Analysis of 25,000 Lab-Confirmed COVID-19 Cases in Wuhan: Epidemiological Characteristics and Non-Pharmaceutical Intervention Effects

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Huge Thanks to Our Staff

- HSPH Biostat: Amanda King, Elizabeth Solinga
- HSPH IT: Shawn DeAntonio, Katherine Targett
- HUIT: Maria Apse, Scott Yockel

Participants are welcome to comment and ask questions using Zoom chat

HEALTH AND SCIENCE

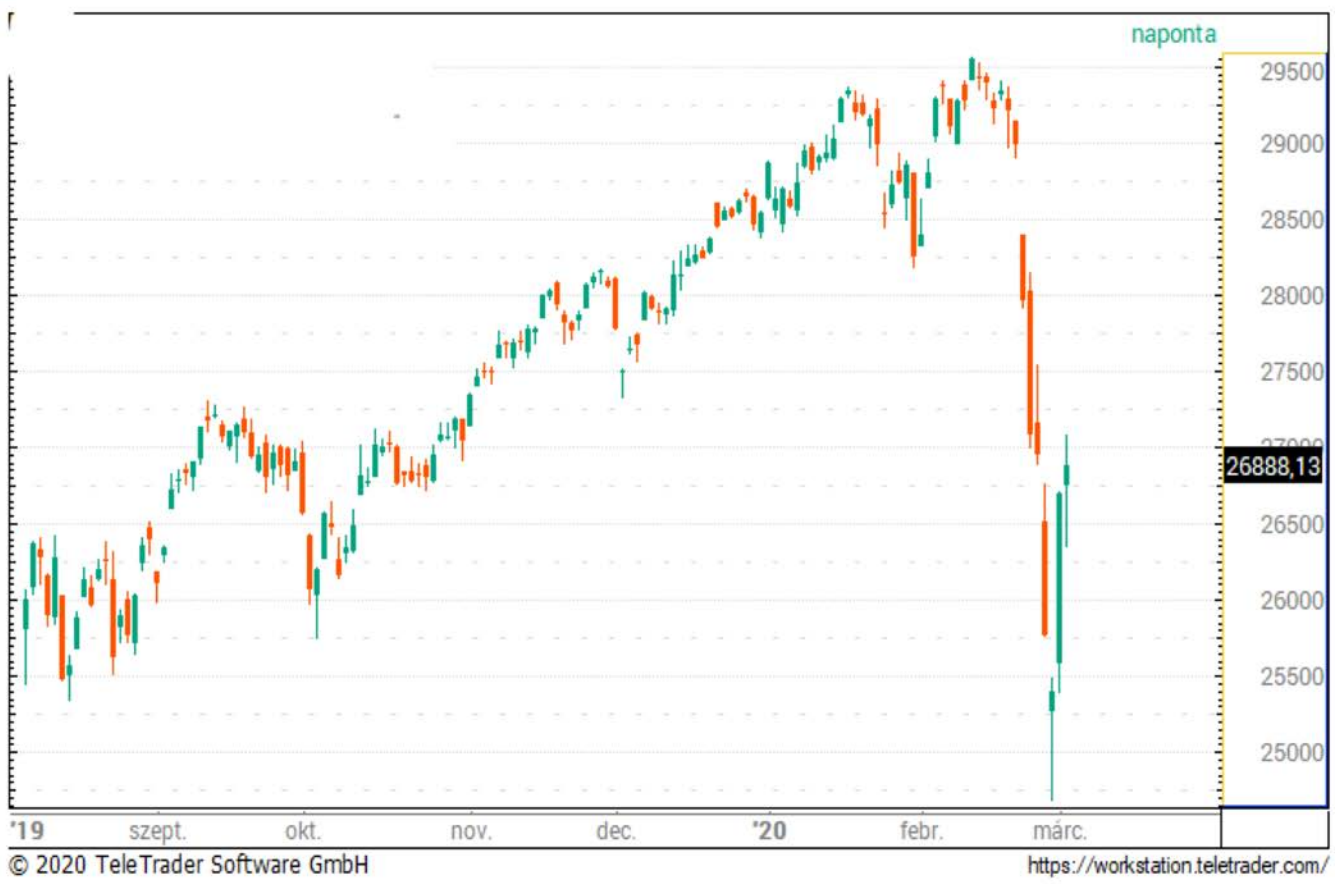
Top US health official says the coronavirus is 10 times 'more lethal' than the seasonal flu

PUBLISHED WED, MAR 11 2020•10:47 AM EDT | UPDATED WED, MAR 11 2020•4:31 PM EDT

Noah Higgins-Dunn
@HIGGINSDUNN
Berkeley Lovelace Jr.
@BERKELEYJR

Dr. Anthony Fauci, Director of the NIH National Institute of Allergy and Infectious Diseases testified about COVID-19, during a Senate Committee on March 3.

Stock Market



Local Grocery Stores, MA (March 12, 2020)

BJ, Natick

Roche Brother, Wellesley

A lot of public panic right now

I would like to start with a positive message

The Wuhan intervention experience tells us that we can stop the COVID-19 outbreak

Main Goals

- What can we learn from the Wuhan experience in controlling for the COVID-19 outbreak?
- What worked and what did not work?
- Take home messages

The manuscript is on MedRxiv

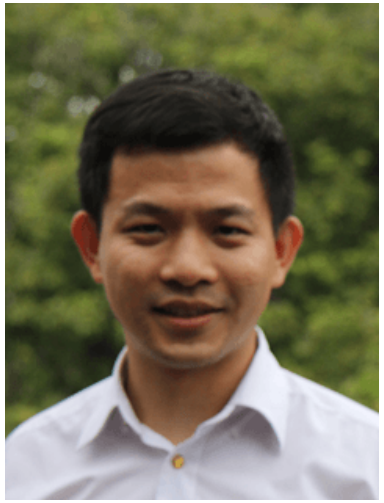
- Wang, et al (2020): Evolving Epidemiology and Impact of Non-pharmaceutical Interventions on the Outbreak of Coronavirus Disease 2019 in Wuhan, China

- A summary of the key findings is at my tweet @XihongLin

Acknowledgement

Chaolong Wang, Li Liu, Xingjie Hao, Huan Guo, Qi Wang, Jiao Huang,

Na He, Hongjie Yu, An Pan, Sheng Wei, Tangchun Wu



Tongji School of Public Health

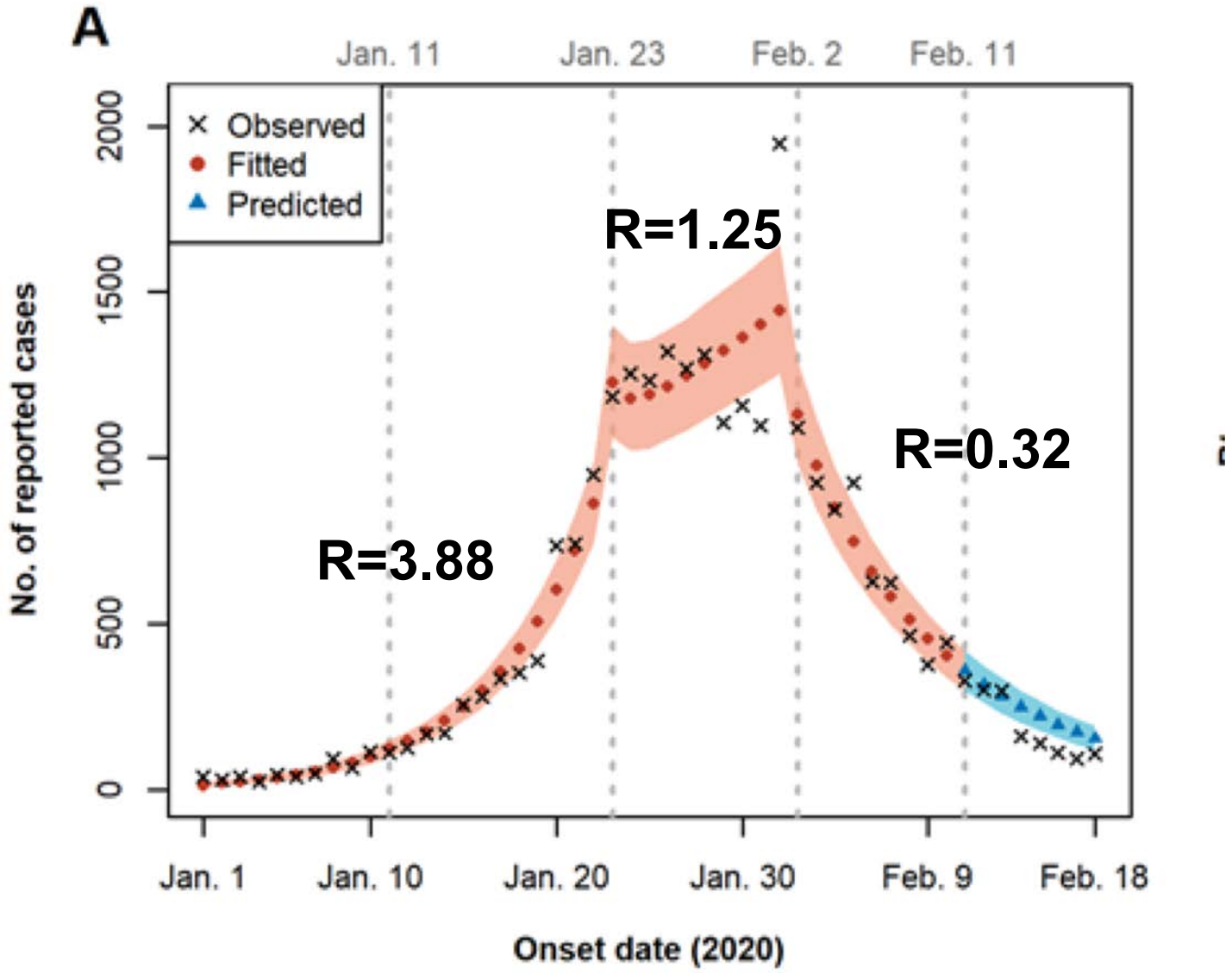
Huazhong Science and Technology University

Wuhan

(blue=HSPH alum)

Thank all of my Tongji SPH co-authors for their tireless work on finishing this manuscript in a short time. The gained knowledge benefits US and other countries at this critical time.

Key Point: Wuhan Experience tells us the COVID-19 Outbreak Can Be Controlled by Effective Interventions: Centralized Quarantine



Effective reproductive number R_t

Wuhan

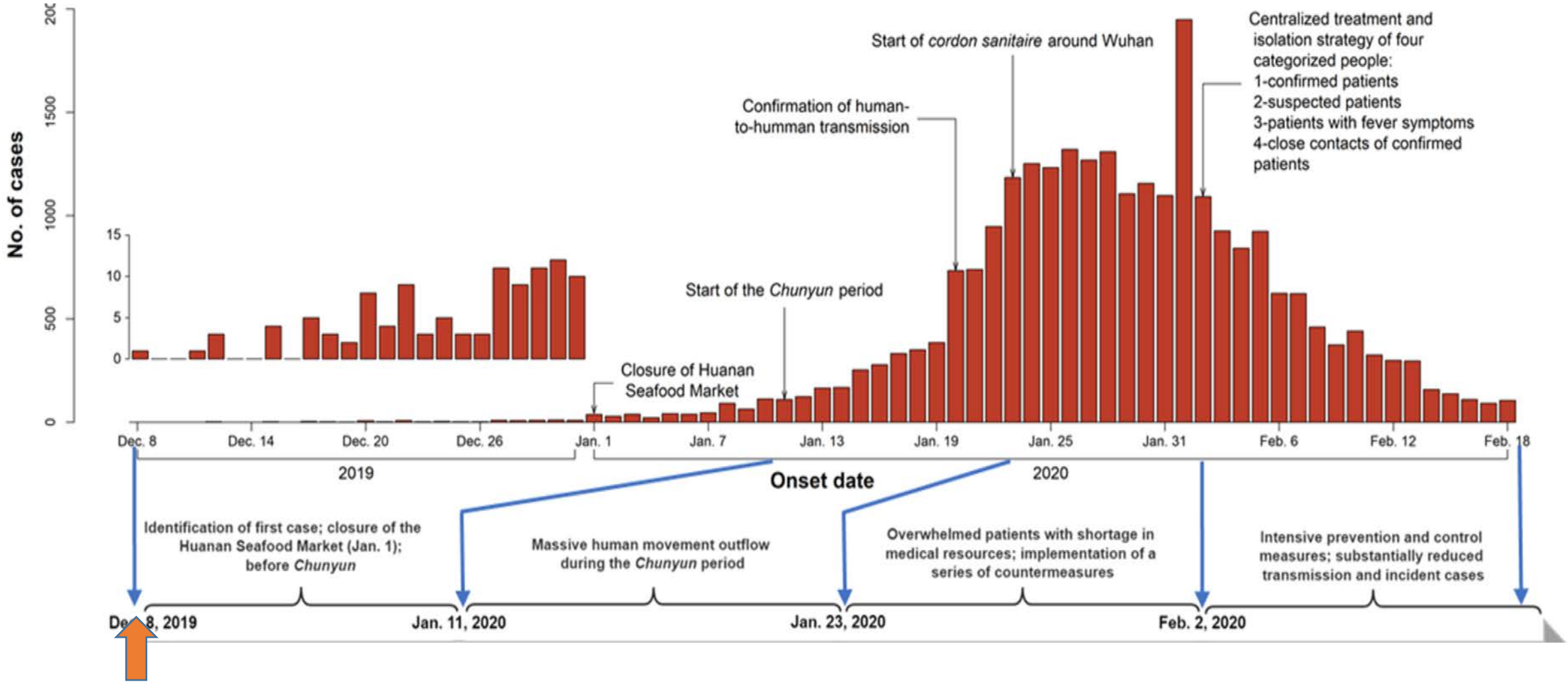
Population size: 11M

Wuhan: A Beautiful City

Wuhan: A Beautiful City

East Lake, Cherry Blossom

Wuhan CDC (n=25,961): December 8 – February 18



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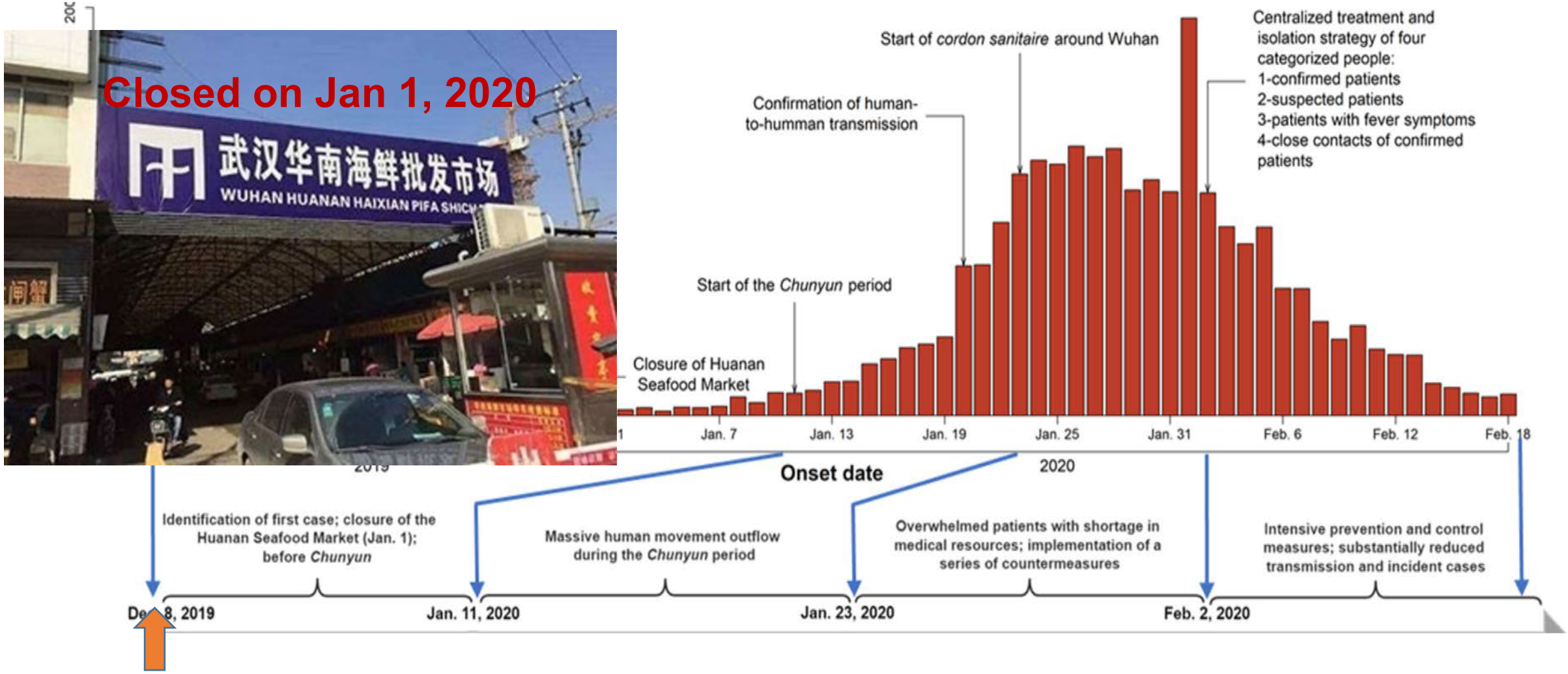

