Quarantine practices and COVID-19 transmission in a low-resource setting: Experience of Kerala, India

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ABSTRACT

Introduction: Disease transmission patterns of COVID-19 have shown that masking, social distancing, contact tracing and quarantine measures are important strategies for reducing transmission. The effective implementation of quarantine is determined by the commitment of the people and monitoring by the State. The aim of the study was to find out the effectiveness of home quarantine practises and its role in determining SARS CoV2 transmission. **Methods:** Record-based retrospective cohort study was conducted among expatriates of Kerala who were on quarantine at their homes and later tested positive for SARS –CoV-2. Quarantine practises were categorised as strict room quarantine, incomplete room quarantine, home quarantine and no quarantine. Risk of transmission was assessed using risk ratios. Multiple logistic regression analysis was performed to find out the determinants of SARS CoV2 transmission. **Results:** The median (IQR) age and duration of quarantine of 95 study participants were found to be 35 (29, 44) years and 7 (3,13) days, respectively. Majority of the participants practised strict room quarantine (57%), whereas 11.6%, 16.8% and 14.7% practiced incomplete room, home and no quarantine, respectively. Home quarantine without room quarantine had 24 times odds for transmitting disease [OR (95%CI): 24.14 (4.87--119.75), $P < 0.001$] and not being in quarantine for any duration before being diagnosed was found to be 14 times riskier when compared with strict room quarantine [OR (95%CI): 14.44 (2.42–86.17), $P = 0.003$]. **Discussion:** Low-resource settings successful in the initial phases of COVID-19 pandemic should make periodic revisions in the quarantine guidelines while continually promoting physical distancing strategies.

Keywords: COVID-19, India, low-income populations, transmission

Introduction

COVID-19 caused by SARS-CoV-2 has affected millions of people around the world. Countries have adopted social distancing, contact tracing, quarantine strategies and personal protection measures as effective strategies to slow the spread of SARS-CoV-2 pandemic.[1–3] The challenges related to quarantine compliance are manifold. Apart from the benefits of quarantine in reducing disease transmission, its negative impact on social, mental and economic domains are felt more on the poor and vulnerable.[4,5] All these have raised concerns regarding the utility of quarantine practices.[6] In resource constrained regions like

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low- and middle-income countries (LMICs), there is a need to develop cost-efficient strategies to prevent rapid transmission of disease. Home-based quarantine measures were advocated for the asymptomatic and mildly symptomatic patients from the initial phase of the pandemic itself.[7]

Disease transmission patterns of SARS CoV2 have been evaluated in various settings.[1,8] Various routes of spread have been proposed for the transmission of SARS-CoV-2 in the community.[1] But understanding the disease transmission patterns in real life settings is imperative for bringing out region specific strategies. The countries affected during the initial phase of the pandemic had adopted social distancing and contact tracing along with quarantine measures as an important strategy for reducing disease transmission.[9,10] The effective implementation of home quarantine is determined by two pillars -- awareness and commitment of people under quarantine and their family members; and monitoring mechanism offered by the State. However, compliance to home quarantine is never uniform and it can result in localised clusters of outbreaks. These local clusters could be utilised to study the transmission dynamics of the disease including its basic reproduction number (R0).[11]

The south Indian State of Kerala has been lauded by national and international media platforms for its effective control of SARS-CoV-2 outbreak.[12,13] Being the first state in India to report SARS-CoV-2positivity in three medical students from Wuhan, the state swung into action much before the rest of the country. Kerala is a densely populated state with high Human Development Index (HDI - 0.779) despite having a low per capita Gross Domestic Product (GDP – USD 2900).[14,15] Kasaragod district, one among the 14 districts is the northern district in Kerala, with more than 1.5 million population has a density of population of 650 individuals per km².[16] The aim of the study was to find out the effectiveness of home quarantine practises and its role in determining SARS CoV2 transmission from foreign returned natives who underwent quarantine at home in Kasaragod district in Kerala.

Methods

A retrospective cohort study was conducted using the data records at the corona control unit of Kasaragod District in Kerala India. The study was conducted in accordance with the declaration of Helsinki and the protocol was approved by the Institutional human ethics committee of Central University of Kerala with a waiver of consent (No- CUK/IHEC/2020/03). The study participants were natives of Kerala who returned from abroad and were on quarantine at their homes and later tested positive for SARS –CoV-2 by reverse transcriptase polymerase chain reaction (RT-PCR). An expatriate tested positive for SARS- CoV-2 was traced for his/her quarantine history. As a protocol, the positive patients were treated at a designated COVID-19 treatment centre and their contacts were sent for quarantine and followed up for another 14 days. All these processes were managed at the district level by the district corona control cell.

