

Incidence of Symptomatic COVID-19 in Close Contacts of Patients After Discharge From Hospital

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Abstract

Background: There is a little evidence about the infectiousness of recovered COVID-19 patients. Considering that the circumstance of the isolation of the COVID-19 patients after-discharge is not always optimal, it is not very unlikely that viral transmission still occurs after hospital discharge. This study aims to investigate incidence of symptomatic COVID-19 in close contacts of recovered patients after discharge from hospital

Methods: Four hundred fifty discharged COVID-19 patients discharged from the largest public treatment center in Tehran, capital city of Iran were followed up. Demographic and clinical data of participants were collected from medical records. Follow-up data were acquired via telephone call interviews with patients or their main caregivers at home.

Results: The study's response rate was 93.77%(422 participated in the study). 257 patients were male (60.90%) and 165(39.10%) were female (sex ratio =1.55 male). The most prevalent comorbidities in these patients were hypertension (n=111, 29.68%) and diabetes (n=93, 24.80%). The mean±sd of home isolation after discharge was 25.85±23.78. Forty-one (9.71%) patients had at least one new case in their close contacts up to three weeks since they discharged. There was a significant association between having at least a comorbidity with the odds of getting infected in close contacts [OR(CI): 2.45 (1.05 – 4.72); P: .03]. Density of inhabitant per houses rooms and the quality of isolation had significant associations with observing new cases in the patients' close contacts [high to moderate; OR(CI): 2.44 (1.06 – 5.61); P: .03], [bad to good; OR(CI): 2.31 (1.17 – 4.59); P: .01], respectively.

Conclusion: After hospital discharge, COVID-19 transmission can still occur, when number of people lives together in a single house. An explanation can be that the less precaution measures are taken by recovered patients' cohabitants. Such condition is more likely to happen when the recovered patient has other chronic diseases.

Background

The coronavirus disease (COVID-19) caused by the novel coronavirus (SARS-CoV-2) represents a significant global medical issue, with a growing number of cumulative confirmed cases[1]. COVID-19 is characterized by a high transmissibility before and immediately after symptom onset that changed it an acute problem in the world[2]. Until 11 July, 2021, the confirmed COVID-19, deaths and recovered cases have been reported 187,276,198, 4,042,981, 171,251,586 respectively[3] all over the world. Countries and particularly health systems selected various polices and clinical measures to control COVID-19 transmission [4–6]. Better understanding of the transmission dynamics of the virus is important for the development and evaluation of effective control measures[2]. The primary criteria to allow discharge of symptomatic Covid-19 patients from isolation was based on RT-PCR test result and the estimation of the duration of viral shedding after recovery. This recommendation stemmed from former knowledge about other coronaviruses[7]. It would require patients to be tested twice at least 24 hours apart[7]. However, in

updated guidelines, the balance between risks and benefits of patients' health has become the forefront of recommendations for the time of discharge, so then, the time point when symptomatic patients are no longer considered infectious has been defined according to the time when disease' symptoms start and disappear. This recommendation had become paramount since the previous one came out infeasible in many settings[8]. It also aims to avoid unnecessary isolation time period and extra clinical tests[9]. These criteria are recommended according to studies which had shown that the viral load of recovered patients declines quickly[10].

However, the criteria for hospital discharge vary widely based on the capacity of services in hospitals and definitions of clinical recovery[11]. Consequently, criteria for hospital discharge patients are not the same as the criteria for isolation discharge patients[12]. About half of clinically recovered COVID-19 patients, have a positive test result at the time of recovery, and some have the RT-PCR positive results prolonged up to 14 days after recovery[13]. Expectedly, there is potential for the viral transmission after hospital discharge, especially when the circumstance of the isolation is not optimal[14]. Cheng et al(2020) showed that discharge from hospital should not be considered the endpoint of monitoring and precautionary measures and the potency of transmission of virus to others should not be underestimated[1].

Providing further evidence to improve isolation criteria for recovered patients and establish the criteria for the post-discharge isolation condition will help to fade the possible risks of viral transmission away. Finding new cases among close contacts of discharged patients, during few weeks after discharge, will show the possibility of viral transmission and the condition in which the transmission is more probable to occur. In doing so, we studied the rate of the incidence of new cases of COVID-19 who had close contacts with recovered and discharged COVID-19 patients and its potential associated factors.