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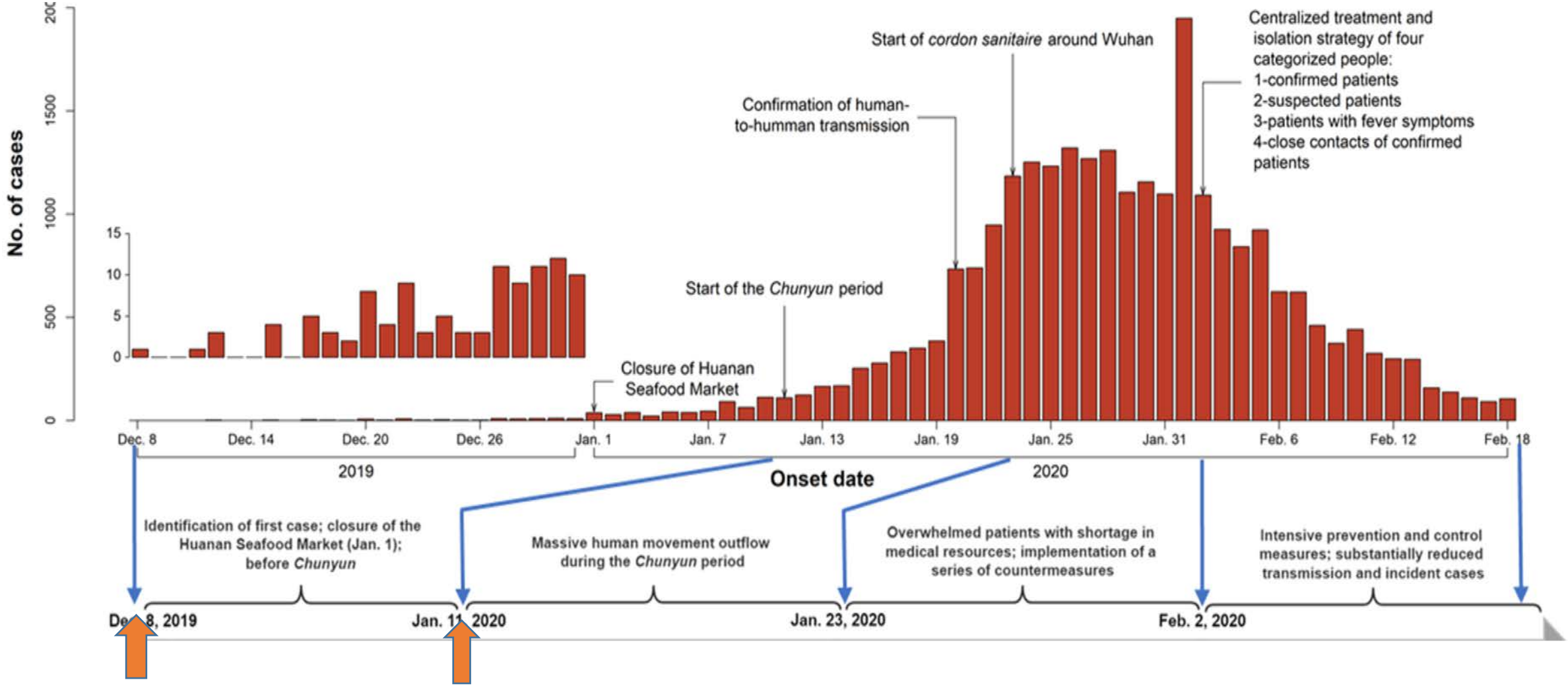

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Jan 11, 2020: Start of Spring Festival Travel

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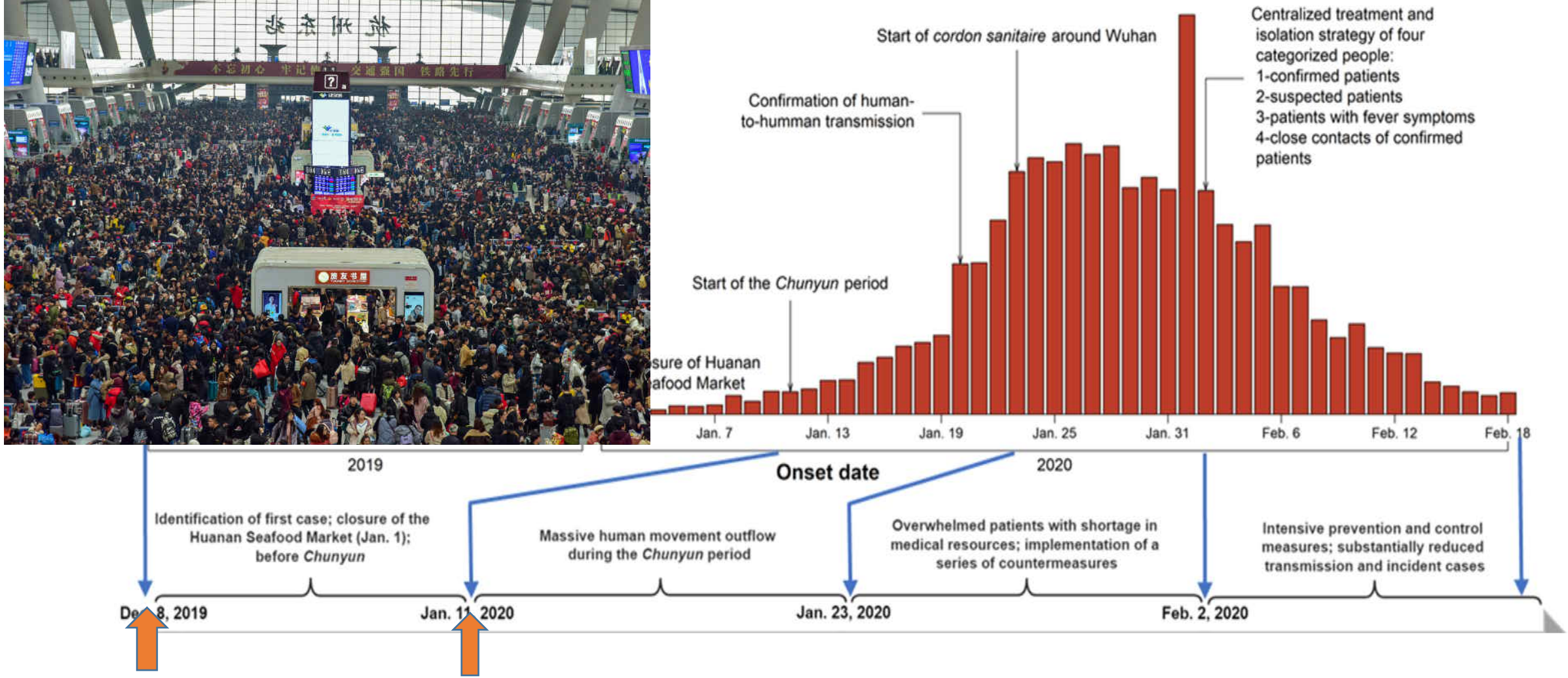

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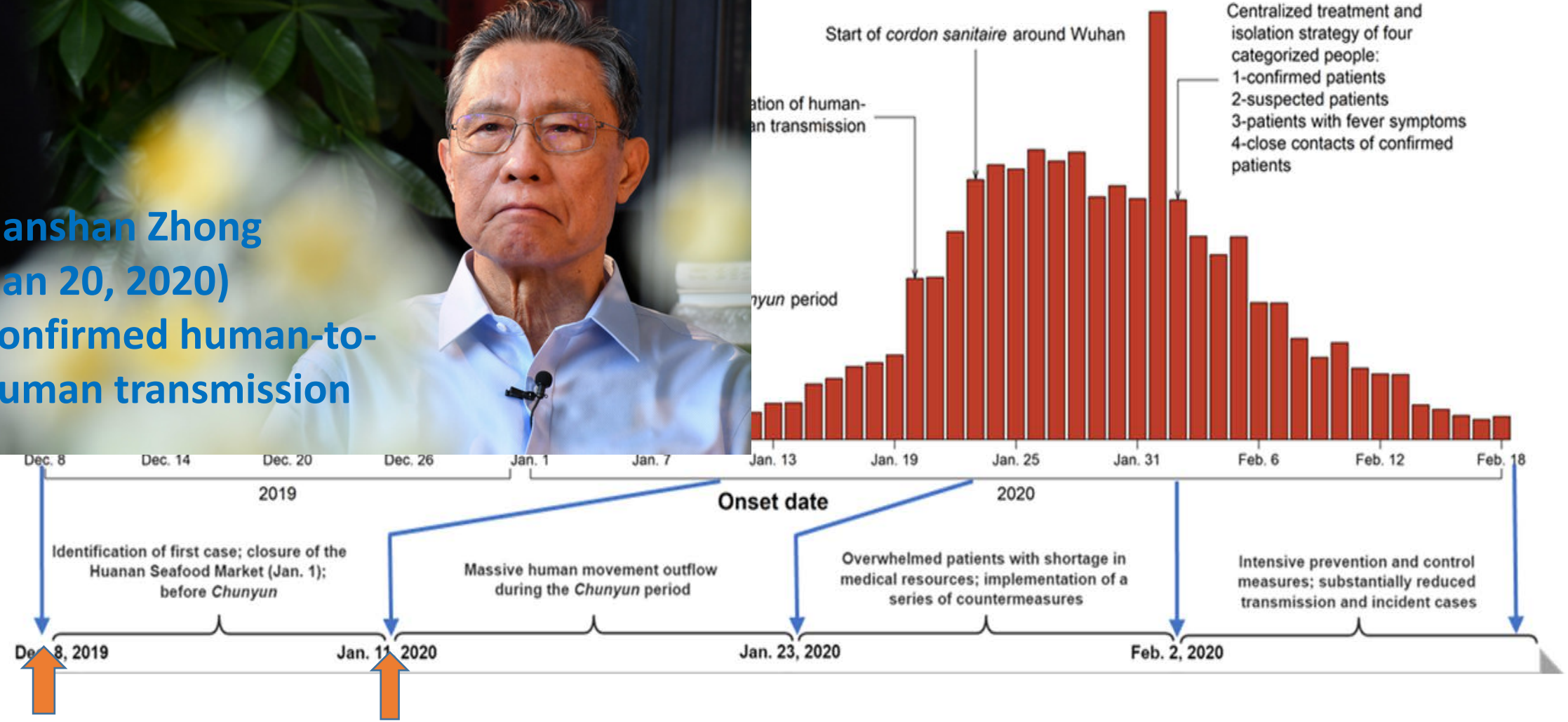
Nanshan Zhong
(Jan 20, 2020)
Confirmed human-to-human transmission



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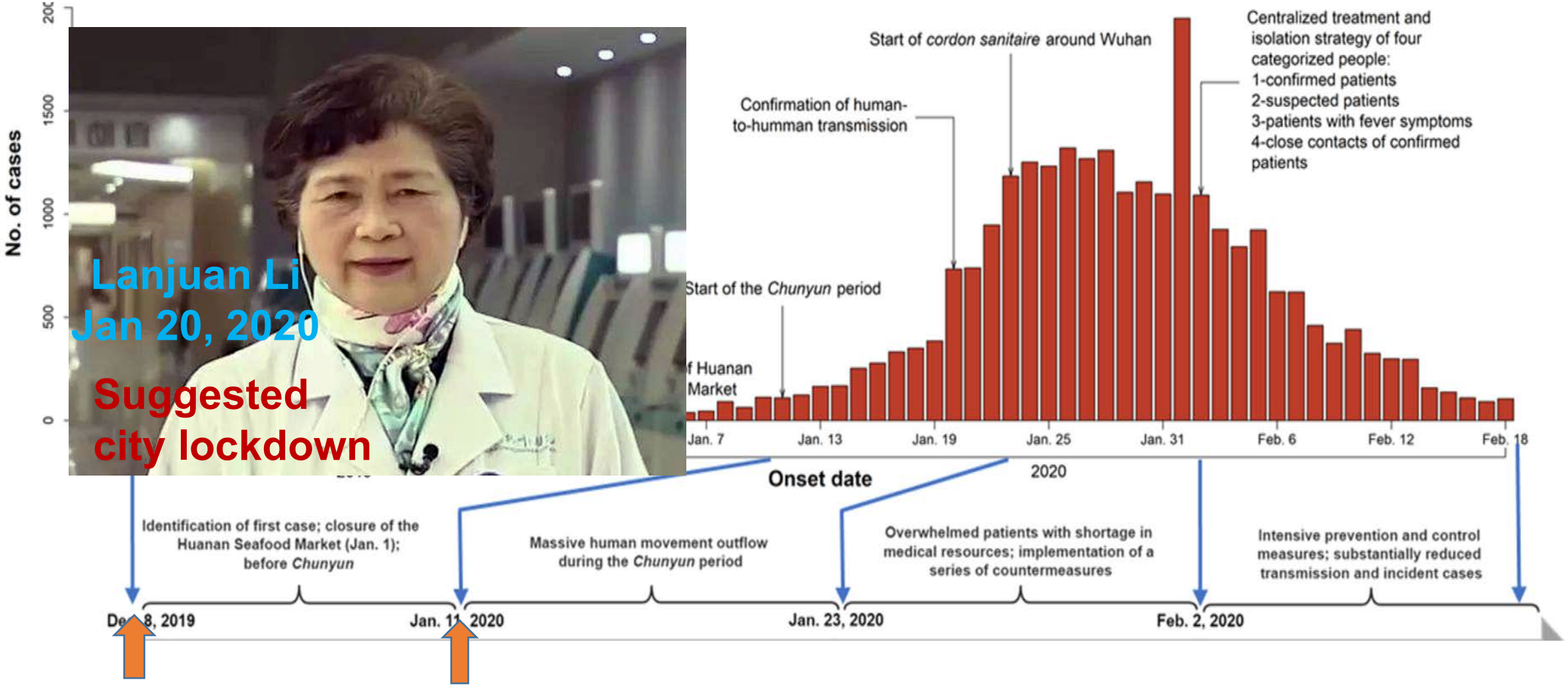

