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ORIGINAL ARTICLE

Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus–Infected Pneumonia

Qun Li, M.Med., Xuhua Guan, Ph.D., Peng Wu, Ph.D., Xiaoye Wang, M.P.H., Lei Zhou, M.Med., Yeqing Tong, Ph.D., Ruiqi Ren, M.Med., Kathy S.M. Leung, Ph.D., Eric H.Y. Lau, Ph.D., Jessica Y. Wong, Ph.D., Xuesen Xing, Ph.D., Nijuan Xiang, M.Med., et al.

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臺北市立聯合醫院教研部
李俊秀教學主治醫師
教學主治醫師群
邱婷芳主任
璩大成副總院長

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ABSTRACT

BACKGROUND

The initial cases of novel coronavirus (2019-nCoV)–infected pneumonia (NCIP) occurred in Wuhan, Hubei Province, China, in December 2019 and January 2020. We analyzed data on the first 425 confirmed cases in Wuhan to determine the epidemiologic characteristics of NCIP.

METHODS

We collected information on demographic characteristics, exposure history, and illness timelines of laboratory-confirmed cases of NCIP that had been reported by January 22, 2020. We described characteristics of the cases and estimated the key epidemiologic time-delay distributions. In the early period of exponential growth, we estimated the epidemic doubling time and the basic reproductive number.

RESULTS

Among the first 425 patients with confirmed NCIP, the median age was 59 years and 56% were male. The majority of cases (55%) with onset before January 1, 2020, were linked to the Huanan Seafood Wholesale Market, as compared with 8.6% of the subsequent cases. The mean incubation period was 5.2 days (95% confidence interval [CI], 4.1 to 7.0), with the 95th percentile of the distribution at 12.5 days. In its early stages, the epidemic doubled in size every 7.4 days. With a mean serial interval of 7.5 days (95% CI, 5.3 to 19), the basic reproductive number was estimated to be 2.2 (95% CI, 1.4 to 3.9).

CONCLUSIONS

On the basis of this information, there is evidence that human-to-human transmission has occurred among close contacts since the middle of December 2019. Considerable efforts to reduce transmission will be required to control outbreaks if similar dynamics apply elsewhere. Measures to prevent or reduce transmission should be implemented in populations at risk. (Funded by the Ministry of Science and Technology of China and others.)

分析2019/12-2020/01新型冠狀病毒肺炎(武漢肺炎)確診個案425位，年齡中位數:59歲(range: 15-89)，240位(56%)是男性。
2019年發病的多數(55%)有海鮮市場有關，2020年發病的只有8.6%有海鮮市場有關(人傳人)。

(統計其中10位個案)潛伏期(接觸到發病)平均為5.2天(95%CI: 4.1-7.0天)，95th percentile在接觸後12.5天(95%CI:9.2-18天)之內發病。

前期(2020/1/4之前)的病例倍增天數為7.4; 平均系列間隔(serial interval: the duration between symptom onset of a primary case and symptom onset of its secondary cases.)為7.5天(95%CI: 5.3-19天)，R0為2.2 (1.4-3.9)。
2019/12月中開始有人傳人的證據。

R0值: 一個人感染到某種病毒之後，可以傳染給身邊多少個人的意思。R0值越大，病毒散佈越快越廣
*比較:
SARS R0 ~ 3 、流感 R0: ~1.28

WHO. Consensus document on the epidemiology of severe acute respiratory syndrome (SARS).
https://www.cdc.gov.tw/uploads/files/e795ef36-5cfb-4c3c-bfa7-abdb21f3cee3.pdf

