

Contact tracing in the context of COVID-19: a case study from Oman

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ABSTRACT

In April 2020, the Ministry of Health (MoH) in Oman, a high-income country in the Eastern Mediterranean Region (EMR), implemented a robust contact tracing (CT) system for COVID-19. To capitalise on Oman's experience, EMRO has developed a case study presenting the methodology used to conduct the CT activities, main functions of the system, challenges encountered, lessons learnt, and the way forward. To develop the case study, a key informant interview was conducted virtually with the CT focal point in the MoH, using a semistructured questionnaire adapted from the WHO questionnaire for the assessment of CT activities. The Oman MoH launched a CT system based on three complementary digital tools: Tarassud plus, Medical Scout and HMushrif applications. Oman's CT strategy classifies contacts into close and casual contacts. Only close contacts are listed using the Tarassud plus application, while casual contacts are requested to self-monitor for 14 days using the other two applications. With the evolution of the outbreak, Oman MoH implemented stricter policies and prioritised the follow-up of close contacts to keep the CT activity manageable. Community health workers and volunteers facilitated the CT activities through sensitisation of the local community to the follow-up process and reducing the COVID-19-associated stigma. Challenges encountered revolved around contact data management, given the offline in-operability of the applications, and lack of national risk communication guidelines to address community concerns and widespread rumours.

INTRODUCTION

COVID-19 is an infectious disease caused by the SARS-CoV-2 virus. Most people infected with the virus experience mild to moderate respiratory illness and recover without requiring special treatment. The virus can spread from an infected person's mouth or nose in small liquid particles when they cough, sneeze, speak, sing or breathe.¹ SARS-CoV-2 infections have been attributed to relatively few individuals in high-transmission settings. Subsequently, case identification is a cornerstone for identifying further unrecognised chains of transmission and common points of exposure.²

Contact tracing (CT) is the process of identifying, assessing and managing people who

SUMMARY BOX

- ⇒ The strengths of this case study include introduction of a novel approach integrates a locally developed digital tool to support contact tracing (CT) activities; approach to contact prioritisation during community transmission; and provision of a qualitative approach that allows in-depth analysis of CT strengths and weaknesses in Oman.
- ⇒ The major limitation of our case study is that data on CT indicators were available for 7 months only. Other challenges are; low laboratory capacity thus not all contacts were tested; poor offline capabilities of Tarassud plus; centralised data storing system; no national risk communication guidelines to address community concerns.

have been exposed to someone who has been infected with the COVID-19 virus. CT and quarantine of contacts identified through CT aim at interrupting transmission between people and are essential public health tools for controlling the virus spread. CT also permits identifying earlier people who are at a higher risk of developing severe disease to get medical care quickly once they develop symptoms.³

CT has been identified by WHO as an effective intervention together with vigorous testing and proper management of cases to curb the transmission of COVID-19.² Disease transmission will be prevented through a multi-levelled process of identifying, assessing and managing people who may be exposed to the disease.

COVID-19 is a disease that requires identification of those who may have been infected and who will need follow-up for 14 days after exposure. Despite the continuous vaccination efforts worldwide, it is essential to continue CT and quarantine contacts to control transmission.²

CT process for respiratory diseases such as COVID-19 requires extensive human and financial resources and should be implemented in a stepwise approach depending on the availability of these resources and transmission scenarios. Such a phased approach

Table 1 COVID-19 transmission scenarios and implementation of CT activities, from the WHO guidance for contact tracing, 1 February 2021⁶

Epidemiological scenario	CT activities
No cases	Identifying and training existing personnel and preparing them for deployment and response.
Sporadic cases	Exhaustive strategies should be implemented. Case investigation for all cases is necessary for timely suppression of transmission.
Clusters	CT is required to suppress transmission within clusters and recognise events that contribute to transmission. These events can be mitigated by different Public Health and Social Measures.
Community transmission (including four subcategories of increasing incidence)	Despite challenges, CT remains crucial, particularly in high incidence scenarios. CT should continue and focus on high-risk exposure contacts in accordance with the available capacities

has been witnessed in many countries through prioritising specific high-risk settings with vulnerable individuals, such as hospitals, nursing homes (eg, dormitories).³