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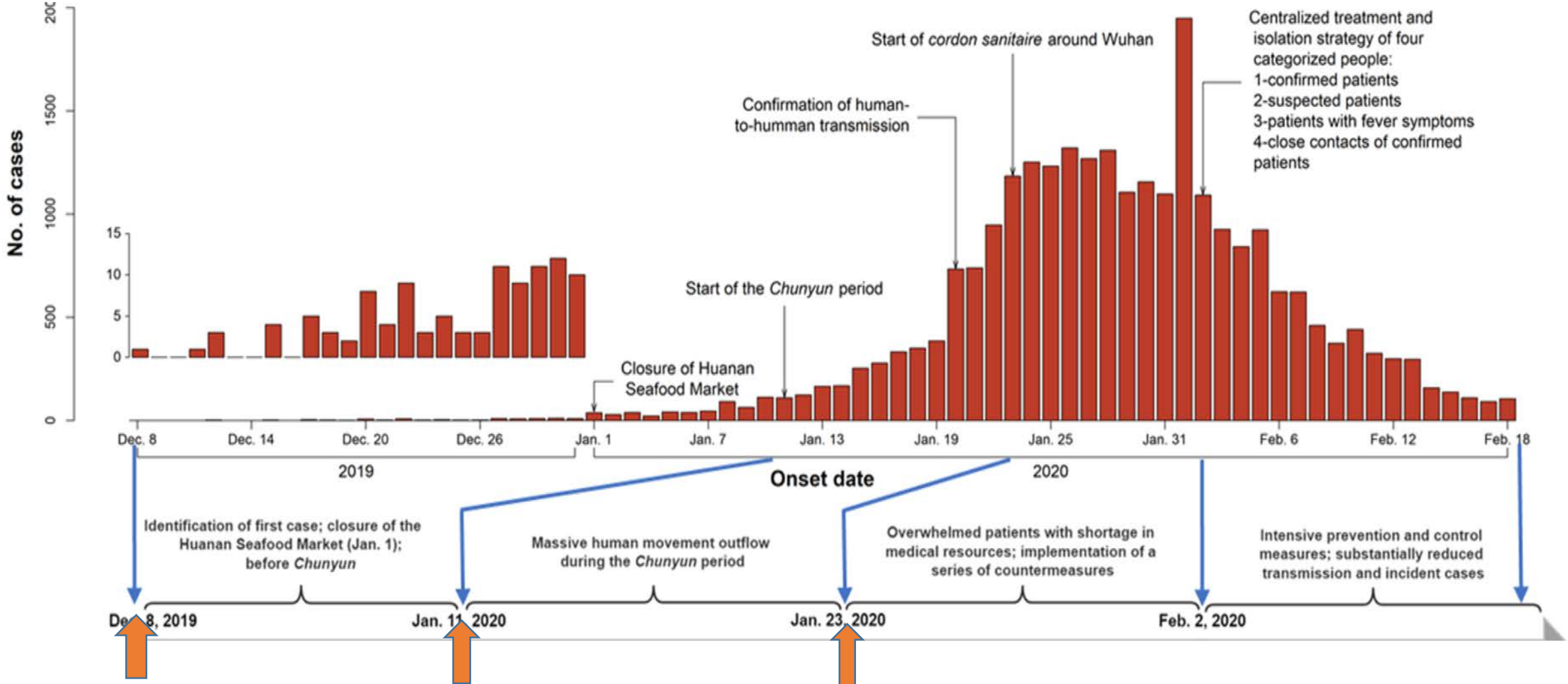

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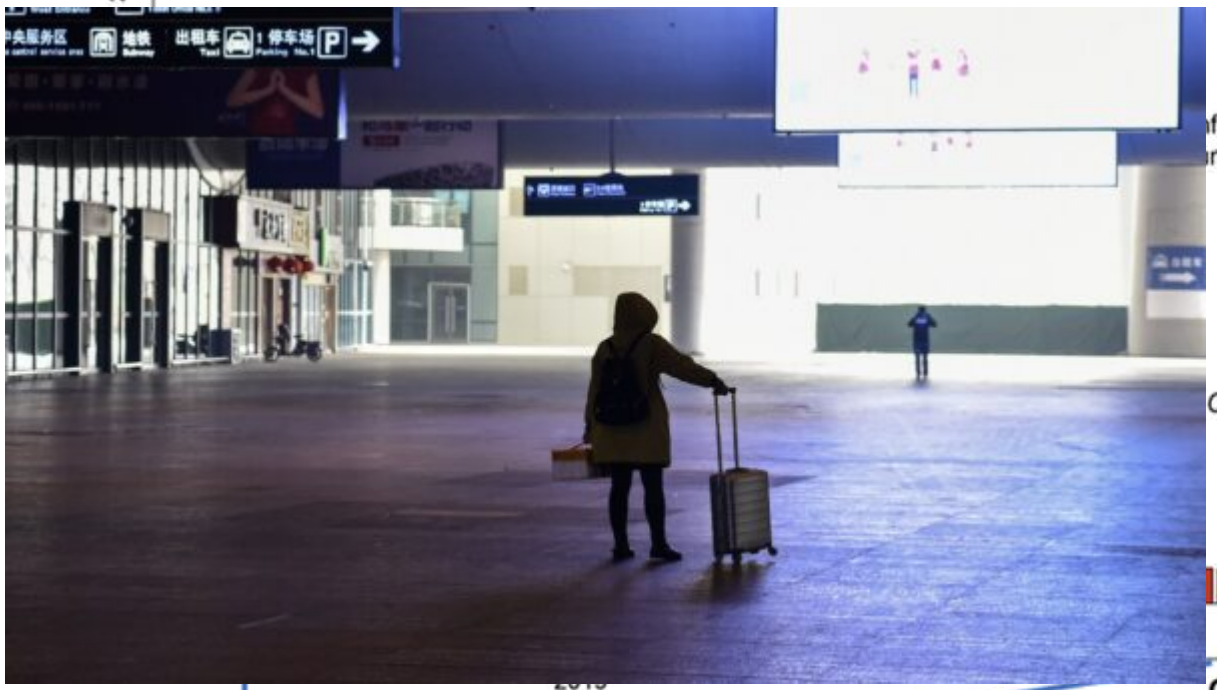

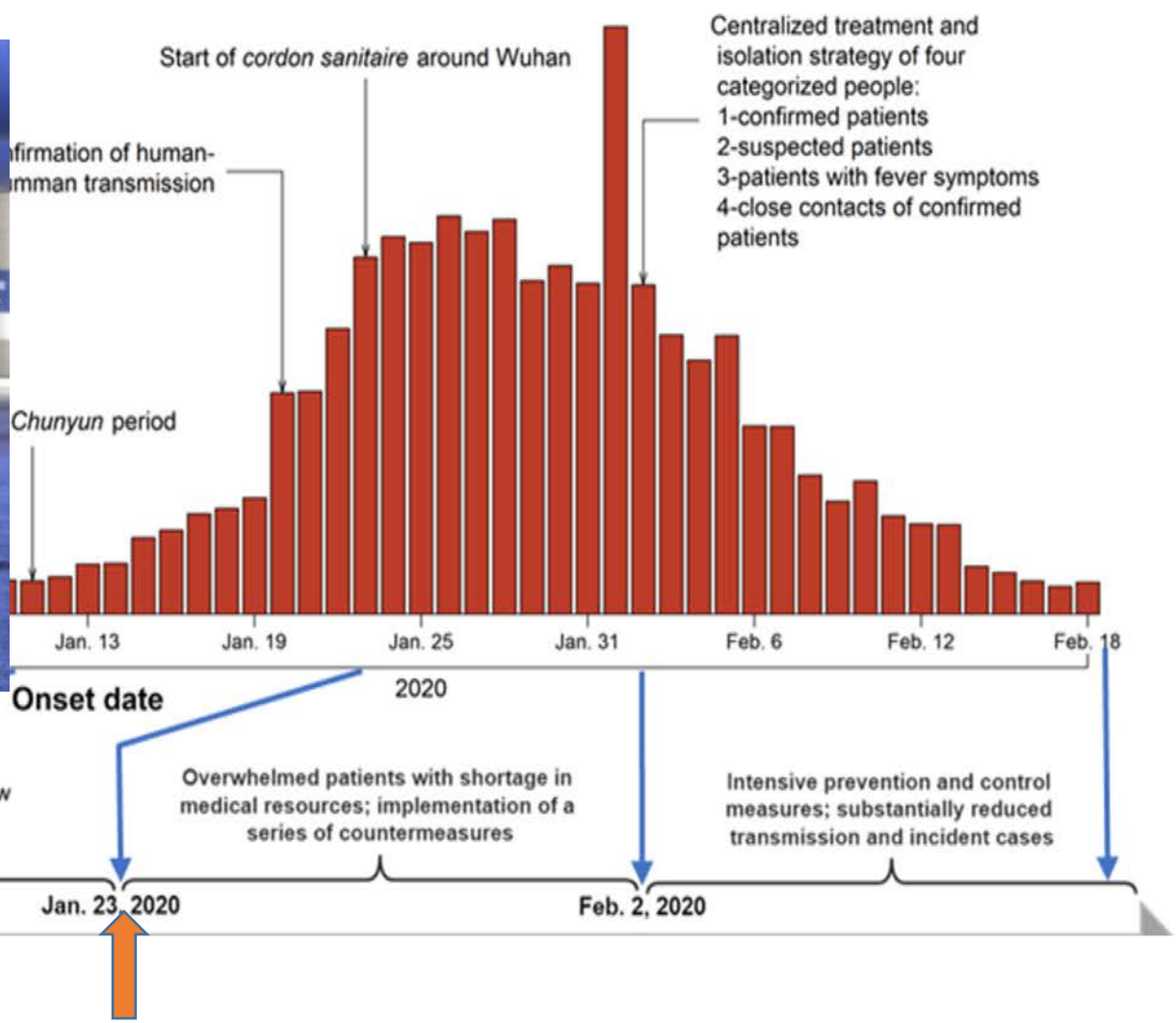

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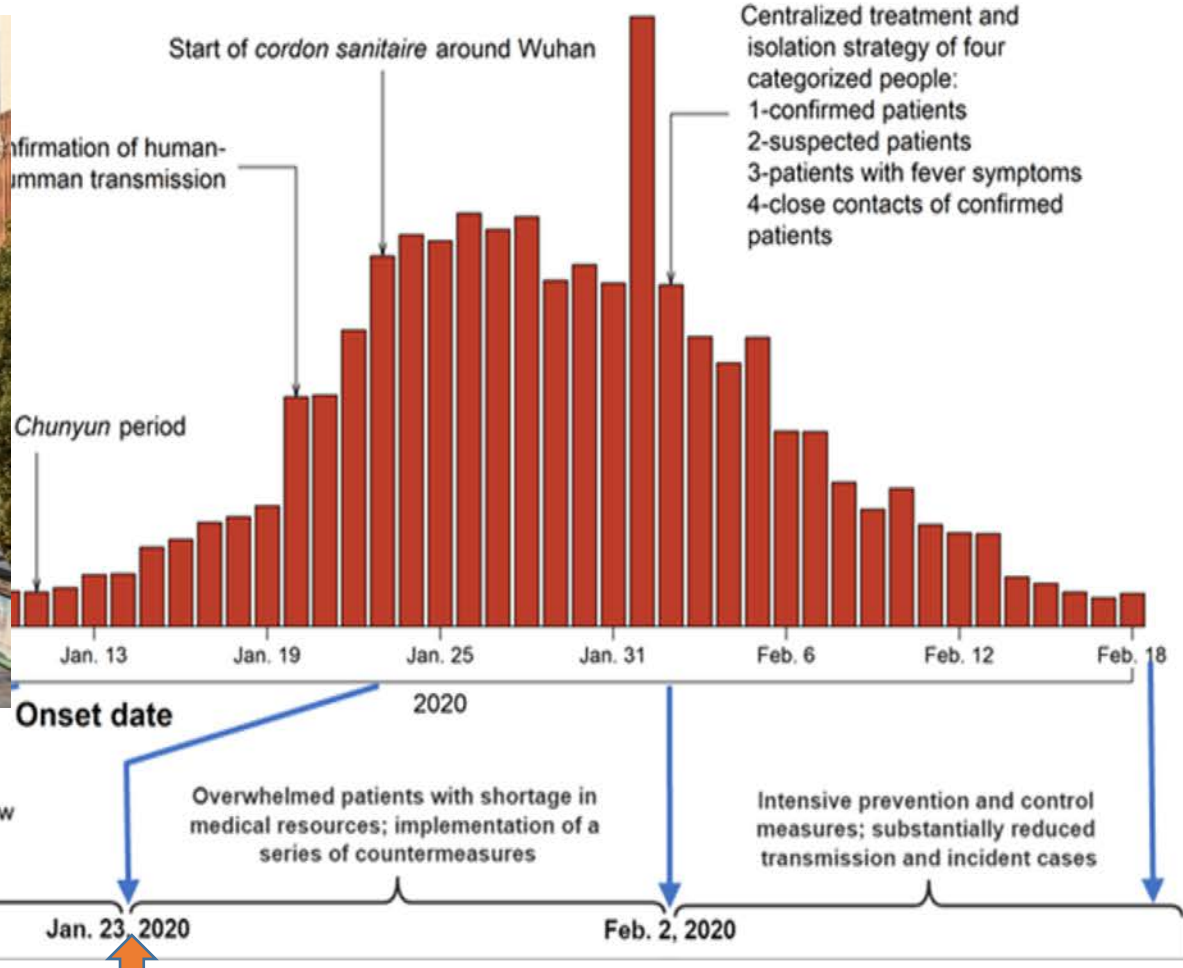