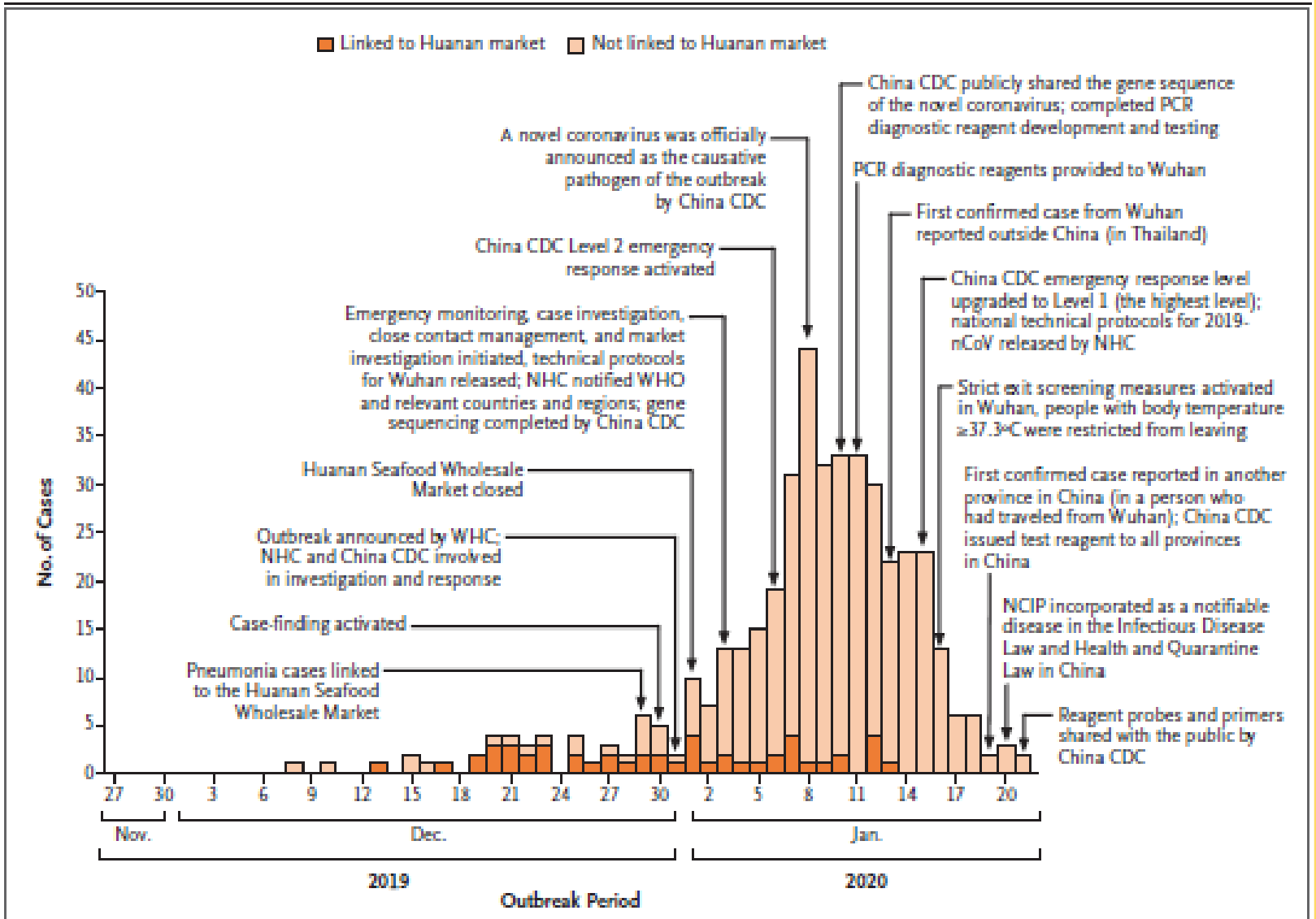


Figure 1. Onset of Illness among the First 425 Confirmed Cases of Novel Coronavirus (2019-nCoV)–Infected Pneumonia (NCIP) in Wuhan, China.

The decline in incidence after January 8 is likely to be due to delays in diagnosis and laboratory confirmation. China CDC denotes Chinese Center for Disease Control and Prevention, NHC National Health Commission of the People's Republic of China, PCR polymerase chain reaction, WHC Wuhan Health Commission, and WHO World Health Organization.

Linked to Huanan market　Not linked to Huanan market

深咖啡色: 與海鮮市場相關
淺咖啡色: 與海鮮市場無關
12/29: 發現與海鮮市場相關的肺炎
12/30: 啟動通報系統
12/31: 中國CDC開始進行調查
01/01: 關閉海鮮市場
01/03:
病例疫情相關調查與緊急情況監測
中國通報WHO
中國CDC完成病毒定序
01/06: 中國CDC啟動二級警報
01/08: 中國CDC公開宣佈新冠肺炎
01/10: 中國CDC公開病毒基因序列
01/11: 提供武漢PCR檢驗試劑
01/13: 泰國發現中國境外首例
01/15: 中國CDC宣佈一級警報，提供技術手冊
01/16: 武漢發燒篩檢啟動，≧37.3度限制離開
01/19: 湖北省以外的中國第一例(武漢旅遊史)

