Adjustment to report "Estimating the potential total number of novel Coronavirus cases in Wuhan City, China" V2

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Background

On 17th Jan. 2020, a report was published by researchers from MRC Centre for Global Infectious Disease Analysis at Imperial College London, estimates the potential total number of novel Coronavirus cases in Wuhan City, China, is much more than the number of clinically comparable cases within Wuhan City that may have occurred thus far [1]. The estimating number in [1] is 1,723 (427 – 4,471), comparing to the 62 cases reported on and before 17th Jan (on 19th Jan, 198 cases in total were reported), as well as 3 cases abroad. This report has been widely cited by many international news, including BBC [2], daily mail [3]. New York times [4], and many news agencies in Chinese [6].

The estimation of the potential total number of novel Coronavirus cases in Wuhan City in [1] is straightforward. To write it simply, it is

Estimate = 3/(3301/19m * (6+4)) = 1723,

where 3 is the number of cases detected overseas, 3301 is the daily international outbound travelers from Wuhan, 19m is the catchment of population of wuhan airport, 6 + 4 are incubation period + time from onset of symptoms to detection = mean time to detection = 10.

In addition, confidence intervals were calculated from the observation that the number of cases detected overseas, X, is binomially distributed as Bin(p,N), where p = probability any one case will be detected overseas, and N is the total number of cases. And the results are obtained based on 4 Caveats [1].

Comments

However, the results in [1] need more assumptions to hold valid, and some data sources used in the report need more clarification.

1. The report assumes that the population in the catchment of Wuhan airport has an equal (or similar) probability of being as an international traveler, which is not true. (this assumption is different from Caveats 4)

Wuhan metro area has 19m population. Actually the catchment of Wuhan airport is larger than her metro area, it could be half Hubei province with a population of around 30m. If the report [1] uses 30m as the catchment population, the estimate number could be higher. However, Wuhan urban area has 9m population [7], consisting of three cities: Wuchang, Hankou and Hanyang, in which Hankou is the city most infectious cases locate. Most infectious people so far are in the Hankou centre, urban area (near a seafood market) [8]. These facts will apparently increase the probability of being a traveler for the people who visit/live near seafood market in the urban area among all population in the catchment of Wuhan airport. The fact that all three patients abroad

being citizens of Wuhan urban area strengthens this hypothesis.

2. The report assumes that the international outbound travelers from Wuhan have an infectious rate as the same (or similar) to the population in the catchment of Wuhan airport (this assumption is different from Caveats 4).

This assumption is normally not valid, and can be bias. The infectious rates in population are usually not uniformly distributed, and travelers have higher chances to be infected because they visit more places. If human-to-human transmission should not be ruled out, travelers who meet more people including other travelers will have a much higher chance of being infected.

3. The '*number of cases detected overse*as' is quite small (3), and one of them is a travel causally linked to the infection status of contacts in Wuhan (this may apply to the case detected in Japan) [9]. Although in [1] the number of cases detected overseas, X, has been assumed binomially distributed as Bin(p,N) to formulate the distribution. But the estimate can easily be manipulated by this small number rather than telling a big picture statistically.

Based on above analysis, we believe the number has been over estimated. If considering the above issues, an adjustment calculation could be

E' = 2.5/((3301/9m)*2*10) = 340.

where the case in Japan is counted as 0.5 in the model, and assuming the chance of being infected as a traveler is doubled to those of normal citizens. If considering travelers and the people in traffic transportation centers have higher probability of visiting the seafood market, the estimate number could be lower, which is comparable to the 198 cases in total were reported on 19th Jan 2020 (GMT time). If more cases would be reported in the next a few days, a more accurate estimate number could be calculated.

Summary:
This article provides a possible explanation of the reason why the estimates of the report [1] have much more cases than currently reported. In the future, the infectious number could continuously increase, but this comment is based on the current scenario, and the mechanism could be used for future analysis. In [1] the report mentioned that 'accounting for either association would increase the probability of a case travelling and therefore reduce our estimates of the total number of cases.' This comment could be seen an extension of this declaration. In the future if surveillance should be expanded to include all hospitalised cases of pneumonia or severe respiratory disease, new computational model and assumptions would be needed to provide a more accurate estimate.

[1] https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/2019-nCoV-outbreak-report-17-01-2020.pdf
[2] http://www.bjd.com.cn/a/202001/20/WS5e24dbf9e4b0e6e58393a478.html
[3] https://www.bbc.co.uk/news/health-51148303
[4] https://www.dailymail.co.uk/health/article-7900047/Scientists-fear-4-500-Chinese-patients-caught-coronavirus.html
[5] https://www.nytimes.com/2020/01/18/world/asia/china-virus-wuhan-coronavirus.html

[6] https://www.bbc.com/zhongwen/simp/chinese-news-51159808

[7] https://en.wikipedia.org/wiki/Wuhan

[8] https://zhuanlan.zhihu.com/p/103066817

[9] Ministry of Health Japan. 新型コロナウイルスに関連した肺炎の患者の発生について. [cited 16 Jan 2020]. Available: https://www.mhlw.go.jp/stf/newpage_08906.html

[10] Bogoch II, Watts A, Thomas-Bachli A, Huber C, Kraemer MUG, Khan K. Pneumonia of Unknown Etiology in Wuhan, China: Potential for International Spread Via Commercial Air Travel. J Travel Med. 2020 [cited 16 Jan 2020]. doi:10.1093/jtm/taaa008

[11] https://commons.wikimedia.org/wiki/File:Top_20_flight_routes_from_Wuhan_with_data_on_IDVI_for_each_country.jpeg

[11] http://www.xinhuanet.com/fortune/2019-08/10/c_1124858883.htm