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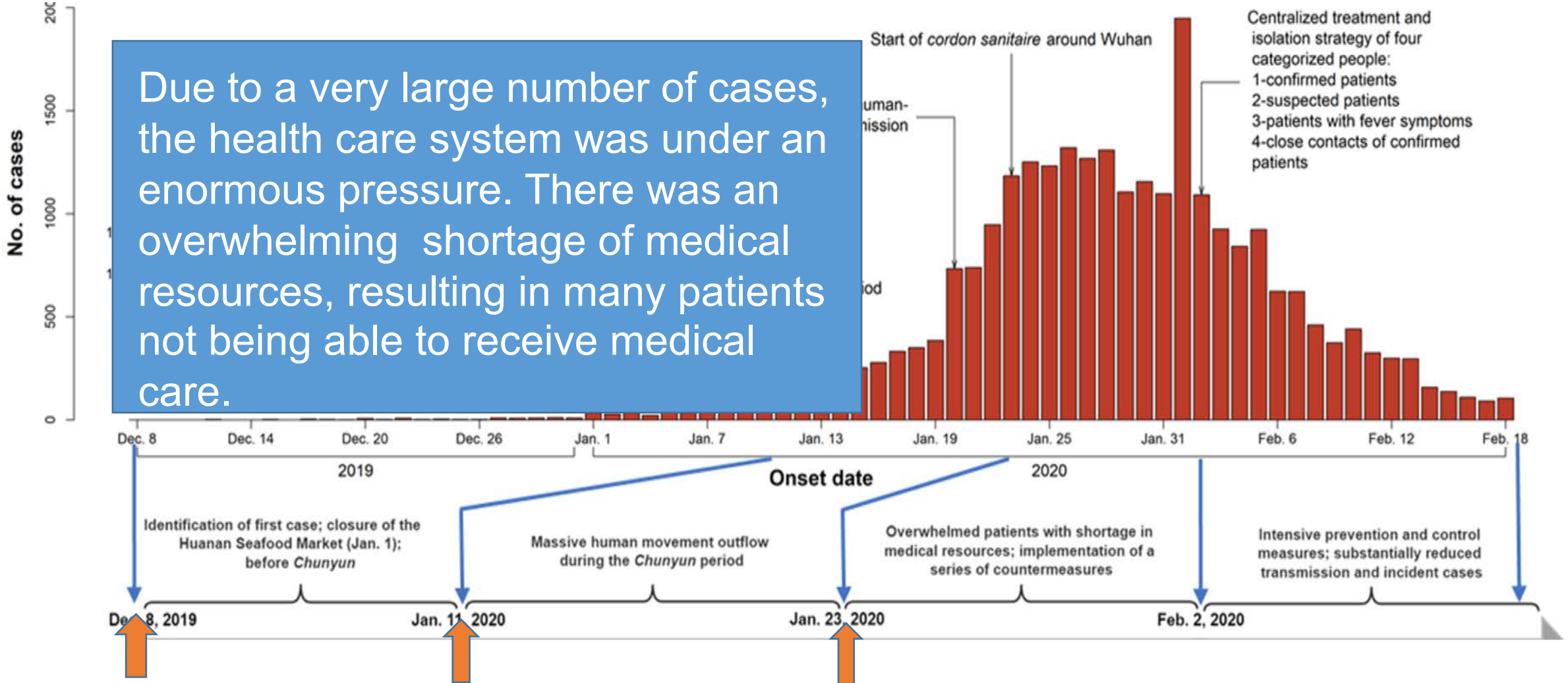

Due to a very large number of cases, the health care system was under an enormous pressure. There was an overwhelming shortage of medical resources, resulting in many patients not being able to receive medical care.

Dec 8, 2019: First case: close to the Huanan Seafood Market

Jan 11, 2020: Start of Spring Festival Travel

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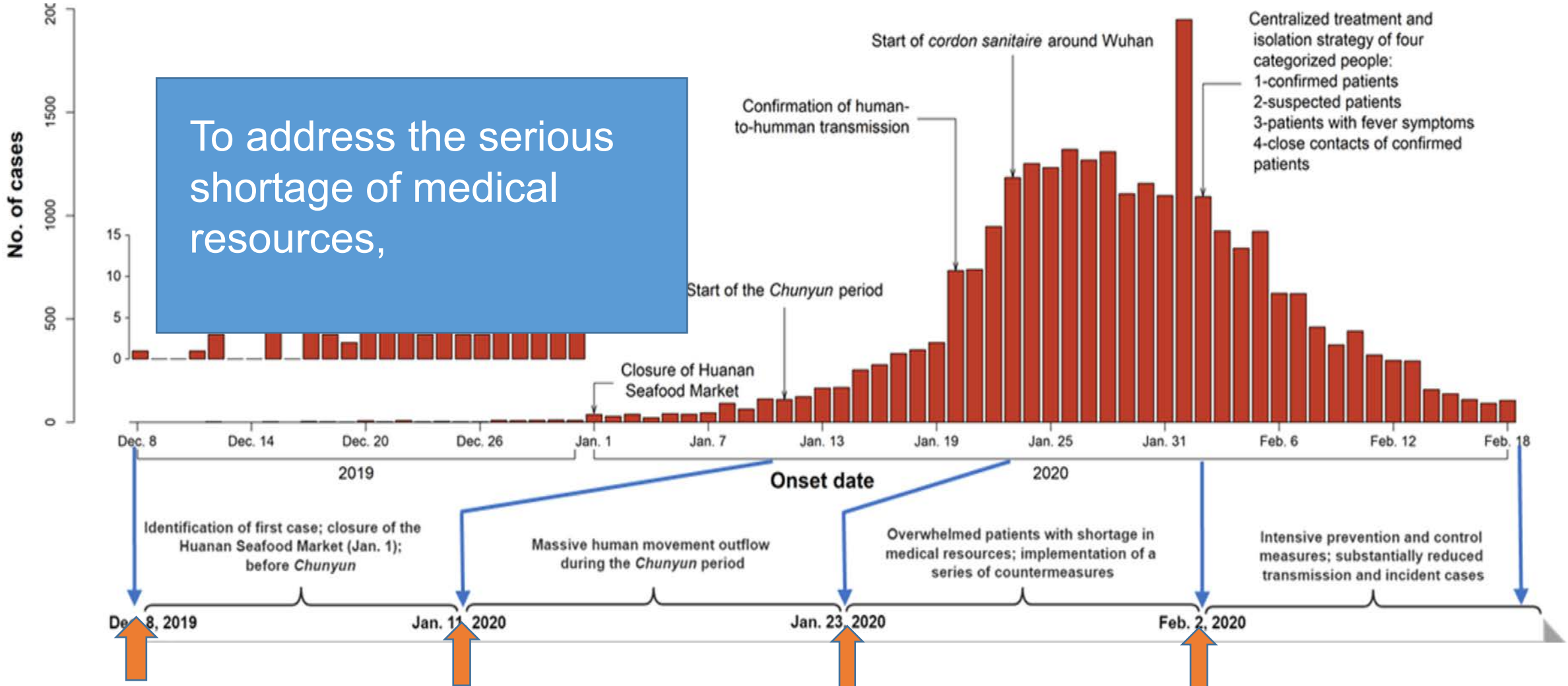
Wuhan CDC (n=25,961): December 8 – February 18

To address the serious shortage of medical resources,



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Feb 2, 2020 Fangchang (Mobile Cabin) Hospitals launched

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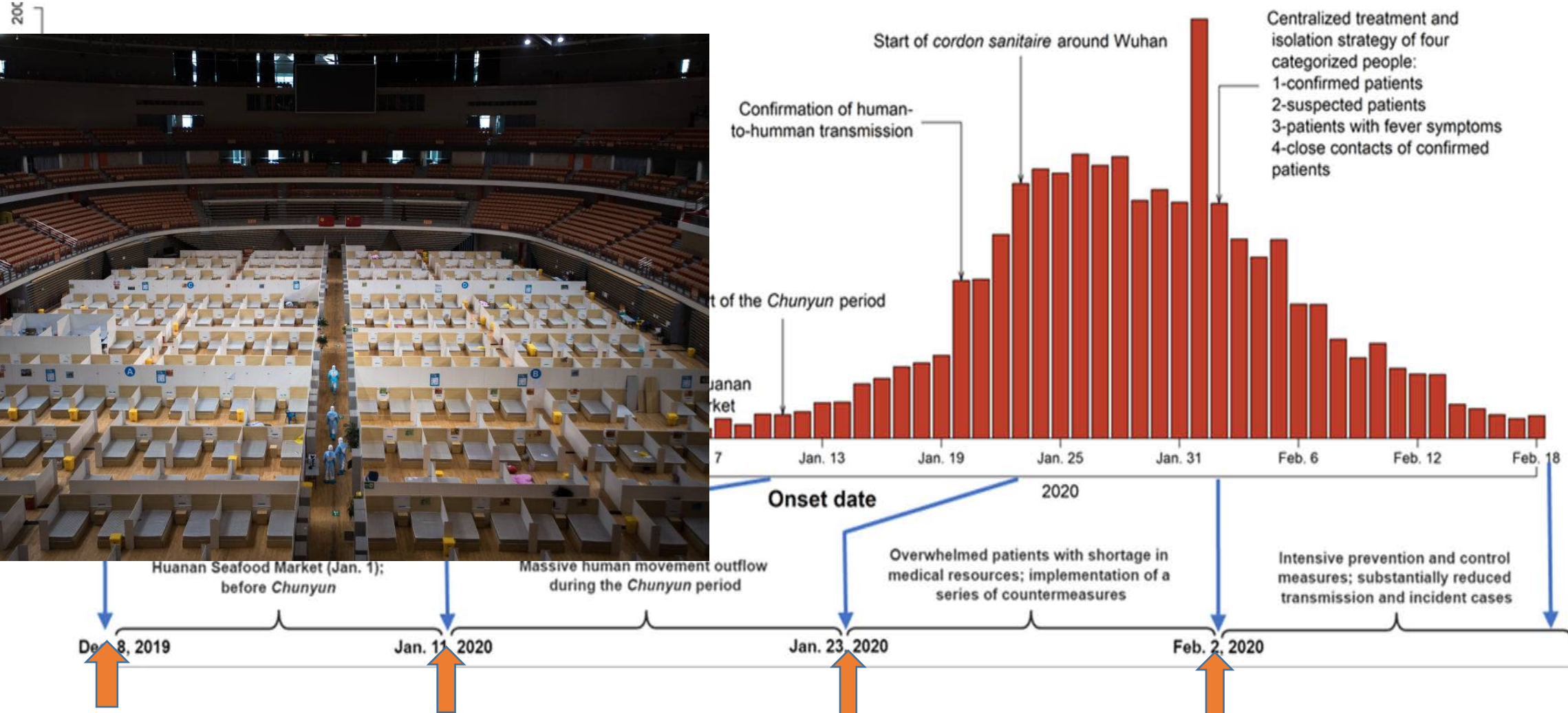

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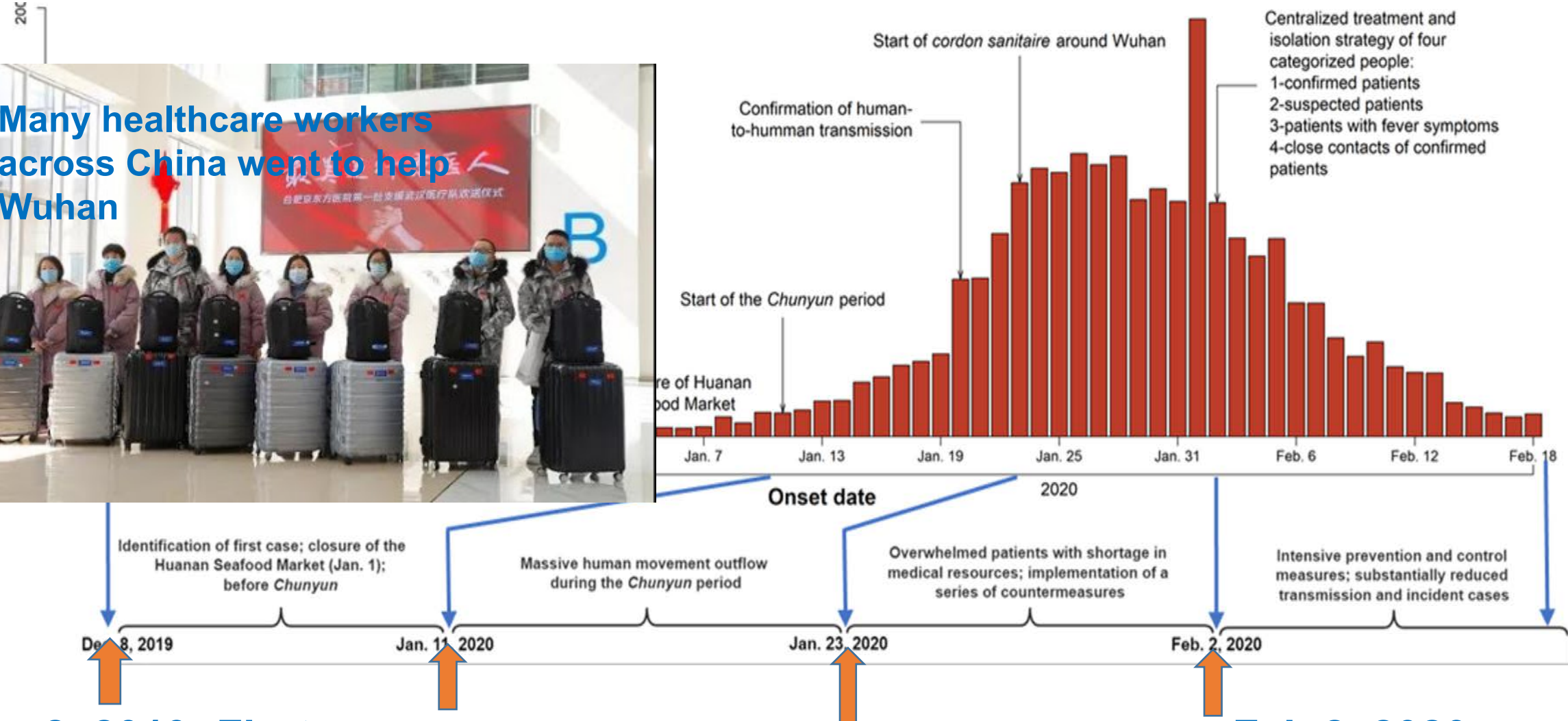

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Wuhan CDC (n=25,961): December 8 – February 18

