td>C206</td>
<td>Respiratory virus (1) Adenovirus, (2) RSV, (3) Influenza A &amp; B, (4) Parainfluenza 1,2,3</td>
</tr>
<tr>
<td>C207</td>
<td>Respiratory virus A &amp; B [Positive Interspecies PCR]</td>
</tr>
</tbody>
</table>
MERS-CoV outbreak in 2015; Novel virus

CDC, NIH & Public Health Laboratories

• Real time PCR kit
  • Distributed to 17 PHLs
• 50 tests were done from 2013 to 2015 (May)
• External Quality Control (twice)
• NIH participated EQC from Robert Koch Institute (Mar-2014)

Medical Laboratories (2015)

• No tests could be performed for novel viruses at first
• “Hospital laboratories have no ability to test such a complicated test.”
• Local government authorities suggested to test for medical laboratories (7-Jun-2015)
MERS in Korea (2015);
Maximum testing (1,400 tests/day)
Communications!

CDC, NIH & Public Health Laboratories

- Organization
  - KCDC; diagnosis, prevention
  - KNIH; vaccine, therapeutic
- KCDC
  - Center for Laboratory control of Infectious Diseases
- Consultative body for diagnostic test
  - CDC
  - Public health laboratories
  - Laboratory Physicians

Medical Laboratories

- TF of Korean Society of Laboratory Medicine
- Commercial reference laboratories
- Consultative body for CDC, local government and academics
Diagnostic detection of Wuhan coronavirus 2019 by real-time RT-PCR

- Protocol and preliminary evaluation as of Jan 13, 2020-

Victor Corman, Tobias Bleicker, Sebastian Brünink, Christian Drosten
Charité Virology, Berlin, Germany

Olbert Landt, Tib-Molbiol, Berlin, Germany

Marion Koopmans
Erasmus MC, Rotterdam, The Netherlands

Maria Zambon

<table>
<thead>
<tr>
<th>Target region</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upstream of the E protein gene (upE)</td>
<td>Highly sensitive (Screening)</td>
</tr>
<tr>
<td>Open reading frame 1a (ORF 1a)</td>
<td>Equal sensitive</td>
</tr>
<tr>
<td>Open reading frame 1b (ORF 1b)</td>
<td>Less sensitive</td>
</tr>
</tbody>
</table>

Charite Hospital in Germany (2020-Jan-13) ; Prof. Christian Drosten

All assays can use SARS-CoV genomic RNA as positive control. Synthetic control RNA for Wuhan virus will be provided shortly.

First line screening assay: E gene assay
Confirmatory assay: RdRp gene assay
Additional confirmatory assay: N gene assay
Ready for testing

CDC & Laboratory Medicine

• Diagnostic kit
  • Emergence Use kits
    • 5 companies: Feb. 4\textsuperscript{th} – Mar. 13\textsuperscript{th}
  • Regulation
    • No antigen, antibody test allowed.
    • Evaluated by 3 medical laboratories

• Lab accreditation and external quality control
  • Nearly 100 laboratories
  • Testing Capacities
    • 20,000 tests per day or more

Health officer, Medical company, M.D.; Seoul Station (Jan. 27\textsuperscript{th})
Molecular test

- Sample collection
  - Negative pressure room; bottleneck
  - Drive-through (Flu-vaccination in USA), Walk-through

- Pooling for mass screening nursing homes, military recruits
  - Pooling of around 10 NPS specimens
  - Low costs, High speed

- K-bio companies
Molecular test

- Diagnostic is useful but it is not for cure
  - Saving persons and waiting for vaccines or therapeutics

- It looked impossible to contain the transmission when the number of patients surged in Daegu, but it seems to be successful till now.

No. of patients in Daegu (>6,000)
Summary

• “Detection, Isolation and Trace”
  • Minimize the transmission of SARS-CoV-2
  • Real time PCR testing is main diagnostic tools

• Cooperation and communication
  • Public health and Medicine
  • Medicine and Biotech companies

• Trained Personnel and Technologies are necessary
  • Real time PCR
  • Rapid real time PCR (future)
Korean Society for Laboratory Medicine Practice Guidelines for the Molecular Diagnosis of Middle East Respiratory Syndrome During an Outbreak in Korea in 2015
Chang-Seok Ki, M.D., Hyukmin Lee, M.D., Heungsup Sung, M.D., Sinyoung Kim, M.D., Moon-Woo Seong, M.D., Dongeun Yong, M.D., Jae-Seok Kim, M.D., Mi-Kyung Lee, M.D., Mi-Na Kim, M.D., Jong-Rak Choi, M.D., Jeong-Ho Kim, M.D., and The Korean Society for Laboratory Medicine MERS-CoV Laboratory Response Task Force

Comparative Evaluation of Three Homogenization Methods for Isolating Middle East Respiratory Syndrome Coronavirus Nucleic Acids From Sputum Samples for Real-Time Reverse Transcription PCR
Heungsup Sung, M.D., Dongeun Yong, M.D., Chang-Seok Ki, M.D., Jae-Seok Kim, M.D., Moon-Woo Seong, M.D., Hyukmin Lee, M.D., and Mi-Na Kim, M.D.

Survey of Clinical Laboratory Practices for 2015 Middle East Respiratory Syndrome Coronavirus Outbreak in the Republic of Korea
Mi-Kyung Lee, M.D., Sinyoung Kim, M.D., Mi-Na Kim, M.D., Oh Joo Kweon, M.D., Yong Kwan Lim, M.D., Chang-Seok Ki, M.D., Jae-Seok Kim, M.D., Moon-Woo Seong, M.D., Heungsup Sung, M.D., Dongeun Yong, M.D., Hyukmin Lee, M.D., Jong-Rak Choi, M.D., Jeong-Ho Kim, M.D., MERS-CoV Laboratory Response Task Force of The Korean Society for Laboratory Medicine

External Quality Assessment of MERS-CoV Molecular Diagnostics During the 2015 Korean Outbreak
Moon-Woo Seong, M.D., Seung Jun Lee, M.D., Sung Im Cho, M.S., Kyunghil Ko, M.T., Mi-Na Kim, M.D., Heungsup Sung, M.D., Jae-Seok Kim, M.D., Ji Soo Ahn, M.T., Byung Su Yu, M.T., Taek Soo Kim, M.D., Eui Chong Kim, M.D., and Sung Sup Park, M.D.