Methods

We recorded 450 hospitalized patients in Imam Khomeini hospital complex, the largest educational referral center in Iran with three hospitals and more than 1200 beds. The considered patients were those who were hospitalized following the covid-19 clinically compatible illness, had a positive RT-PCR test result, and were discharged from the hospital because their main symptoms went away and their recovery was clinically confirmed. A data collection tool was prepared according to study objectives. The tool had two main parts: the first part included demographic and clinical data, which were retrieved from hospital records, and the second part included follow-up data which were collected through telephone call interviews with discharged patients or their main caregivers. The follow-up data were including patients' symptoms after discharge, their current health status, and any confirmed new cases in their close contacts. Telephone calls were made by three interviewers and were repeated up to three times in different hours and days to increase the response rate. Patients were registered as non-response, if they did not answer all the calls. Furthermore, patients that answered telephone calls but were not interested in participation in the study were registered as non-response as well.

Statistical Analysis

Patients' characteristics were described by the mean and standard deviation or frequency and percent. The incidence of new cases of covid-19 was defined as hospitalized or having positive test results for covid-19 in close contacts. Those patient who stated that they had at least one new case of covid-19 in their close contacts within three weeks, after their discharge time(considered cases) were compared to participants who stated no new case of covid-19 in their close contacts (considered controls). Cases and controls were described and were compared regarding potential effective factors. House density was defined as the number of patients' cohabitants in a same house divided by the number of rooms the house has. Educational level was defined in four levels including illiterate or elementary, lower intermediate, upper intermediate and academic. The quality of isolation defined as the staying in an independent room in the home for at least 10 days with separated meal plus the patient's own point of view about his quality of isolation after discharge. The association of relevant variables was analyzed using univariate and multivariable logistic regression analysis, adjusting for age, sex and the level of education. All analysis was performed in stata14 (Stata Statistical Software: Release 14. College Station, TX: StataCorp LLC)

Results

Among 450 COVID19 patients, 422 answered the call and agreed to be interviewed (response rate:93.77%). Among responders, 257 cases were male (60.90%) and 165(39.10%) were female (sex ratio = 1.55 male). Most patients were in upper-middle education level (n = 148, 33.77%). The prevalence of smoking was 11.84%(n = 50). One hundred sixty-five patients (39.09%) reported the history of being in condition with a risk of exposure to COVID-19, such as attending a party or event (n = 85, 51.1%), use of public transportation (n = 55, 33.33%), history of referral to a hospital of health care center (n = 11, 6.6%) and keep going to work (n = 14, 8.4%), within 14 days before the onset of their symptoms. Out of 262(62.09%) patients with recorded co-morbidities, the most prevalent comorbidities were hypertension (n = 111, 42.36%), followed by diabetes (n = 93, 35.49%), hyperlipidemia (n = 76; 29.00%) and history of cardiovascular disease (49; 18.70%). The mean \pm sd of staying at home (home isolation) after discharge was 25.85 ± 23.78 days (Table 1).

Table 1

Demographic, contact history, and co-morbidities of COVID-19 patients participated in this study

Total(n = 319)		
Sex(male) *	Male	257(60.90)
	Female	165(39.10)
Education level	Illiterate or elementary	98(23.31)
	Under intermediate	83(19.84)
	Upper intermediate	140(32.71)
	Academic	101(23.96)
Age (years)	< 40	94(22.38)
	40–50	73(17.38)
	50–60	100(23.81)
	60–70	89(21.91)
	70<	64(15.24)
Co-morbidities (n = 262, 62.08)	HTN	111(42.36)
	Diabetes	93(35.49)
	Hyperlipidemia	76(29.00)
	Cardiovascular	49(18.70)
	Cancer	34 (12.97)
	Renal	17(6.48)
	Asthma	16(6.10)
	Intestinal	14(5.34)
	Liver	11(4.19)
	COPD	6(2.29)
	CVA	3(1.32)
Hospital duration(days)	< 3	215(50.94)
	3–7	141(33.41)
	7–10	37(8.76)
	10<	28(6.63)

Total(n = 319)		
History of potential exposure within 14 days before symptoms	Yes	165(39.09)
	No	220(52.13)
	Not remembered	37(8.76)
Having symptoms after discharge,	Yes	252(59.71)
	No	170(40.28)
Days did not go out after discharge (weeks)	< 2	111(26.30)
	2–3	142(33.65)
	3–5	116(27.49)
	5<	53(12.56)
Visited after discharge	Yes	220(52.13)
	No	147(34.83)
	Not remembered	55(13.03)
Apartment/house	Apartment	232(54.97)
	House	52(12.31)
	Not answered	138 (32.70)
Return to job	Yes	85(27.24)
	No	227(72.76)
Quality of isolation/	Good	255(60.42)
	Bad	79(18.72)
	Not answered	88(20.8)
House density	Low	138(32.70)
	Moderate	218(51.66)
	High	66(15.64)