Many donations from China and other countries

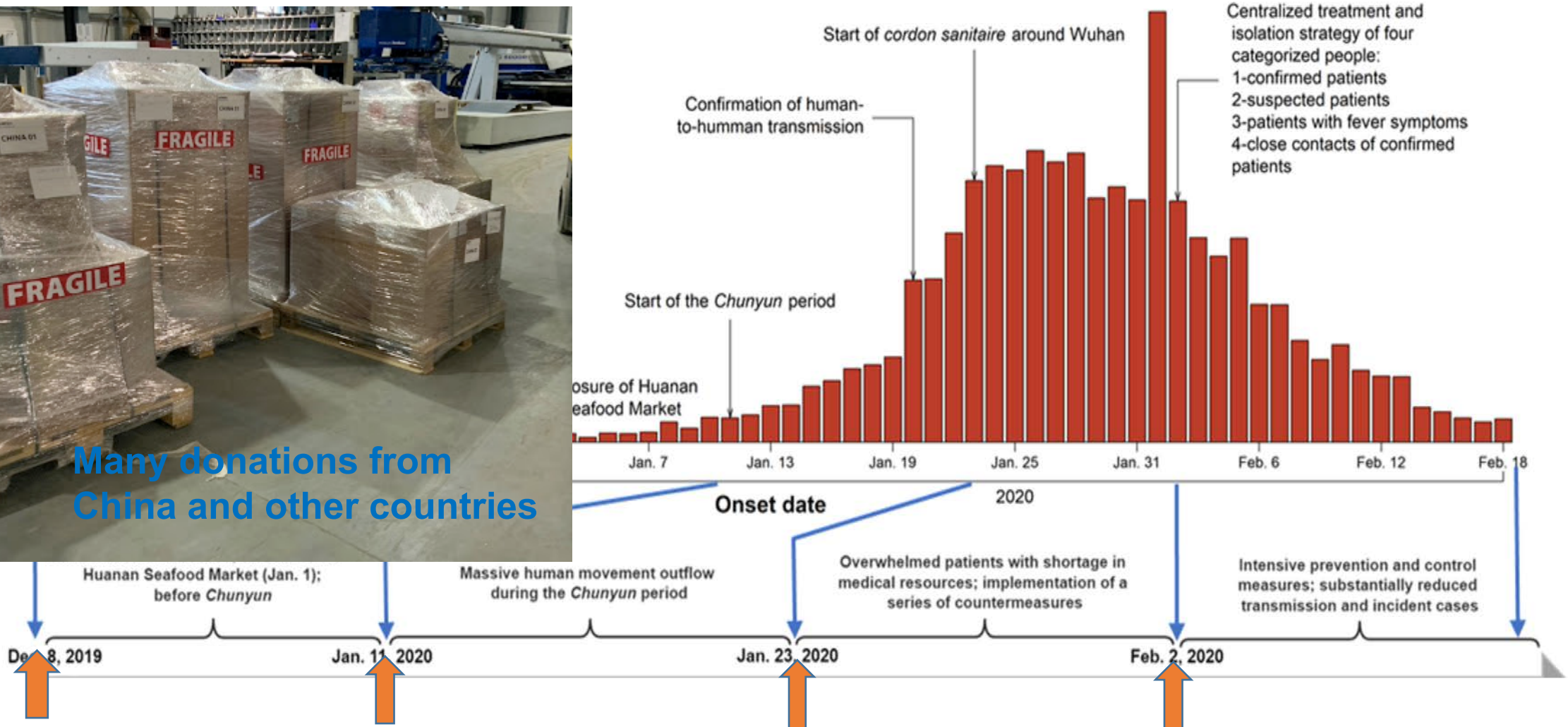

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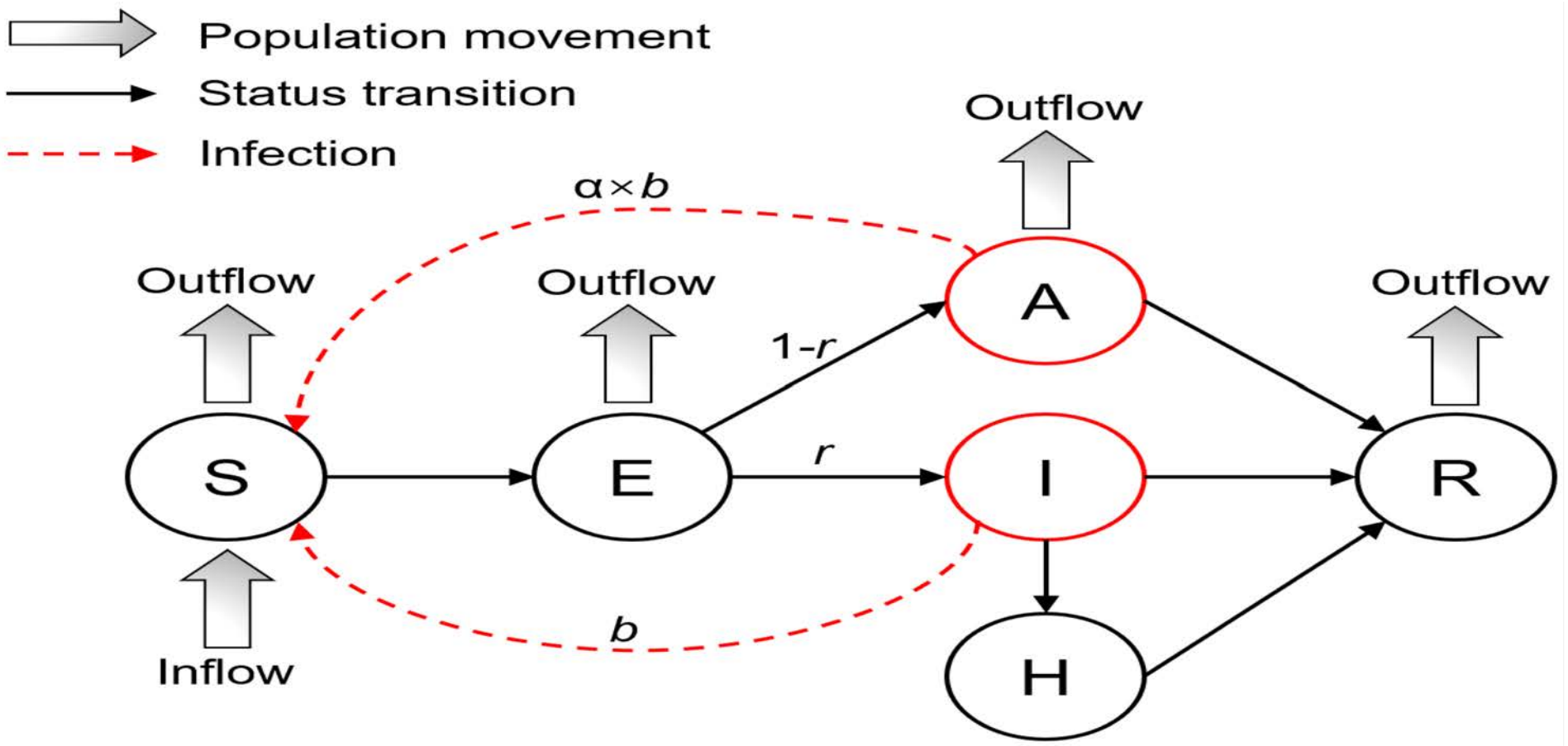
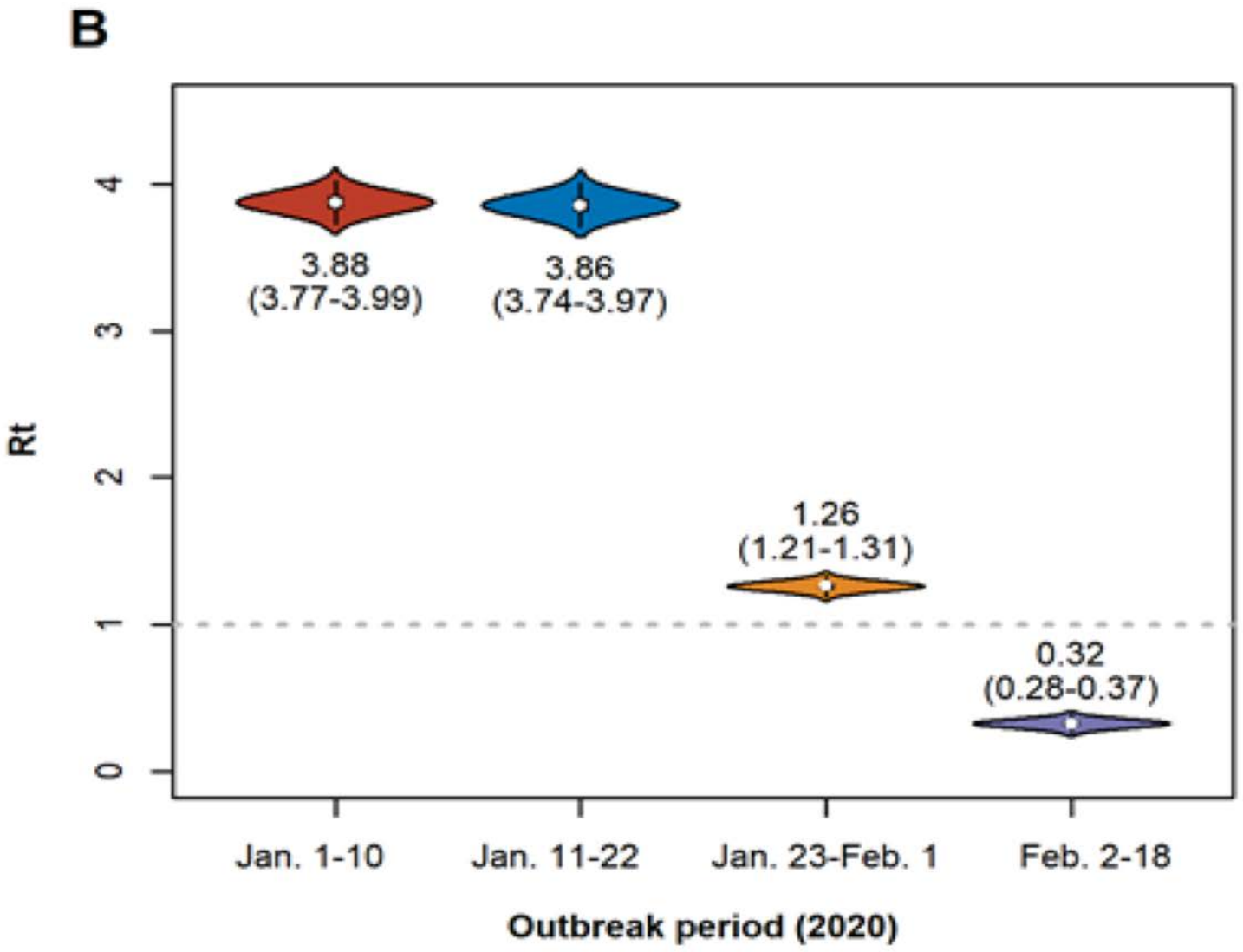
Illustration of the Extended SEIR Model



S (susceptible), E (latent), I (ascertained infectious), A (unascertained infectious), H (hospitalized), and R (removed)

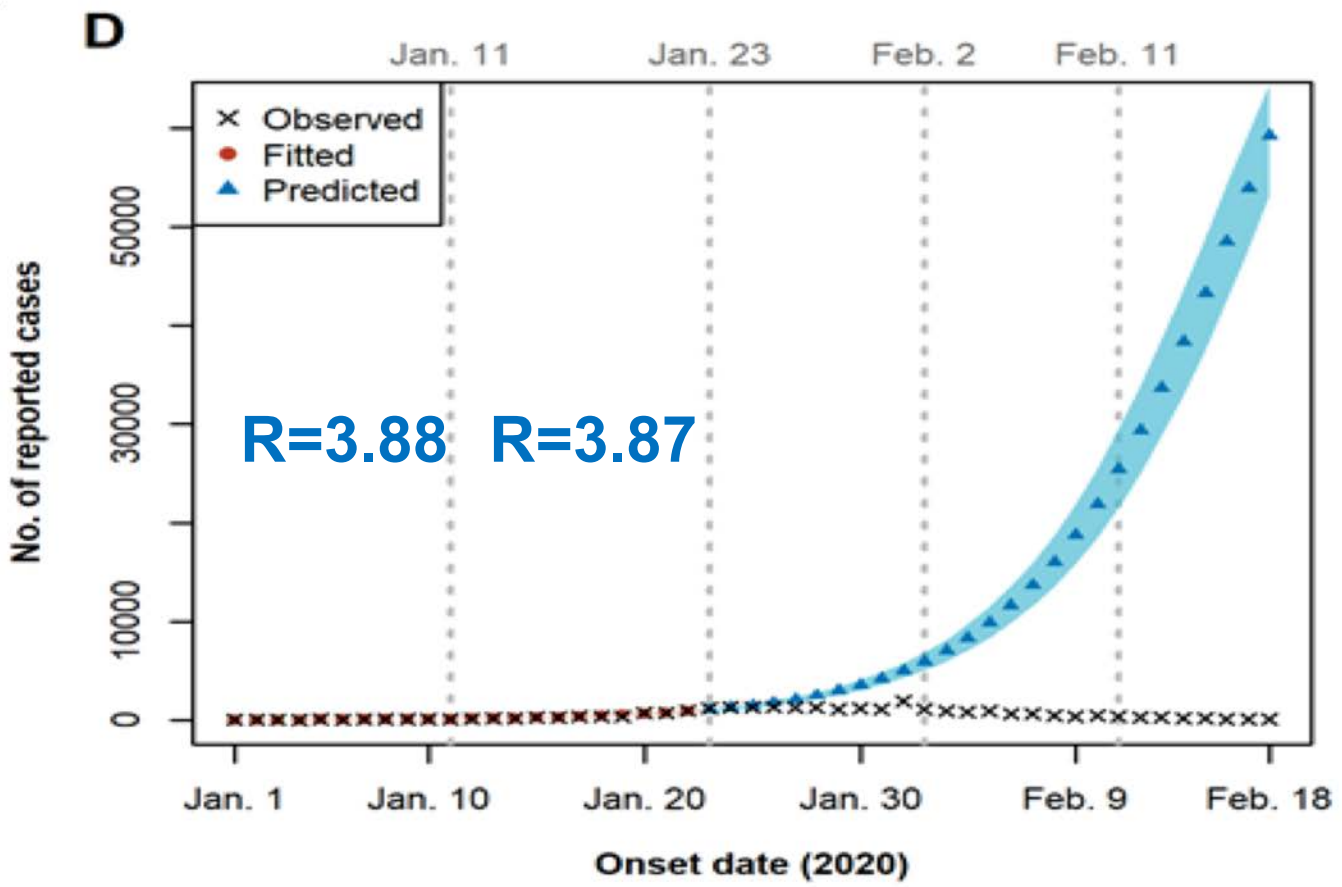
Estimated Effective Reproducible Number R



Assume

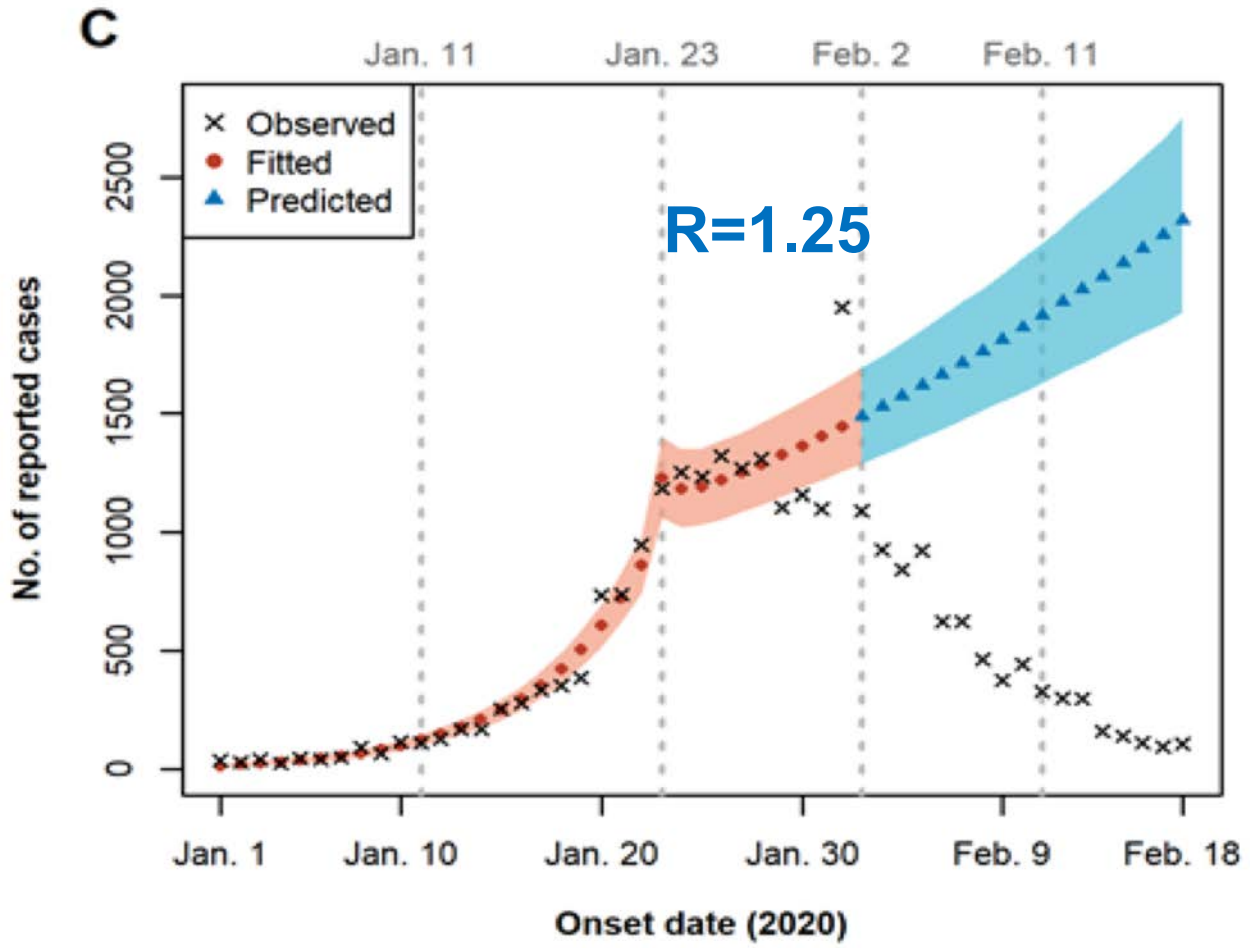
- Incubation period =5.2 days
- Infection period=2.3 days
- # of unascertained cases = # of ascertained cases
- 9 sensitivity analyses

Reported daily COVID-19 infections when there was no intervention before January 23, 2020



Blue = projected trajectory if no prevention had continued

Reported daily COVID-19 infections under lockdown with traffic ban and many quarantined at home between January 23-Feb 1, 2020



Blue = Projected trajectory if this intervention had continued.