Expatriates were arriving in the district from outside the country until 24th March 2020. The district of Kasaragod reported 179 patients to be positive for SARS-CoV-2 until last week of April 2020 with no new cases in the first 10 days in May 2020. COVID-19 positivity was ensured through throat sample taken from expatriates at the time of their arrival into the state. All those who could remain in strict room quarantine at their homes till the results of the swab tests were available were sent to their homes with sufficient precautions.

Individuals with travel history abroad and on home quarantine were the inclusion criteria for the current study. Out of 179 positive patients in the district, 107 patients were from abroad, among which 101 had gone into quarantine at home and 6 had gone directly into quarantine at hospitals. Six patients who had elderly/ill people at their homes chose to directly go to the hospital for quarantine and were hence excluded. Additionally, six other participants were excluded due to incomplete data regarding the quarantine practises. Excluding participants with missing data, a total of 95 patient records were used for analysis and interpretation. Data were extracted using a semi structured questionnaire.

Information collected by the district health authorities at the time of initial examination before the start of quarantine was used as the baseline data. Routine data collected during follow-up monitoring of the patients were also used for the study. Admission at hospital following positive diagnosis for SARS CoV2 by RT-PCR or successful completion of quarantine period with test positivity was considered as the end of follow-up period. Details regarding the type of quarantine practises were obtained. The primary contacts of all these patients were traced and tested, and it provided valuable information regarding transmission dynamics in home quarantine conditions. Two trained nurses were entrusted with primary contact name elicitation activities in Kasaragod district. Once a person was diagnosed to be positive, the patient was be contacted over phone by either of these persons. Multiple conversations by the same person during the follow-up phone calls helped in creating valuable rapport with the patients leading to meticulous data on quarantine practises adopted by patients at their homes. Additionally, this helped in allaying their apprehensions better. Details regarding age and gender of patient, total number of symptoms, number of primary and secondary contacts, number of primary and secondary contacts who turned positive, number of comorbidities, median age of contacts and tobacco smoking habits were obtained. Social desirability bias was minimised by confirming the details of quarantine from friends and family members and by enquiring in detail regarding the nature of contact with the index case.

Based on the extent of quarantine practised by the patients, they were categorised into 4.

Category 1: Strict room quarantine (Complete compliance with the advice of the district authorities. Remaining in the dedicated

space or room inside the house, cleaning of clothes and utensils done by self, without stepping out of the room. No direct contact with household members)

Category 2- Incomplete room quarantine (Room quarantine with cleaning of clothes or utensils done by others with or without occasional stepping out of the room. Occasional low-risk contact with one or a maximum of two household members)

Category 3- Home quarantine (No room quarantine practised, but never stepped out of the house. Frequent contact with other household members)

Category 4- No quarantine (Home quarantine with occasional/frequent contacts with individuals other than household members)

Incomplete room quarantine and *home quarantine* have been combined to '*home quarantine without room quarantine*' during the course of analysis.

Additionally, a *primary contact* is defined as person who has resided in the same household, travelled in the same vehicle or even persons who has visited the household of an index case. The primary contact may not necessarily have any contact with the index case. This broad definition adopted in state of Kerala was used to trace and test the maximum number of possible contacts in Kasaragod district also. All primary contacts were tested by RT-PCR test in government accredited laboratories for confirming the diagnosis. A person is said to have transmitted the disease when one or more of the primary contacts are tested as positive for SARS CoV2.

The statistical analysis was done using SPSS 16.0 (SPSS Inc. Released 2007. SPSS for Windows, Trial Version 16.0. Chicago, SPSS Inc.). The quarantine practices were expressed as proportions. Risk of transmission with different quarantine practices were assessed using risk ratios. Multiple logistic regression analysis was performed to find out the determinants of SARS CoV2 transmission. Significance level less than 0.2 was the initial criteria used for assigning co-variates to the regression model. Backward LR method of regression was employed for discarding non-significant exposure variables. Maximum value of Nagelkerke R square with minimum number of variables and significance of the model in the analysis of variance table were the criteria used for finalizing the model. Ethical clearance has been obtained from Central University of Kerala. (IHEC No:- CUK/IHEC/2020/03)

Results

The mean (SD) and median (IQR) age of 95 study participants were found to be 36.48 (9.44) and 35 (29, 44) years, respectively. The study population is a younger population with only six individuals aged above 50 years. There was only one female among the participants. The lower age of the patients was complemented

by comparatively lower burden of comorbidities (26.3%, $n = 25$). A quarter of the study subjects (25.3%, $n = 24$) were asymptomatic. The mean (SD) number of symptoms were 1.99 (1.9) with 28 participants reporting three or more symptoms before or at the time of diagnosis. The type and combinations of various symptoms is part of another study and is not described in this manuscript. Only 9.5% ($n = 9$) were smokers at the time of diagnosis, whereas 70% ($n = 67$) had never smoked in their lifetime.

