

# Primary to tertiary COVID-19 transmission in a hospital – A cluster outbreak analysis

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### ABSTRACT

The recent pandemic of SARS COV-2, a novel coronavirus requires research into understanding of its transmission dynamics and clinical presentations to help in understanding the spread of the disease, how to prevent it not only locally but also for national policy formulations. In this study, we described the transmission dynamics and clinical presentations of a cluster outbreak of SARS COV-2 in a tertiary level hospital. We also calculated the secondary attack rate for the primary, secondary, and tertiary transmissions. We conclude that symptomatic COVID-19 are primary and secondary contacts rather than tertiary contacts, hence, former to be quarantined. However, tertiary transmission is causing more COVID-19 compared to other transmissions in a hospital outbreak without further transmissibility. And overall secondary attack rate is very low in a hospital outbreak.

**Keywords:** Coronavirus, hospital outbreak, nosocomial transmission, secondary attack rate

### Introduction

The recent outbreak of SARS COV-2 pandemic has led to a frenzy of research into the disease and its causative organism. One area relatively untouched is the transmission pattern and their effects on the varied phenotypic manifestations of the disease. Dynamics of transmission of COVID-19 in the hospital setup is another unexplored field. Patients range from asymptomatic carriers, or have severe acute respiratory illness and complications like multiorgan dysfunction and diffuse intracellular coagulation. At the beginning of the epidemic, primary cases of COVID-19 had been traced back to the Wuhan seafood market, with secondary cases occurring at hospitals among nurses and physicians who had extensive contact with COVID-19 patients. Furthermore, several individuals who did

not have direct contact with the seafood market or any other positive cases were diagnosed with the disease.<sup>[1]</sup> This indicates that the virus probably spreads through asymptomatic carriers as well. 30-59% of SARS-CoV-2 infections are asymptomatic, which poses a great burden on the health care system to identify and quarantine cases to curb the spread of the pandemic.<sup>[2]</sup>

By definition when a case is positive, if source is identified, then it is primary transmission and from same case when it is transmitted to another case, then secondary transmission occurs and similarly existence of a tertiary transmission and so on. Not enough data is available regarding this. The classification is used in calculation of secondary attack rate of the agent in a particular cluster outbreak. Secondary attack rate (SAR) is the probability that infection occurs among susceptible persons within a reasonable incubation period following known contact with an infectious person or another infectious source. It is used to estimate transmission of a disease in close setups like households, barracks. A study was conducted in Guangzhou, China where they calculated the SAR of SARS CoV-2, the results showed that the rate was low among young patients

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Received: 11-10-2020

Revised: 02-12-2020

Accepted: 01-01-2021

Published: 08-04-2021

#### Access this article online

##### Quick Response Code:



Website:  
www.jfmpc.com

DOI:  
10.4103/jfmpc.jfmpc\_2104\_20

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**How to cite this article:** Aishwarya M, Singh M, Panda PK. Primary to tertiary COVID-19 transmission in a hospital – A cluster outbreak analysis. J Family Med Prim Care 2021;10:1489-92.

and asymptomatic cases, this value increased as the patients became more symptomatic and increased age of the patients.<sup>[3]</sup> This suggests that infectivity depends on characteristics of the primary contact. However, it was not clear whether SAR is dependent upon types of transmission: primary to tertiary. And this brings us to our second question whether clinical features depend upon the type of transmission and third question what is the SAR of the virus in a hospital setup.

Here we want to discuss about eight cases in the hospital setup, and through their epidemiological links try to explain primary, secondary, and tertiary transmissions and their effects on clinical features. We have also analyzed the SAR in this hospital setup cluster outbreak.

### Case Series

This tertiary care hospital had two divisions (COVID and non-COVID zones) for all visited patients (either through OPD or Emergency) based on COVID-19 suspect criteria as per institute protocol of patient management. Whole hospital was preparing for COVID-19 outbreaks until index case (case 1) admitted in Medicine ward (non-COVID zone) of our hospital on 22 April 2020. She had co-morbidities with a history of cerebrovascular accident 40 days back, tracheostomised, having multiple hospitalizations, and on presentation was having ventilator-associated pneumonia. Due to delayed recovery and CXR suggestive of viral pneumonia patterns, after 5-days of the present hospitalization, COVID-19 test was performed and found to be positive. On contact tracing of last hospitalised HCWs/patients, five close contacts HCWs were found positive. Primary transmission were already there considering case 1 got infection from last hospital's HCW. In our hospital, total 54 primary high-risk contacts have been traced and quarantined [Table 1].

One day before the diagnosis of case 1, Case 2 (male nursing staff posted in Surgery ward, another non-COVID zone) became symptomatic with fever and sore throat and reported to be COVID positive. On detailed investigations, it was found that he had been exposed with primary contacts of case 1 in common ward areas before case 1 was detected positive. This suggested secondary transmission w.r.t. case 1.

Among primary high-risk contacts (quarantined) of case 2, after two days, two high-risk contacts were tested COVID-19 positive. One was another female nursing staff (case 3) that was posted in same Surgery ward and one was relative (case 4) of a negative patient of the same ward who was present as care taker at bedside with maximum times of the day. This suggested tertiary transmission w.r.t. case 1.