Take home message #1: Lockdown with Traffic Ban and Home-Quarantine Helped but was not enough

- Family transmission is common.
- Infected cases might infect family members and close contacts, who could infect others in the community.
- It was challenging for infected cases to seek for medical care due to traffic ban
- As it was an honor system, it was difficult to enforce cases to stay at home. Some cases might still go out, grocery shopping, resulting in infecting others.
- Traffic ban, mitigation (social distancing) and home quarantine helped reduce R from 3.88 to 1.25, but was not good enough

Boston Case Study (Amy Proal)

Thread

Amy Proal
@microbeminded2

So I have decided to make my situation public. I am not in critical condition and am stable, but since about Feb. 23rd have been very sick with the symptoms of #COVID19 minus a high fever. My boyfriend first got sick with these symptoms on Feb. 21st and we are both still ill

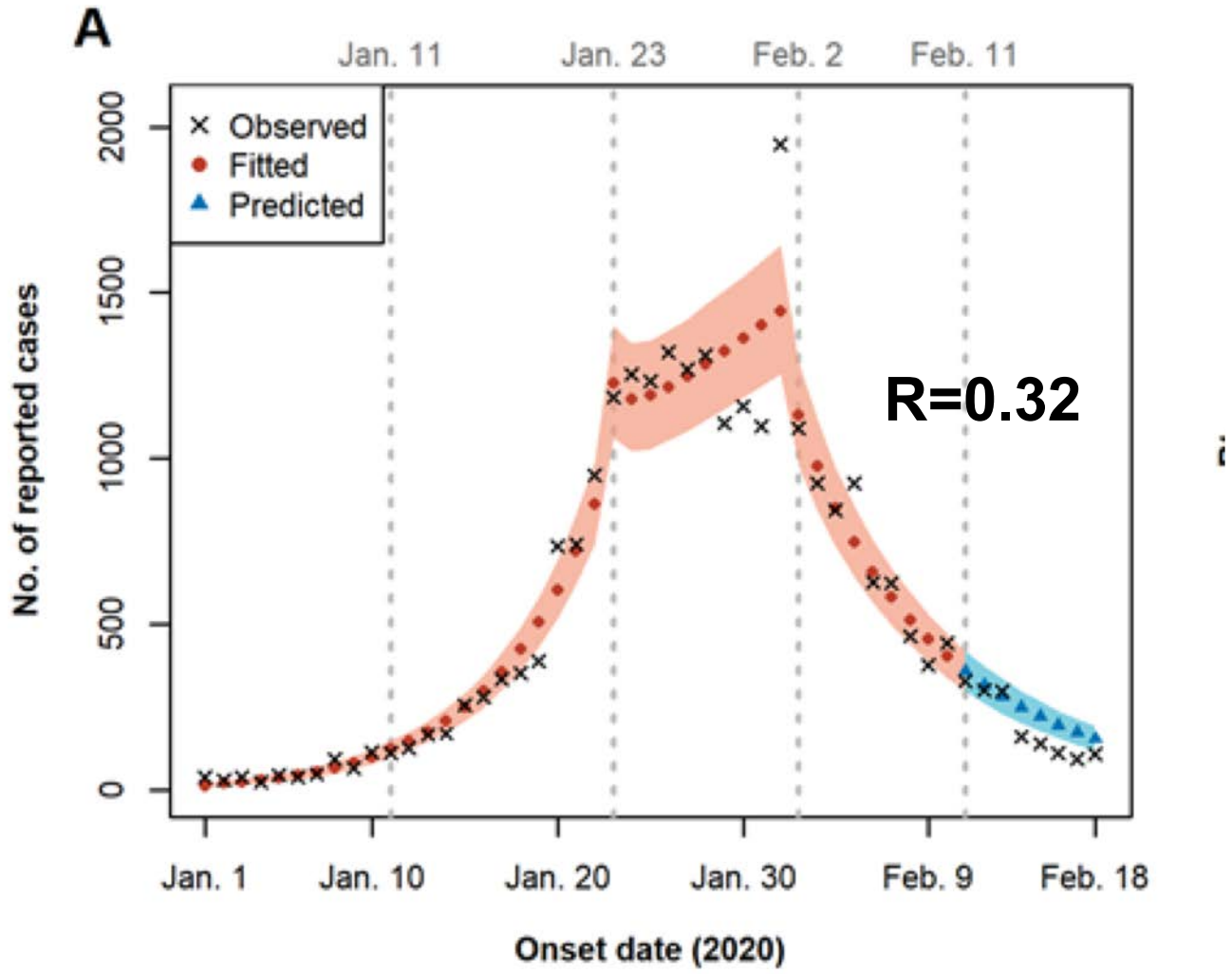
8:36 PM · Mar 9, 2020 · Twitter Web App

1.1K Retweets **3.8K** Likes

Boston Case Study 1 (Amy Proal)

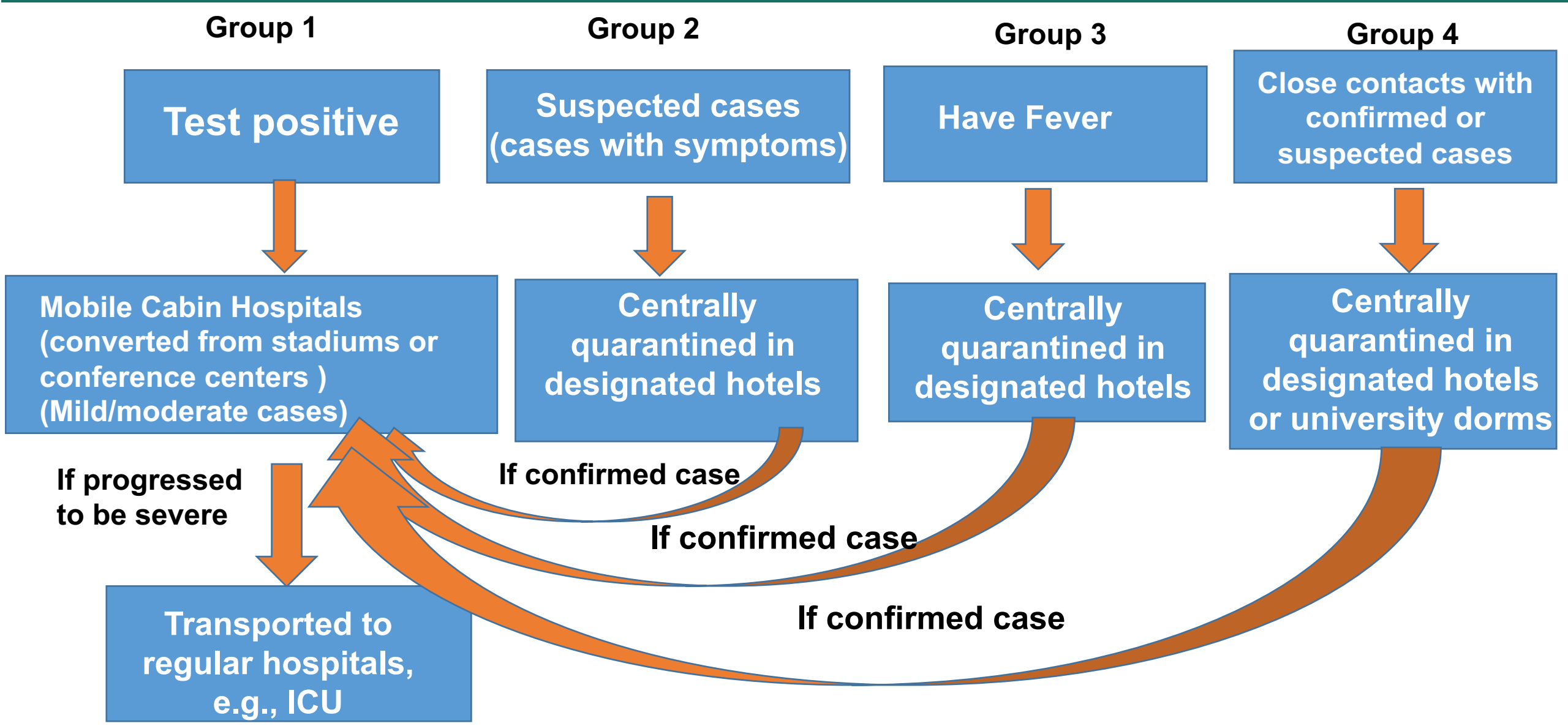
- Amy's case is typical and illustrates the issues with home isolation.
- Amy had symptoms on Feb 21, then her boyfriend had symptoms.
- Both could not get tested at MGH.
- Her boyfriend went to see his internist with no mask (as he could not find one).
- If he was infected and went to see doctor by public transportation, he might have infected others but he needed to be helped with transportation.
- The internist and the medical staff in the clinic were likely not fully protected and hence were likely to be infected.
- He was then told by his doctor to go to CVS to get medicine: He would be likely to infect others at CVS if he was a case, but he needed to get medicine.
- If mild cases are not treated early, they are likely to progress and become severe, and are at a much higher risk of death.

Reported daily COVID-19 infections using Centralized Quarantine after Feb 1, 2020



Blue = Projected trajectory if this intervention continues.

Centralized Quarantine Strategies After Feb 1, 2020



Measures for Other People During the Centralized Quarantine Period in Wuhan

- Continue home-quarantine
- Continue general traffic suspension
- Provide transportation for groups 1-4 to go to hospitals or designated hotels
- Control frequencies of going out, e.g., grocery shopping, for each household, and arrange grocery delivery
- Healthcare workers who treat patients stay in hotels or other designated facilities to avoid them from infecting family members and communities, if they are infected
- Healthcare workers in contact with cases and exposed subjects are fully protected by PPEs, such as protective suits, medical goggles, caps, face shield, masks and two layers of gloves.

Take home message #2: Centralized Quarantine worked !

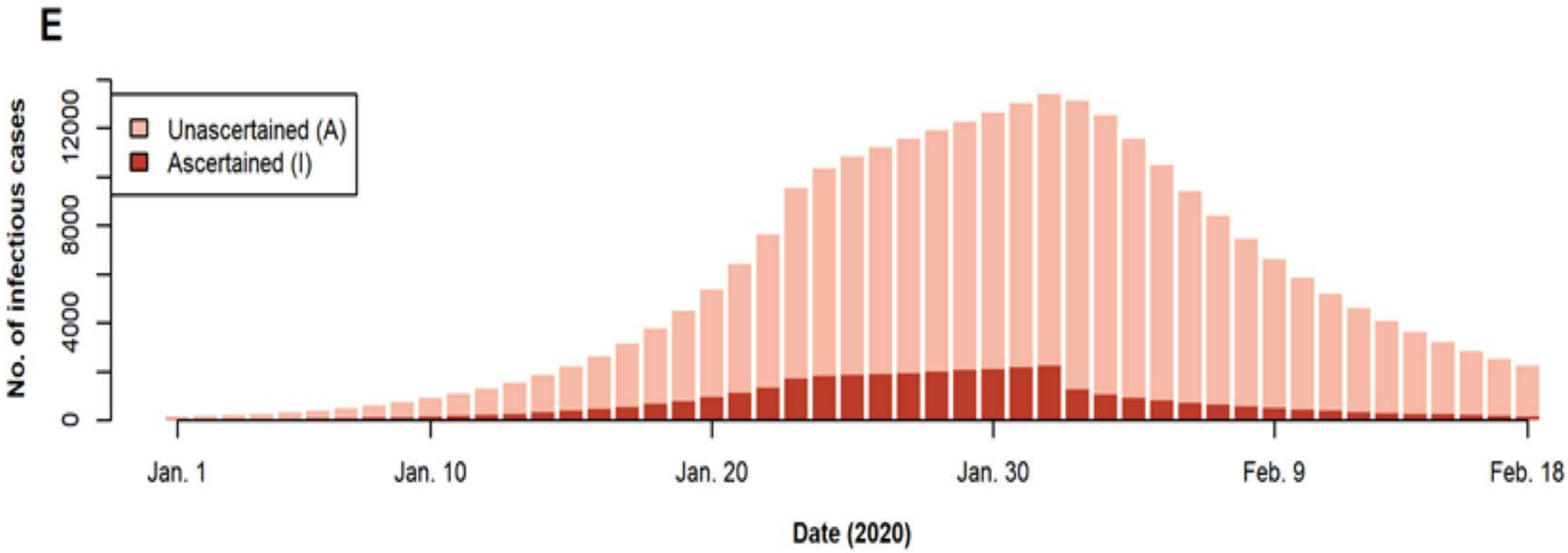
Under Centralized Quarantine:

- Infected patients, suspected cases and close contacts were less likely to infect others (reduce transmission).
- Patients received medical care immediately
- Mild cases were treated. This reduced the chance for progressing to be severe cases.
- Made case and close contact management and their medical care access easier

Take home message #2: Centralized Quarantine worked!

- If a patient progressed to become a severe case in a mobile cabin hospital, he/she was immediately transferred to an ICU in a main hospital.
- Reduced the burden on ICU and health care system, which was under an enormous pressure before Feb 1, resulting in many patients without care.
- Avoided suspected cases and close contacts from infecting family members and other community members.