The median (IQR) duration of quarantine was found to be 7 (3,13) days. Majority of the participants practised strict room quarantine (57%, $n = 54$), whereas 11.6% ($n = 11$), 16.8% ($n = 16$) and 14.7% ($n = 14$) participants practiced incomplete room, home and no quarantine respectively. The total number of primary contacts for the 95 study participants was found to be 1394. The median (IQR) number of primary contacts per positive patient was 6 (3,18), whereas their median (IQR) age was 29.6 (25,35) years. A total of 20 study participants transmitted the disease to 65 primary contacts, whereas 75 participants did not transmit disease.

The relative risk of various factors for transmission was estimated. (Table 1: Risk of SARS CoV2 transmission) Higher age (41 years in transmission group and 35 years in non-transmission group) of patients was found to be a significant risk factor ($p = 0.02$). Number of symptoms and presence of comorbidities were found to be non-significant. Not practising strict room quarantine significantly increased the chance of transmission [RR (95% CI): 11.85 (2.91--48.23), $P < 0.001$], whereas duration of quarantine was found to be nonsignificant. Binary logistic regression (Table 2: Binomial logistic regression analysis for finding predictors of SARS CoV2 transmission) revealed that home quarantine without room quarantine had 24 times odds for transmitting disease when compared to strict room quarantine [OR (95%CI)): 24.14 (4.87--119.75), $P < 0.001$]. Being not in quarantine for any duration before being diagnosed was found to be 14 times riskier when compared with strict room quarantine [OR (95%CI)): 14.44 (2.42–86.17), $P = 0.003$]. The regression model was found to be significant ($p < 0.001$) with Nagelkerke R^2 value of 0.36.

The reasons for not practising strict room quarantine were lack of clarity in understanding instructions, lack of facilities at home, psychological distress of being in quarantine and lack of compliance despite proper instructions. None of the participants reported lack of support from family members.

Discussion

Use of face masks and practising hand hygiene was found to reduce SARS-CoV-2 transmission. Additionally, reduction in droplet transmission from infected individuals in internal environments could be achieved by adequate quarantine practises.[17] Hence, advocating strict quarantine for persons with travel history from geographies with increased disease occurrence was essential for

Table 1: Risk of SARS-CoV 2 transmission

Factors associated with transmission- Bivariate analysis

Variable		Transmitted disease (*n*=20)	Did not transmit disease (*n*=75)	Relative Risk (95% confidence interval)	*p value*
Quarantine practises	No room quarantine	18 (43.9%)	23 (56.1%)	11.85 (2.91-48.23)	<0.001
	Strict room quarantine	2 (3.7%)	52 (96.3)		
Smoking	Ever smoked	7 (25%)	21 (75%)	1.29 (0.58-2.89)	0.547
	Never smoked	13 (19.4%)	54 (80.6%)		
Symptoms	With symptoms	5 (20.8%)	19 (79.2%)	0.99 (0.4-2.43)	0.976
	Without symptoms	15 (21.1%)	56 (78.9%)		
Co-morbidities	Comorbidities present	6 (24%)	19 (76%)	0.83 (0.36-1.93)	0.677
	Comorbidities absent	14 (20%)	56 (80%)		

Variable	Transmitted disease, Mean (SD) (*n*=20)	Did not transmit disease, Mean (SD) (*n*=75)	*P*[#]
Age (in years)	41.10 (9.95)	35.25 (9.1)	<0.001
Number of symptoms	2.15 (1.9)	1.95 (1.94)	0.570
Number of primary contacts	19.95 (25.87)	13.27 (24.91)	0.014
Number of positive cases among primary contacts	3.20 (4.19)	0.00	<0.001
Number of secondary contacts	10.85 (15.15)	3.79 (10.42)	0.007
Age of primary contacts (in years)	27.12 (6.72)	30.088 (10.81) years	0.012
Duration of quarantine period (in days)	8.35 (4.92)	9.03 (7.48) days	0.801

[#]*p* value < 0.05 is considered as statistically significant

Table 2: Binomial logistic regression analysis for finding predictors of SARS CoV2 transmission