Later on, among primary contacts of case 1, two more high-risk contacts were tested COVID-19 positive: one intern (case 5) who came in direct contact with case 1 in emergency and another nursing staff (case 6) who posted in same Medicine

**Table 1: Demography and clinical details of COVID-19 cluster**

Case contact	Age/ sex	Designation (possible location of acquiring infection)	Nature of transmission	Date of symptom onset	Date of diagnosis	No of primary contacts	No of primary contacts who became positive	Clinical features	TLC/Hb/ PLT	SGOT/ SGPT	Ur/Cr
Case 1	56/f	Patient (Last admitted Hospital)	Index case	Can't specify, mostly 20 <sup>th</sup> April	28 <sup>th</sup> April	153	02 (in our hospital)	Fever, cough, breathlessness, alter sensorium	5800/8.1/2.2	40/42	51/2.45
Case 2	28/m	Nursing staff (Surgery ward)	Secondary	24 <sup>th</sup> April	26 <sup>th</sup> April	101	04	Fever, sore throat	4311/16/1.6	95.6/201.3	20.5/0.91
Case 3	30/f	Nursing staff (Surgery ward)	Tertiary	Not applicable	28 <sup>th</sup> April	77	0	Asymptomatic	5120/13/1.4	29/32	27/0.74
Case 4	35/F	Relative of a patient (Surgery ward)	Tertiary	Not applicable	28 <sup>th</sup> April	25	0	Asymptomatic	12910/13/2.4	0.23/0.12	21/0.67
Case 5	23/f	Intern (posted in Emergency)	Primary	28 <sup>th</sup> April	1 <sup>st</sup> May	146	0	Fever, running nose	5929/16/2.26	13/18.9	26.0/81
Case 6	29/f	Nursing staff (Medicine ward)	Primary	1 <sup>st</sup> may	3 <sup>rd</sup> May	48	1	Sore throat, headache	4474/11.4/1.4	20/29	12/.68
Case 7	38/f	Relative of a patient (Surgery ward)	Tertiary	Not applicable	4 <sup>th</sup> May	39	0	Asymptomatic	7033/12/2.7	16/16	18/.69
Case 8	31/m	Patient (Surgery ward)	Tertiary	Not applicable	8 <sup>th</sup> May	39	0	Asymptomatic	4150/6.2/5.7	36.1/50.1	11.5/0.53

ward and caring case 1. This suggested primary transmission w.r.t. case 1.

Within one week time of case 2 detection, one relative (case 7) of another negative patient (getting treated in same cubicle of case 1) of the Medicine ward and one patient (case 8) of Surgery ward (getting treated under care of case 2) tested positive. This suggested tertiary transmission w.r.t. case 1.

These non-primary cases got infection through possible commonplace of eating with primary contacts in canteen and common place of working among secondary contacts.

## Discussion

Through this case series, we have observed that all the primary and secondary contacts of the index case who were positive, developed symptoms. The tertiary contacts who were positive later did not show any symptoms. Through this, we also see that extensive testing of tracing contacts is required to detect asymptomatic contacts of the disease in a hospital.

Although the reproductive number for SARS CoV-2 is estimated to be 2 from the early research conducted in Wuhan china, this value is unable to provide an insight into the transmission dynamics of COVID-19 among close contacts in enclosed areas.<sup>[4]</sup> Here comes the role of secondary attack rate (SAR). In this cluster hospital outbreak, the SAR for primary transmission is 1.3% (2/153, falsely low since previous hospital data were not included), for the secondary transmission 0.005% (1/194), and for tertiary transmission 0.04% (4/101), which is lower compared to the SAR among household contacts which have been quoted in studies. In one study conducted in Guangzhou, SAR were 13.2% (95% CI 10.9–15.7) among household contacts and 2.4% (1.6–3.3) among non-household contacts, when household was defined on the basis of close relatives.<sup>[5]</sup> However in our study, SAR is very low in the hospital set-up, may be due to better use of various precautions. In a tertiary hospital in Singapore a system engineering initiative for patient safety model was used to illustrate the measures that can be taken to prevent the intra-hospital transmission of COVID-19, which may be useful to further reduce SAR.<sup>[6]</sup> Future research can further divide the SAR among health care workers who have worn personal protective equipment and those who have not, similarly for patients, attendants, etc. This information will be valuable in assessing the efficacy and adherence of social distancing measures, PPE, etc.

In this hospital cluster outbreak, index case transmitted infection to two primary contacts (28.57%,  $n = 2/7$ ), one secondary contacts (14.28%,  $n = 1/7$ ), and four tertiary contacts (57.15%,  $n = 4/7$ ). Primary and secondary contacts were symptomatic while tertiary were asymptomatic. However, first two category of contacts transmitted to next level of contacts but last category could not may be due to asymptomatic nature, use of precautions in a good way, and

decrease of viral load as level of contacts increase. In a study conducted in China through a cluster outbreak they proved that asymptomatic carriers can cause transmission of SARS COV-2 among their contacts, not shown in our study.<sup>[7]</sup> This is especially relevant in closed and dynamic set-ups like hospitals where asymptomatic transmission and tertiary contacts could not be prevented otherwise whole hospital will be closed due to quarantine. Hence, despite higher number of tertiary contacts with high positivity rate, hospital/public should not worry for these tertiary transmissions. And universal masking in a hospital set-up gives added advantage for low transmission rate.<sup>[8]</sup> Furthermore, primary and secondary contacts if quarantined will avoid further spread and control of hospital transmission.

Through this analysis of the hospital outbreak we can conclude that primary and secondary positive contacts tend to be symptomatic in contrast to asymptomatic tertiary contacts, should be quarantined. Furthermore, all symptomatic contacts should isolate themselves to avoid further spread. However, tertiary transmission is causing more COVID-19 compared to other transmissions in a hospital outbreak and is asymptomatic carriers of the disease but not transmissible to others. Henceforth, overall SAR is very low in hospital outbreak.

## Acknowledgment

Thanks to COVID-19 management team who are working hard day and night after wearing personal protective equipments. This is sometimes unbearable to wear the full covered suite. Still team is dedicated for isolating, diagnosing, and treating patients since the onset of pandemic. A wholeheartedly gratitude to them.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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