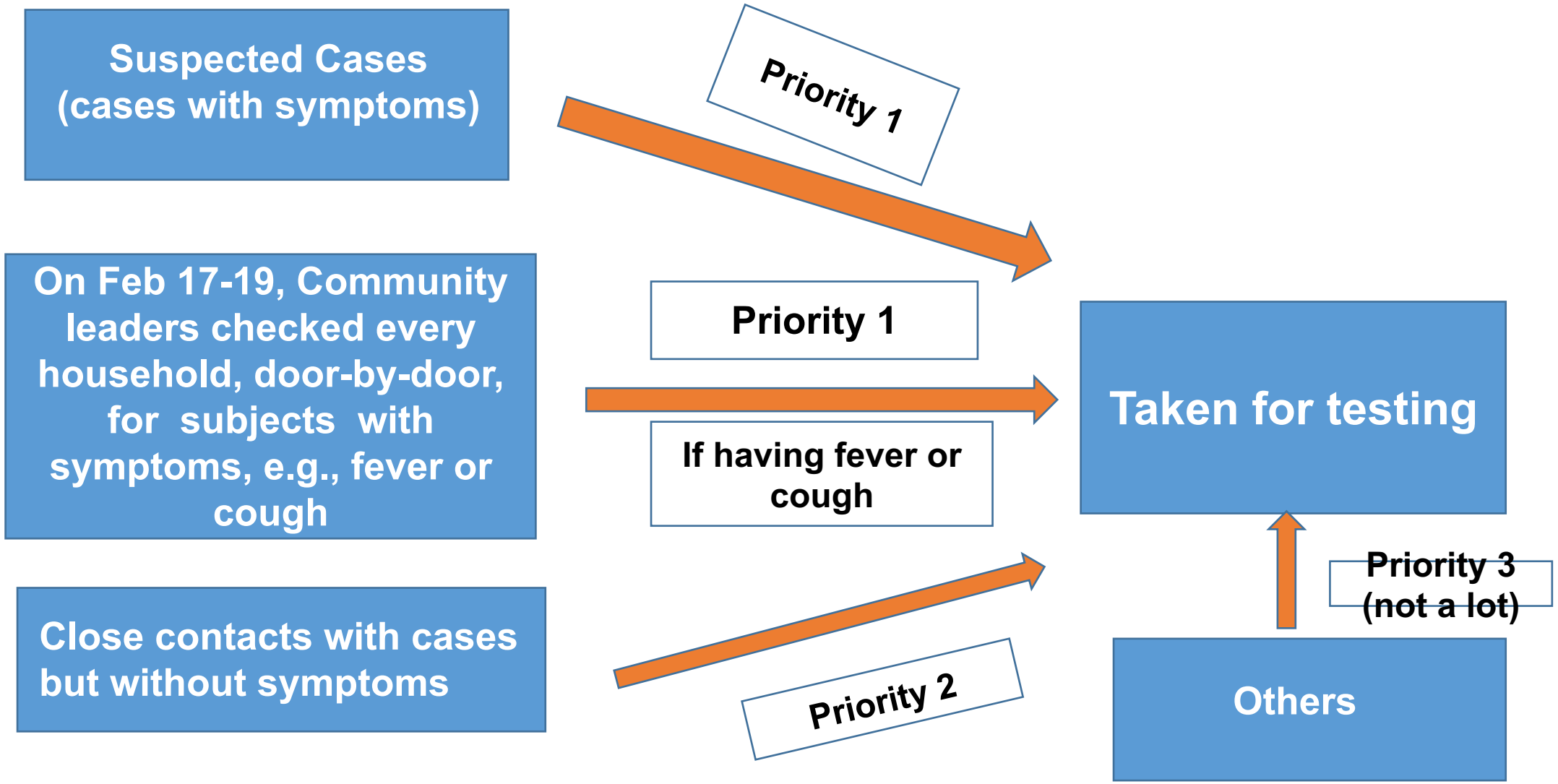
Estimated Numbers of Ascertained and Un-ascertained Cases



Take home message #3: A good proportion are community cases: Testing, Testing, Testing

- We estimated using the SEIR model that about 60% of infected cases were un-ascertained.
- They are often asymptomatic community cases, who could infect others.
- This means increasing testing capacity for early diagnosis is critically important.
- **Current issue in US: Low testing capacity (Need an intermediate multi-pronged strategy)**

Wuhan Community Screening Strategy and Testing Priorities In the Presence of a Shortage of Testing Kits



Predicted date of zero case in Wuhan
(Sum of # of ascertained cases and # of un-ascertained cases)

- Early May
- 95% Creditable Interval (Mid-April to Late May)

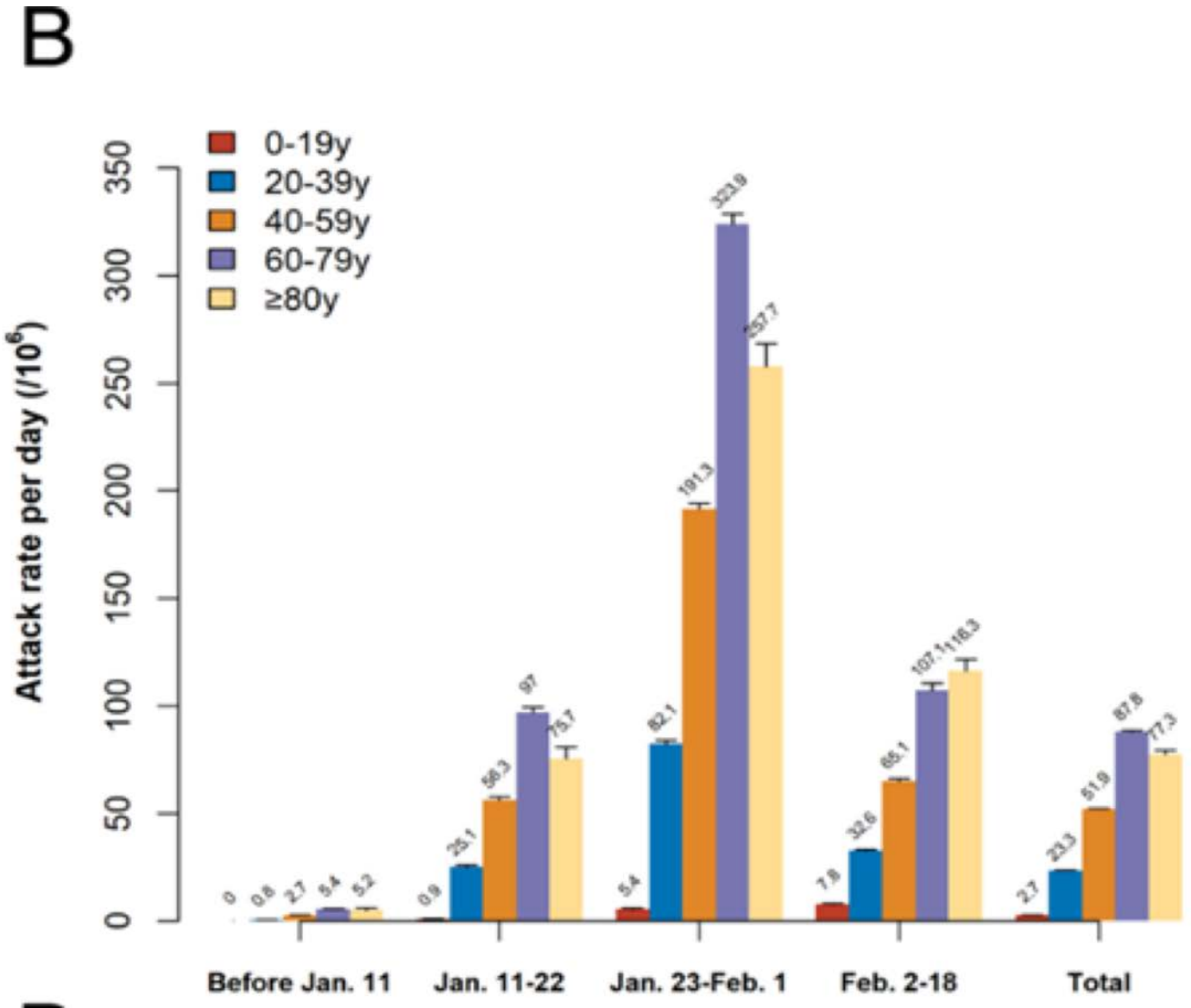
Take home message 4: A Multi-pronged Approach is needed

- Large scale screening using symptoms (with/without testing kits)
- Increase testing capacity
- Mitigation (social distancing) and home quarantine
- Centralized quarantine for confirmed and suspected cases, symptomatic cases and close contacts (asymptomatic)

Epidemiological Characteristics of 25,000+ Lab-Confirmed COVID-19 Cases

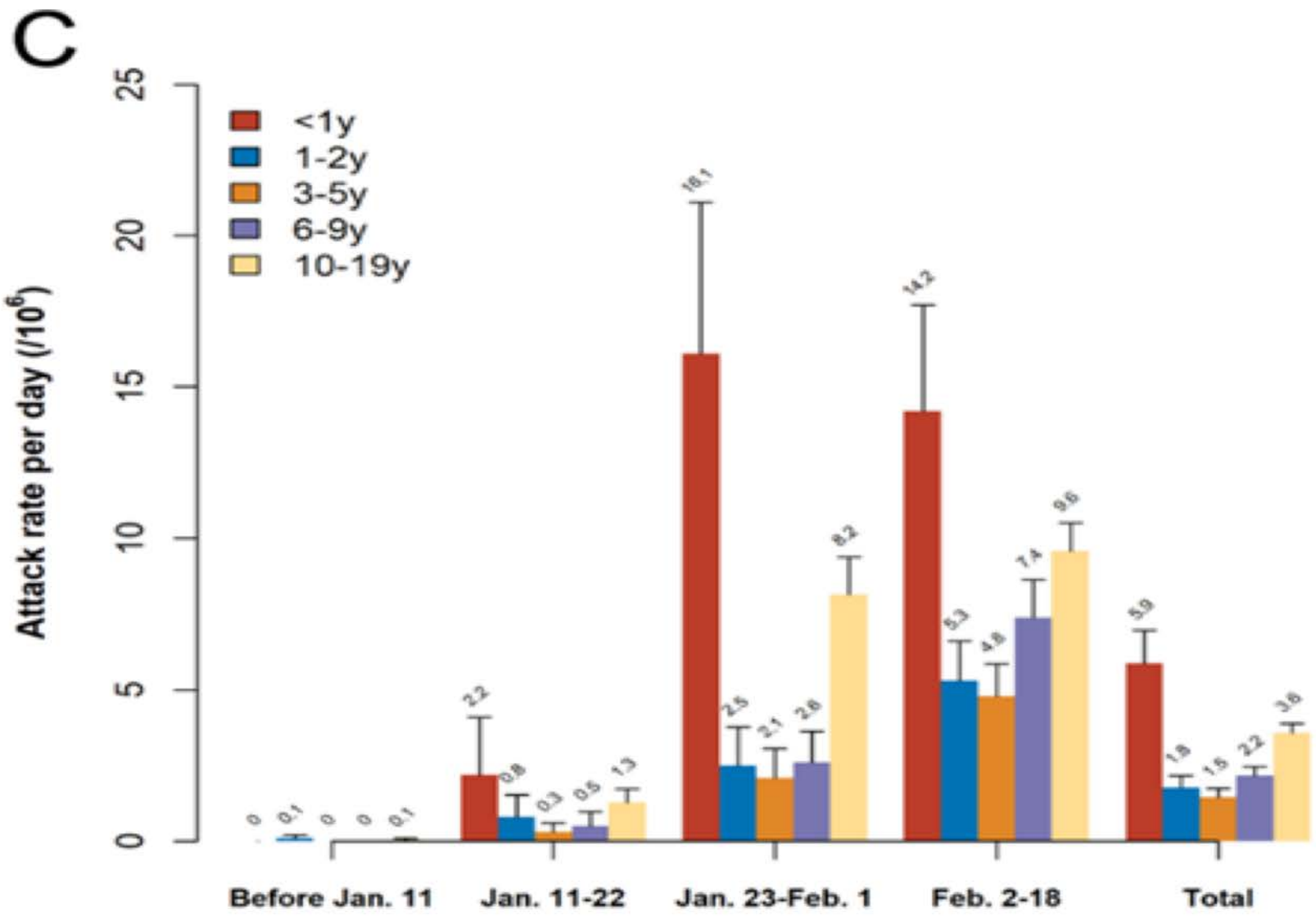
Table 1. The numbers and proportions (%) of the laboratory-confirmed Covid-19 cases stratified by sex and age in Wuhan from December 8, 2019 to February 18, 2020					
Characteristics	Before January 11	January 11-22	January 23 - February 1	February 2-18	Total
Total no.	637	4599	12879	7846	25961
Sex — no. (%)					
Male	334 (52.4)	2266 (49.3)	6354 (49.3)	3952 (50.4)	12906 (49.7)
Female	303 (47.6)	2333 (50.7)	6525 (50.7)	3894 (49.6)	13055 (50.3)
Median age (IQR) - yr	60.9 (19.4)	57.1 (21.3)	57.2 (22.2)	56.4 (24.5)	57.0 (22.7)
Age group — no. (%)					
0-19 yr	2 (0.3)	16 (0.3)	79 (0.6)	193 (2.5)	290 (1.1)
20-39 yr	71 (11.1)	820 (17.8)	2235 (17.4)	1508 (19.2)	4634 (17.8)
40-59 yr	235 (36.9)	1742 (37.9)	4929 (38.3)	2851 (36.3)	9757 (37.6)
60-79 yr	287 (45.1)	1806 (39.3)	5026 (39.0)	2826 (36.0)	9945 (38.3)
≥80 yr	42 (6.6)	215 (4.7)	610 (4.7)	468 (6.0)	1335 (5.1)
Healthcare workers — no. (%)	26 (4.1)	411 (8.9)	632 (4.9)	247 (3.1)	1316 (5.1)

Attack Rate Per Day By Age



Attack Rate Per Day By Gender and Local Healthcare Workers

Attack Rate Per Day By Children Age



Take home message #5: Protect the Four Vulnerable Groups

- Healthcare workers are at a much higher risk of being infected, especially in the absence of protection.
- Elderly people are at a much higher risk of being infected.
- Family members and close contacts of confirmed and suspected cases and close contacts are at a higher risk of being infected
- Children's infection risk is much lower than adults, but the risk increased with time periods.

Centralized Quarantine is Happening in the State of Georgia!

attend. The elderly and "medically fragile" should avoid large gatherings, long travel and "certainly avoid getting on a cruise ship," he said.

March 12, 2020

5:44 a.m. Georgia state park receives 1st patient

A patient who tested positive for the novel coronavirus has been isolated on state park grounds in Georgia, authorities said.

It's the first COVID-19 patient to be transferred to Hard Labor Creek State Park in Morgan County since state authorities prepared the site as a location for isolating and monitoring people who may have been exposed to the deadly virus. Earlier this week, officials installed seven emergency mobile units and delivered supplies in an isolated section of the park that will remain separated from the rest of the property.

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The State of Georgia has quarantined the first COVID-19 patient in a state park which has a site with 7 emergency mobile units.

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New York Times, March 13, 2020

The New York Times

Two Women Fell Sick From the Coronavirus. One Survived.

The young medical professionals, who worked long hours on the front lines in Wuhan, first came down with fevers. Within weeks, both were in hospital beds, hooked up to IVs or oxygen machines.

By Sui-Lee Wee and Vivian Wang March 13, 2020

They were infected before Feb 2 (lack of proper protection). The situation has been much better since Feb 2.