	Odd's ratio (95% confidence interval)	*P*	Constant
Quarantine practises			
Strict room quarantine	Reference		
Home quarantine without strict room quarantine	24.14 (4.87-119.75)	<0.001	3.18
No quarantine	14.44 (2.42-86.17)	0.003	2.67

controlling the spread of COVID-19 in Kerala. Such a strategy was necessary for minimising disease spread to close contacts of these persons. Ensuring individual quarantine of persons with such travel history and active monitoring for development of symptoms were the key strategies adopted for all immigrant patients tested positive for COVID-19 in Kerala state of India.[13] This strategy provided commendable results comparable to resource-intensive techniques suggested and adopted in developed countries.[10,18] The relative success was evident by few or no new cases being reported from entire Kerala at the beginning of May 2020.[19] However, spread of disease to family members and immediate contacts did occur in some occasions. A super spreader event (SSE) involving three generations was also reported. This occurrence was similar to other reported SSE.[20]

Our study reports a significant higher amount of transmission due to deficits in strict room quarantine. Strict quarantine strategy is an essential component of SARS-CoV-2 transmission containment as seen from the initial stages of the outbreak.[7] With exponentially increasing cases, it is imperative that the community is made aware of the need to practise strict room quarantine for breaking transmission chains. This could be strictly ensured in social settings where the social environment is favourable and economic impact is lower.

With more than half of the infections being projected to be caused by pre-symptomatic and asymptomatic individuals, active rapid contact tracing and quarantining will remain essential throughout the course of this pandemic.[11,18,21] When there is a larger pre-symptomatic infectivity period of about 2 days, strict individual quarantine practise by individuals with high risk of infection has definitive advantages over active monitoring strategies alone. Additionally, supplementary measures like social distancing need to be practised to keep the reproduction number (R) under 1 in general community.[22] But as the number of cases keep on increasing in low income or socially deprived settings, dynamic strategies based on rapid feedback loops need to be adopted as seen in countries like Liberia.[8,23]

Number of tests adjusted for the population size is much less in resource poor settings. Additionally, delay in getting the test results will have an impact on disease transmission in such low income settings.[24] The economic impact of the disease may result in lower compliance to disease control strategies.[5] Hence, efforts should be diverted to ensure other interventions like physical distancing rather than only trying to ensure strict quarantine for contacts. This pragmatic approach will help in keeping both economic deprivation and disease transmission under check. This is relevant due to recent evidence showing only marginal benefit for strict quarantine over active monitoring.[22] This is especially significant

when there is an exponential increase in number of contacts with only a few of them becoming positive, as seen during later stages of the pandemic.[11] Estimations based on Indian contexts has also echoed similar findings.[25] Even in highly efficient settings where 90% of all contacts are getting traced, ensuring strict quarantine alone may not have the required effects.[22] The relative importance of quarantine over active testing as the major strategy depends upon the pace of disease transmission in the community, which is often measured by the serial interval. But quarantine as a strategy is much resource sparing and definitely advantageous with other evidence-based strategies.[22]

Moreover, the role of appropriate quarantine in reducing household transmission should be realised by primary care physicians. The transmission of SARS-CoV2 is 10 times higher in household contacts than other contacts.[26] It is three to four times more in adults than in children.[26,27] Hence, strict advice must be provided by primary care physicians to people with respiratory symptoms to minimise the interaction with older comorbid individuals within their households also. This is essential as the current practise of masking and social distancing is prioritised in community, whereas scant regard is given to the same within households. Additionally, the chance of greater infectivity could be during the incubation period rather than the symptomatic period.[28] Hence, awareness need to be created in primary care practise regarding the need to segregate the vulnerable individuals in the household to the maximum extent possible.

Meticulous contact tracing, practising strict room quarantine and identification of SSEs were instrumental in controlling the pandemic in Kasaragod district in the initial stages. This achievement in a low GDP - high HDI setting like Kerala is laudable. But with increasing number of cases and contacts over larger durations of time, such actions may not remain economically and socially viable. Low-resource settings which were successful in the initial phases of the COVID-19 pandemic have to make periodic revisions in quarantine guidelines while always ensuring physical distancing strategies. Adequate resource allocation and periodic policy revisions based on emerging evidence will help low-resource settings to tide over the crisis until more permanent solutions like vaccines or herd immunity emerge.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Ethical clearance

Ethical clearance obtained from Institutional human ethics committee Central university of Kerala, Kasaragod district. No- CUK/IHEC/2020/03.

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Conflicts of interest

There are no conflicts of interest.

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