Within three weeks since the discharge, 41(9.71%) participants had at least one new case in their close contacts. Among others, 307(72.74%) stated that there was no new case in their close contacts. The rest of the patients, 74(17.53%) did not know whether there was any new case in their closes or not. Of those who had new cases in their close contacts, 30 (73.17%) patients stated that there was one new case,

eight patients (19.51%) stated that there were two new cases, and three patients (7.31%) stated that there were three new cases in their close contacts. In sum, there were 55 symptomatic new cases which can potentially have got the infection from 41 discharged patients within 3 weeks of their time of discharge. The majority of new cases were male (n = 23; 59.25%) and the average age was 39.35 ± 14.73 .

Those patient who had at least one new case of covid-19 in their close contacts (n = 41) were compared to participants who stated that there was no any new case in their contacts (n = 307) (control to case ratio 7.48:1). The mean (sd) of cases and controls were 54.19(15.90) and 53.72(15.98), respectively (p = 0.73). Nineteen patients (46.34%) with new cases in their close contacts were female, while it was 34.85% (n = 107) for the rest [male to female; OR(CI): 0.61(0.32–1.19); P:0.15]. The direction of having a high level of education (academic) was in reverse with the probability of potential infectivity (not significant) [low to high; OR(CI): 1.11 (0.47–2.6); P: 0.80.8].

There was no statistically significant difference between smoking habits regarding the risk of potential transmission (n = 6, 12.5% versus n = 34, 11.45% respectively); [OR(CI): 1.10 (0.43–2.79); P: 0.83]. However, there was a significant association between having a co-morbidity in patients with the odds of getting infected in their close contacts [OR(CI): 2.45 (1.05–4.72); P: 0.03].

The density of inhabitant per houses rooms and the quality of isolation had significant associations with potential transmission in close contacts [high density to moderate density; OR(CI): 2.44 (1.06–5.61); P: 0.03], [bad condition to good condition; OR(CI): 2.31 (1.17–4.59); P:0 .01], respectively. Regarding the result of multivariable analysis, there was no significant simultaneous confounding effect by age, sex, and education level, for observed associations and the results of the univariate analysis did not change significantly in multivariate analysis(Table 2).

Table 2

Crude and age-sex- education-adjusted associations for potential determinant factors and the incidence of the symptomatic COVID-19 in close contacts of COVID-19 recovered patients, within three weeks after discharge.

potential determinant factors of being a source of infection		New case in closed contacts (n;%)		Crude OR(95% CI)	P	Adjusted odds ratio(CI)	P
		YES	NO				
Hospital duration	More than 3days	20(48.78)	156(50.98)	.91(.47–1.75)	.79	.85(.43–1.69)	.48
	Less than 3days(reference)	21(51.22)	150(49.02)				
Having symptoms after discharge	Yes	26(63.41)	200(65.15)	.92(.47–1.82)	.82	.85(.43–1.69)	.48
	no(reference)	15(36.59)	107(34.85)				
Visit health centers after discharge	Yes	11(27.50)	120(40.40)	.55(.26–1.16)	.11	.53(.25–1.11)	.09
	no(reference)	29(72.50)	177(59.60)				
return to job	Yes	9(25.71)	75(27.88)	.89(.40–1.99)	.78	1.03 (.42 – 2.51)	.93
	no(reference)	26(74.29)	194(72.12)				
Days not to go out	More than 3wks	16(39.02)	142(46.25)	.74(.38–1.44)	.38	.76(.38–1.52)	.44
	Less than 3weeks (reference)	25(60.98)	165(53.75)				
home density	low	15(36.59)	103(33.55)	1.57(.72–3.39)	.25	1.65 (.75 – 3.63)	.20
	high	12(29.27)	53(17.26)				
	moderate(reference)	14(34.15)	151(49.19)	-	-		
Quality of isolation	bad	17(41.46)	203(76.60)	2.31 (1.17–4.59)	.01	2.19 (1.09–4.39)	.02
	good(reference)	24(58.54)	62(23.40)				

Discussion

Our follow up study on discharged COVID-19 patients showed that there is a potential chance of viral transmission to patients' close contacts within three weeks of discharge. Our findings also implied that the probability of seeing new infected cases will go up when the discharged patient has chronic co-morbidities and when the quality of isolation is low. These findings show that although the risk of

infectivity in recovered patients can fairly be considered low, having effective contact with the recovered patients might lead to the transmission of the infection. Since the data about discharged COVID-19 patients and their closed contacts are not widely available, these results can be considered meaningful for the providing of sound recommendation for discharged patients[1, 15, 16].