Our healthcare workers do not seem properly protected

No protective suit with hood

No medical goggle

No cap

Infection can be through eyelashes and hair

ABC News: Kirkland Fire and Rescue ambulance workers walk back to a vehicle after a patient was loaded into an ambulance, Tuesday, March 10, 2020, at the Life Care Center in Kirkland, Wash.,

Wuhan's Strategies for Protecting Healthcare Workers

- Full gear: protective suit, medical goggle, cap, face shield, mask and gloves when seeing suspected cases and exposed subjects.
- Transmission can be through eyelashes and hair
- Developed a stringent protection protocol
- Trained healthcare workers how to follow the protection protocol

Wuhan's Strategies for Protecting Healthcare Workers

- Suspected cases, e.g., with symptoms, are seen in designated clinics, instead of ER or PCP offices
- COVID-19 hospital level prevention and control management protocol
- Patient management protocol
- Cleaning and disinfection protocol

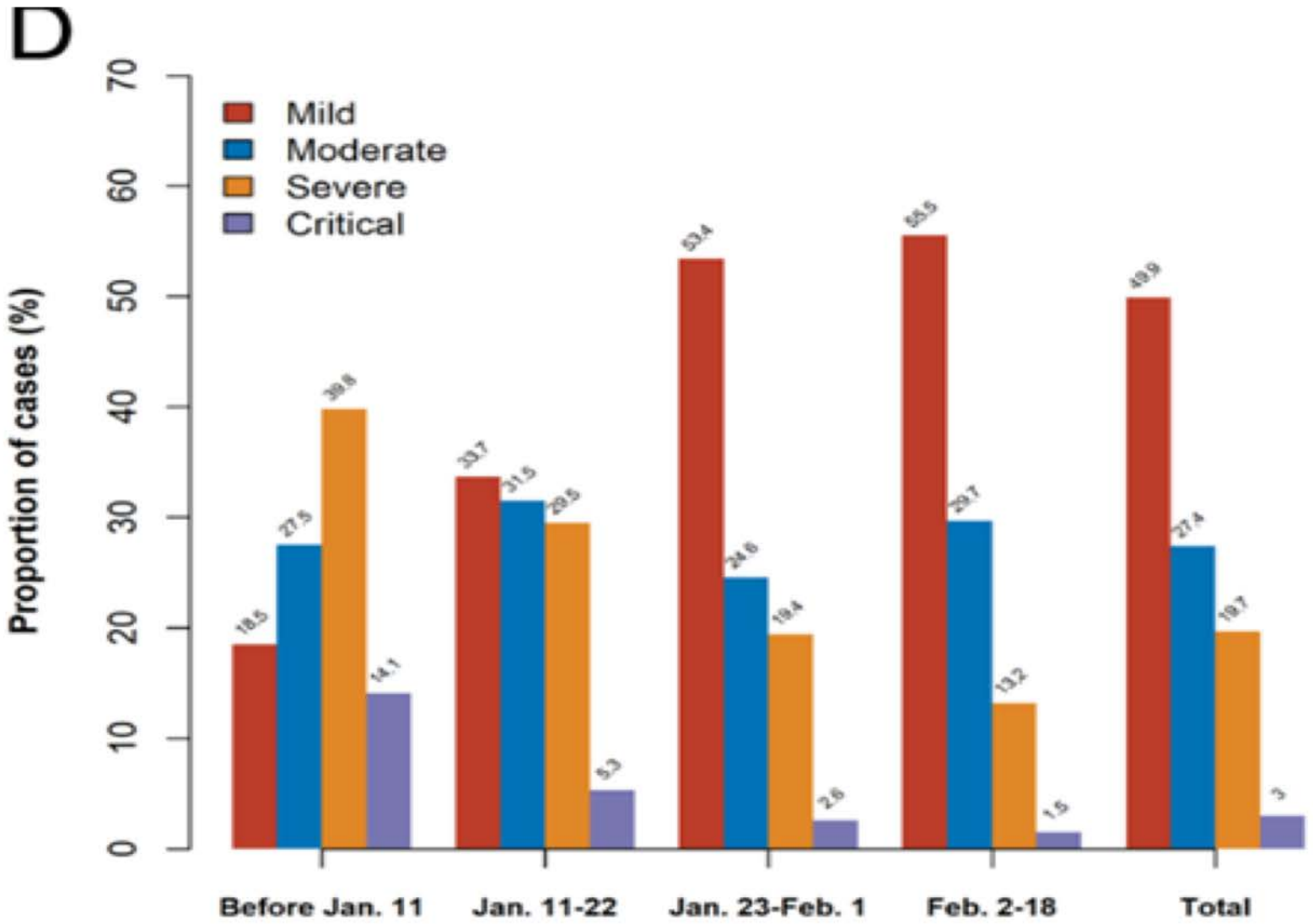
Take home message #5: These Protection Strategies Worked!

None of the 42,000 external healthcare workers who went to help Wuhan has been infected, according to the news on March 12!

0 out of 42,000 infection!

Full protection, stringent protection and management protocol, training

Severity Risk



Relative Risk (RR) of Severe+Critical Status vs Mild+Moderate Status

Characteristics	OR (95% CI)	P value
Age group (years)		
20-40	Ref.	
0-10	0.334 (0.136 - 0.823)	0.017
10-20	0.637 (0.341 - 1.189)	0.157
40-60	1.437 (1.295 - 1.595)	<0.0001
60-80	2.758 (2.490 - 3.054)	<0.0001
≥80	5.110 (4.420 - 5.908)	<0.0001
Sex		
Male	Ref.	
Female	0.890 (0.837- 0.946)	0.0002

Relative Risk (RR) of Severe+Critical Status vs Mild+Moderate Status

Outbreak period	Coefficient (CI)	P-value
Period 1	Ref.	
Period 2	0.479 (0.397 - 0.577)	<0.0001
Period 3	0.249 (0.208- 0.299)	<0.0001
Period 4	0.152 (0.126- 0.184)	<0.0001
Occupation		
Non-healthcare worker	Ref.	
Healthcare worker	1.120 (0.958- 1.308)	0.155

Findings on Severity Risk

- The risk of severity increases with age, and elderly people are at a statistically significant much higher risk of becoming severe (RR=3 for 60-79 and RR=5 for 80+, p-value<0.0001).

- Women have a statistically significant lower risk of becoming severe than men (RR=0.9, p-value=0.002)

- Healthcare workers have a statistically insignificant slightly higher risk of becoming severe compared to general public (RR=1.12, p-value=0.16)

Take home message #6: Early Diagnosis and Early Treatment

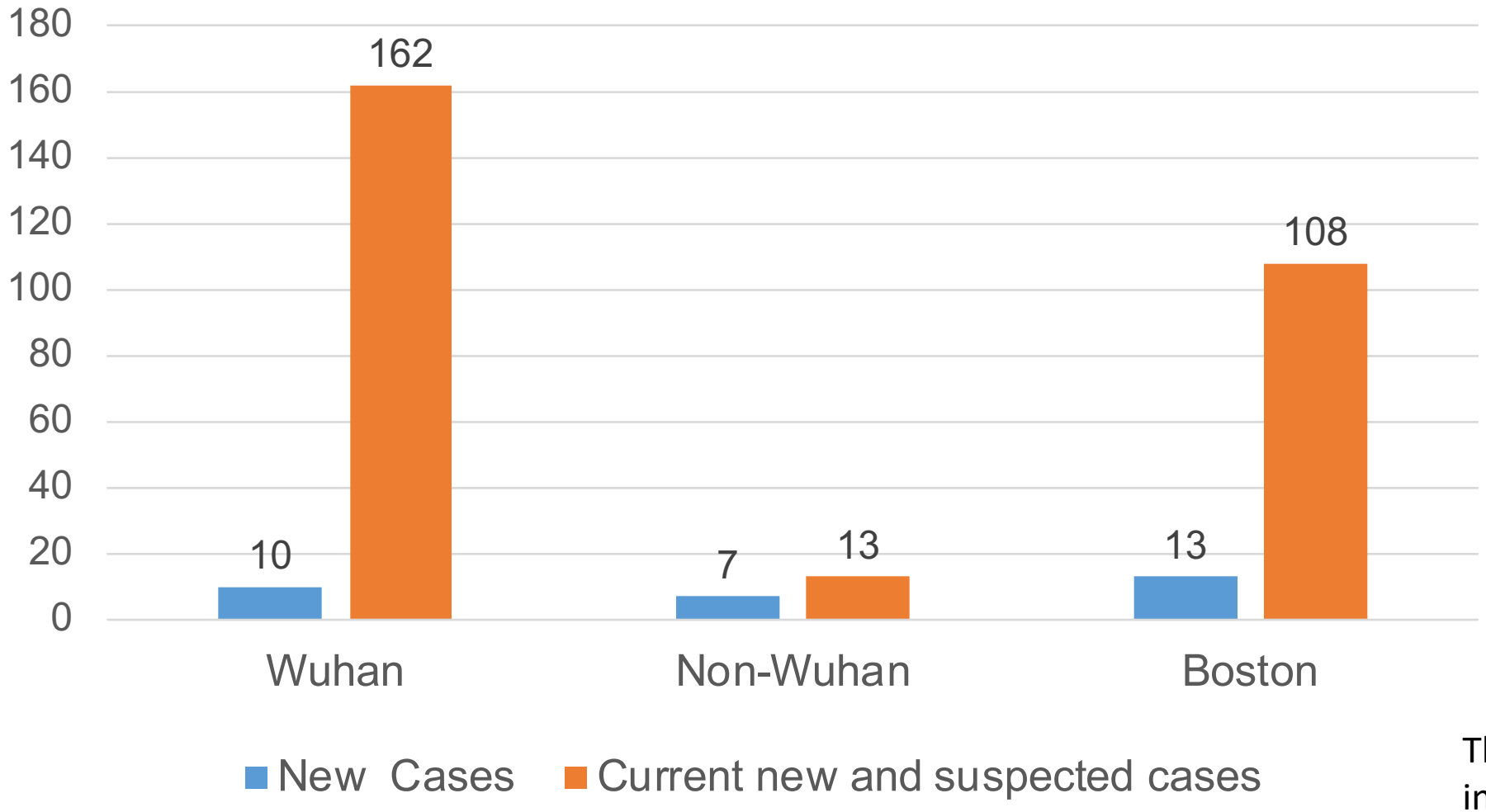
- Early diagnosis and early treatment will help prevent cases from progressing to become severe cases, who have a much higher risk of death, like ARDS patients

- Especially for elderly people and healthcare workers.

All the 16 Fangchang (Mobile Cabin) Hospitals in Wuhan were closed on March 10, 2020: Cleared All Patients

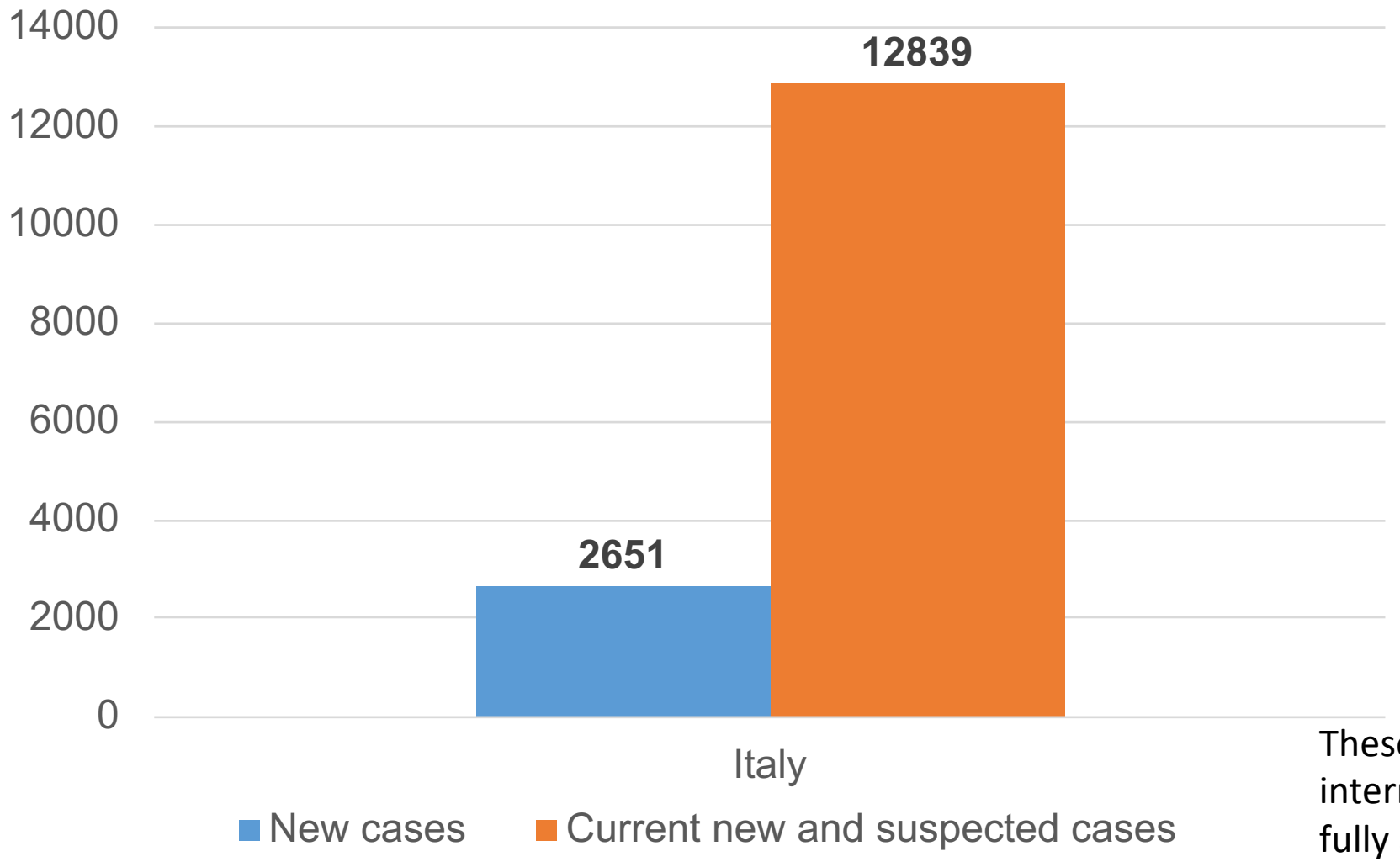
Congratulations, Wuhan!

#s of New and Total Current Suspected Cases: Wuhan, Non-Wuhan and Boston, March 13, 2020



These numbers are from internet, and might not be fully accurate

#s of New and Suspected Cases in Italy, March 12, 2020



These numbers are from internet, and might not be fully accurate

Acknowledgement

Huge thanks go to all the citizens of Wuhan, the local healthcare workers, and the 42,000 healthcare workers cross the country who went to help Wuhan, for their tremendous sacrifice and efforts.

They are my heroes

Concluding Remarks

- As we are at the early stage, starting the effective intervention, centralized quarantine of ill patients and exposed subjects, early, will significantly reduce the number of new infections, stop the outbreak, save lives, relieve the enormous pressure on health system, e.g. a lack of ICU capacity.

- It will protect our beloved family members from being infected, help patients receive immediate medical care early, reduce community transmission, reduce mortality by preventing progression to severity, which has a much higher risk of death.

Everyone is a team member fighting against COVID-19

Go Boston!

- Wuhan experience helps us not start from zero.
- Find the best strategy suitable for each city and country by learning from the Wuhan experience
- Good policy, strategy and leadership, cooperation are the key!
- Song “We are the people”