個案數呈現指數增加造成流行性傳染病，但近期下降的趨勢，是因為個案數未確診及延遲確認及通報的情形。也就是說，看起來個案數變少並不代表新發生個案的高峰期已過。

Table 1. Characteristics of Patients with Novel Coronavirus–Infected Pneumonia in Wuhan as of January 22, 2020.*

Characteristic	Before January 1 (N=47)	January 1–January 11 (N=248)	January 12–January 22 (N=130)
Median age (range) — yr	56 (26–82)	60 (21–89)	61 (15–89)
Age group — no./total no. (%)			
<15 yr	0/47	0/248	0/130
15–44 yr	12/47 (26)	39/248 (16)	33/130 (25)
45–64 yr	24/47 (51)	106/248 (43)	49/130 (38)
≥65 yr	11/47 (23)	103/248 (42)	48/130 (37)
Male sex — no./total no. (%)	31/47 (66)	147/248 (59)	62/130 (48)
Exposure history — no./total no. (%)			
Wet market exposure	30/47 (64)	32/196 (16)	5/81 (6)
Huanan Seafood Wholesale Market	26/47 (55)	19/196 (10)	5/81 (6)
Other wet market but not Huanan Seafood Wholesale Market	4/47 (9)	13/196 (7)	0/81
Contact with another person with respiratory symptoms	14/47 (30)	30/196 (15)	21/83 (25)
No exposure to either market or person with respiratory symptoms	12/47 (26)	141/196 (72)	59/81 (73)
Health care worker — no./total no. (%)	0/47	7/248 (3)	8/122 (7)

* Reduced denominators indicate missing data. Percentages may not total 100 because of rounding.

早期個案較年輕
有較多海鮮市場暴露史

此研究並無15歲以下兒童發病
比較: LANCET 10歲發病

A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 7
Relationship	Mother of patient 3	Father of patient 3	Daughter of patients 1 and 2	Son-in-law of patients 1 and 2	Grandson of patients 1 and 2	Mother of patient 4 in Shenzhen
Age (years)	65	66	37	36	10	63
Sex	Female	Male	Female	Male	Male	Female
Occupation	Retired	Retired	Office worker	Architect	Student	Retired
Chronic medical illness	Hypertension; benign intracranial tumour treated by gamma knife	Hypertension	None	Chronic sinusitis	None	Diabetes

2020後醫療人員開始得到肺炎且逐漸增加，但比例較SARS、MERS低，可能是尚未發生超級傳染事件 (superspreading event)