In this study, having co-morbidity was in association with the risk of the occurrence of symptomatic disease in the patients' close contacts, within three weeks after discharge. Previous studies implied that comorbidities increase the chances of infection[17] and patients with COVID-19 disease who have comorbidities are more likely to develop a more severe course and progression of the disease[18]. However, to our knowledge, the infectivity of COVID-19 patients with different co-morbidities has not been extensively explored. Regarding co-morbidities and the infectivity of COVID-19 patients, it seems as though the level of care that a patient needs and the physical proximity of his caregivers are more determinant than the pathophysiological characteristics of a specific co-morbidity[19]. The specific behavioral and residential condition, in which COVID-19 patients live within, after discharge from hospitals, can become a key factor of viral transmission. Close contacts of discharged patients may feel less risk of getting the infection and may intend to spend more time with them when the discharged patient needs to be cared by his caregivers. The mentioned finding is compatible with other evidence which imply that physical distancing and verbal interactions are the determinant factors for viral transmission[20].

The vast majority of evidence, concerns the virus-related factors such as viral shedding and the presence of replication-competent virus as influential factors for the infection transmission[21]. Furthermore, individual characteristics of contacts were being considered determinant factors for household infection as well[22]. In this regard, we found that the density of residents in a household (number of residents in a house divided by the number of rooms) and the quality of isolation (having an isolated room and taking care with considering standard protection) were in association with the risk of the incidence of new cases in close contacts of the COVID-19 recovered patients. Not very surprisingly, this association was independent of patients' gender and age and the level of education. This result is in consistent with Luo L(2020) findings that pointed out the household transmission as the main route of the transmission[23].

In this study the incidence of new cases in close contacts was measured via the patients' statement. It is identifiable that patient statement is not the optimal measure for establishing the transmission link between new patients and the discharged patients. It means the observed new cases in close contacts of discharged patients, might have got the infection from other sources. Having said that, there might be new cases around a discharged patients that were missed falsely, either for being asymptomatic or simply missed by the interviewee. Nevertheless, the denominator for calculating the risk of observing symptomatic patients in close contacts of discharged patients was not established in this study, the average risk of infection in the society in the same time long is too small to be considered influential. It is also worth mentioning that criteria for the recovery from the disease are somehow changing time by time, depending on the availability of tests and accessibility of services as well as the rate of new cases who are in need to become hospitalized[11, 14]. As a consequence, a patient who was considered recovered

and was discharged at a specific time might have not been considered so, if he had got the disease at a different time and different circumstances.

Conclusion

Finding a fairly high number of new cases in close contacts of discharged patients shows that the considering recovered patients thoroughly out of the risk of transmission might not be quite safe, especially for those contacts that are in touch with the patients in longer durations of time. Such condition is more likely to happen when the recovered patient has chronic co-morbidities which put him in a place of getting care by his closes. We also found that discharged patients can become a source of infection for others, especially when the quality of isolation is low and the strictness of precautions is not considered serious. It might become worse when higher numbers of people live together in a single house.

Abbreviations

COVID-19: coronavirus disease; RT-PCR: Reverse Transcription Polymerase Chain Reaction; OR: Odds Ratio; CI; Confidence Interval

Declarations

-Ethics approval and consent to participate

The proposal of this study was approved by Imam Khomeini Ethical committee under ethical code: IR.TUMS.VCR.REC.1399.108. Interviewees were informed about the study objectives, and their verbal consent was obtained.

-Consent for publication

Not applicable.

-Availability of data and material

All supportive data are available within the article and its supplementary files.

-Competing interests

Authors declare that they have no competing interests.

-Funding

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-Authors' contributions

AA & KZ conceived the study, participated in data collection, development tool and data analysis and interpretation, as well as preparation of the manuscript. AHP, SN, BE, NM, MSS, SFA contributed to the development of the data collection tool, conducting data collection and carried out some parts of data analysis. LD participated in writing, several editing of the manuscript, data analyses and interpretation. All authors read and approved the final manuscript.

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