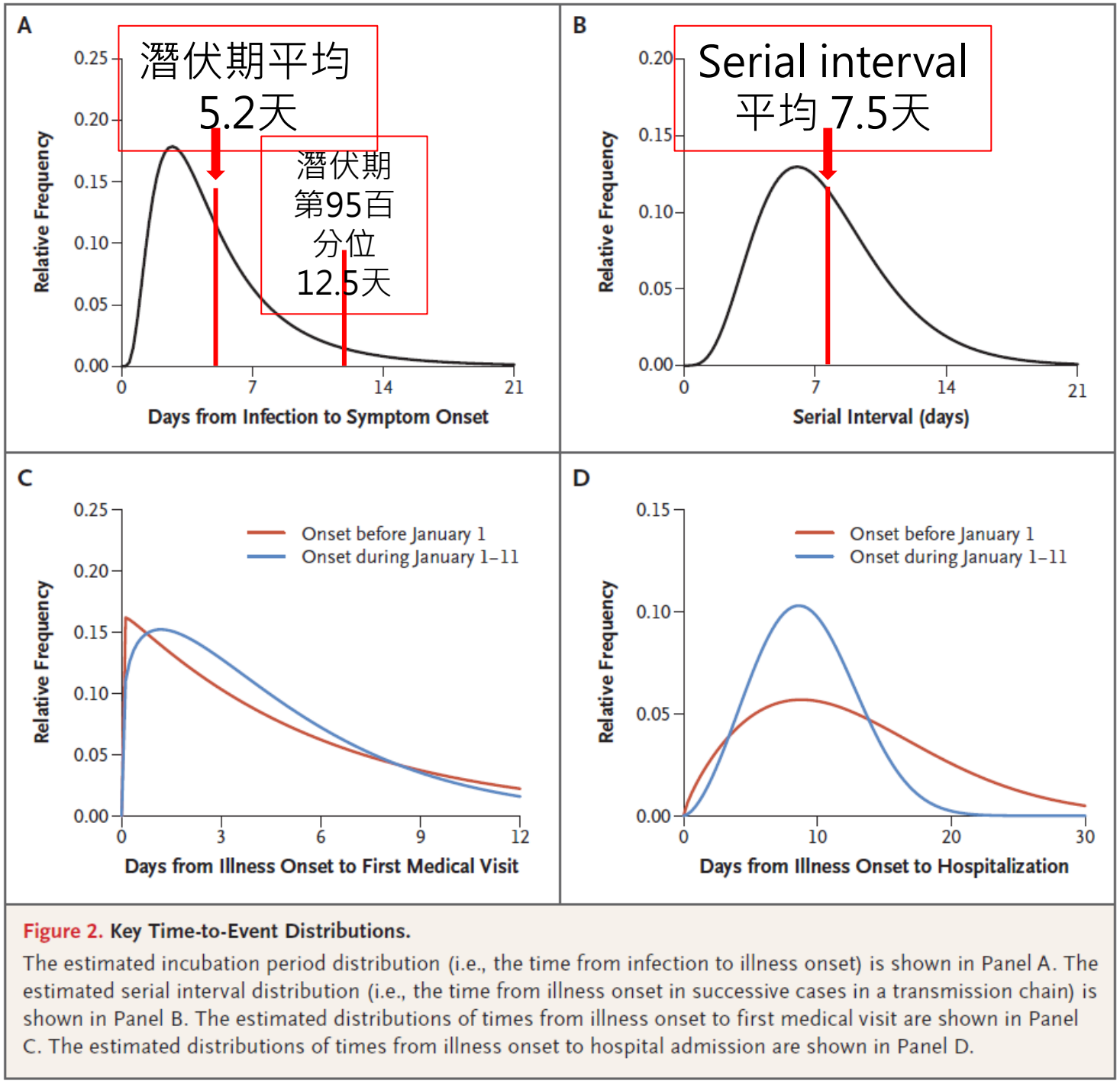


Figure 2. Key Time-to-Event Distributions.

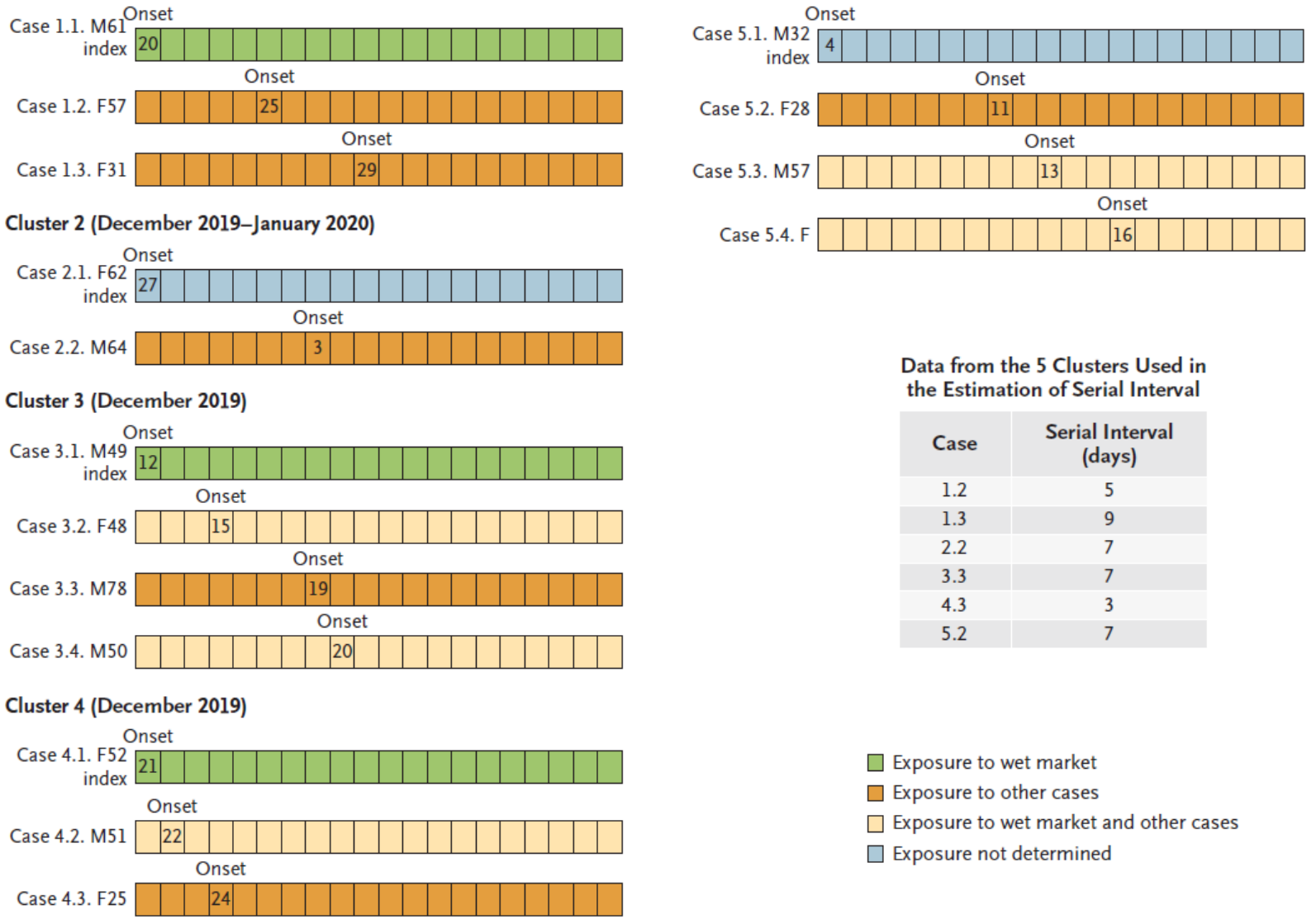
The estimated incubation period distribution (i.e., the time from infection to illness onset) is shown in Panel A. The estimated serial interval distribution (i.e., the time from illness onset in successive cases in a transmission chain) is shown in Panel B. The estimated distributions of times from illness onset to first medical visit are shown in Panel C. The estimated distributions of times from illness onset to hospital admission are shown in Panel D.

A圖: 潛伏期(統計來自10名確診案例)
平均5.2天 (95%CI: 4.1-7.0天)
第95百分位 12.5天(95%CI: 9.2-18天)

B圖: serial interval間隔天數
平均7.5天(SD:3.4天) (95%CI: 5.3-19天)

C圖: 發病至首次就醫天數
2019與2020發病至首次就醫天數差異不大
紅色: 發病在2020/1/1之前(45位個案)
發病至就醫平均天數: 5.8天(95%CI: 4.3-7.5)
藍色: 發病在2020/1/1-1/11之間
發病至就醫平均天數: 4.6天(95%CI:4.1-5.1)

D圖: 發病至住院天數
2019發病比2020發病至住院的天數長
紅色: 發病在2020/1/1之前(44位個案)
發病至住院平均天數: 12.5天(95%CI: 10.3-14.8)
藍色: 發病在2020/1/1-1/11之間
發病至住院平均天數: 9.1天(95%CI:8.6-9.7)



Data from the 5 Clusters Used in the Estimation of Serial Interval

Case	Serial Interval (days)
1.2	5
1.3	9
2.2	7
3.3	7
4.3	3
5.2	7

Figure 3. Detailed Information on Exposures and Dates of Illness Onset in Five Clusters Including 16 Cases.

Numbers in boxes are calendar dates in December 2019 and January 2020. Data from the 5 secondary cases (patients who had clear exposure to only one index case and had no other potential source of infection) were used to estimate the serial interval distribution. The first four clusters were identified in Wuhan, and the fifth cluster was identified in Huanggang.

分析5組群聚感染，由明確的接觸史推算出serial interval的天數為7.5±3.4天 (95%CI: 5.3-19天)

討論

- 新型冠狀病毒肺炎可以經由人傳人，且近期已成為流行性傳染病，可能以肺炎或是腸胃道症狀來表現，在兒童甚至可能是沒有症狀的感染症。
- 此次早期研究個案只有僅少數的兒童，而且幾乎一半的個案年齡比六十歲大，但我們的個案定義為嚴重需要醫療介入的個案。
- 兒童個案可能較少被感染或是呈現較輕微的症狀。
- R0初估為2.2 (SARS: R0約等於:3)。
- 醫療工作人員被感染，但比例較SARS和MERS爆發時來的低，有可能是因為新型冠狀病毒肺炎仍未發生超級傳染事件(superspreading event)，但未來仍然有可能發生。
- 有症狀到住院比有症狀首次求醫的時間來得長，可能是因為早期辨別個案有其困難度 (是否隱含TOCC重要性)。
- 本研究仍然支持14天觀察期的重要性。