The WHO recommends prioritisation of CT activities according to country transmission scenarios. SARS-CoV-2 transmission status is characterised into four epidemiological scenarios, with the last one accommodating four sub-categories. Strategies for CT need to be tailored in accordance with the local transmission dynamics and response capacity and should have the dynamicity to adapt to the context and emerging trends (see [table 1](#)).^{3,4}

CT in the Eastern Mediterranean Region (EMR) is facing a multitude of obstacles. According to an unpublished review conducted among EMR Member states, the main challenges identified are lack of resources (human and/or financial) for the sustainability of CT activities, difficulties for training CT teams because of physical distancing/ lockdown measures, difficulty to scale-up CT in emergency/conflict settings, and insufficient community compliance to contact follow-up and public health and social measure (PHSM).

SARS-CoV-2 was first detected in Oman on 24 February 2020. By 20 May 2021, 208 607 confirmed cases were reported, including 2239 deaths (case-fatality ratio of 1.1%).⁵ Five per cent of patients required hospitalisation. About 64% of the confirmed COVID-19 cases were between the ages of 25 and 44 years with overall male to female (M:F) ratio of 2.4. The M:F sex ratio was higher among expatriates,⁶ who constitute about 38% of Oman population⁷ (3.6 vs 1.5 for nationals).

During the first peak of the outbreak in Oman, which was reached in mid-July 2020, there were more than 65 000 confirmed cases and over 300 deaths.⁵ Then, the

country transitioned into community transmission of COVID-19, and the number of contacts for follow-up grew exponentially. CT capacity has consequently been scaled up, including the use of digital proximity tracking solutions.⁸

This case study aims to describe Oman's implementation of digital solutions and other strategies to augment CT activities during the widespread transmission of COVID-19. Annexes 1 and 2 provide details regarding the methods used.

DESCRIPTION OF CT METHODOLOGY IN OMAN

As part of their digital transformation away from traditional paper-based methods, the MoH launched a CT system based on three complementary digital tools: the Tarassud plus,⁹ Medical Scout and HMushrif applications.¹⁰ All contacts of laboratory-confirmed or probable COVID-19 cases were advised to instal all three applications that manage the different steps of CT synergistically on their smartphones.

Contact prioritisation

CT is conducted by the MoH Directorate General of Disease Surveillance and Control (DGDSC). Oman's CT strategy classifies contacts into close and casual contacts. Close contacts are those who present with either of the following scenarios^{11 12}:

- ▶ Anyone within 2 m for >15 min of a COVID-19 patient.
- ▶ Direct physical contact with a COVID-19 patient.
- ▶ Provision of direct care for a COVID-19 patient at home without proper personal protective equipment (PPE).
- ▶ An exposure through living in the same household with a COVID-19 patient within 14 days from the onset of symptoms in the patient.

Only close contacts are monitored and entered in Tarassud plus application, while casual contacts are requested to self-monitor for 14 days using the other two applications. With the evolution of the outbreak, Oman MoH implemented stricter policies and prioritised the follow-up of close contacts to keep the CT activity manageable.¹¹

Contact identification and listing

Tarassud plus serves as the mandatory platform for contacts and case listing to ensure proper follow-up and documentation by public health authorities (primary healthcare unit).

All cases and close contacts are interviewed in person (face to face) or by telephone if an in-person meeting is not possible. Case investigation and contact listing forms have been developed for both cases and contacts, and adapted into the Tarassud plus application.

Contact follow-up

Prior to the initiation of contact follow-up, all contacts sign a consent form in which they agree to comply with CT directives. The Medical Scout application sends daily

messages to contacts to inquire about any symptoms they may have developed, allows users to fill information on any comorbidities/risk factors (≥ 60 years old, diabetes, hypertension, chronic heart, lung, renal and liver diseases, immunosuppressed patients, pregnant women, etc) and performs an automated risk assessment.

In addition, the HMushrif application is used to track contacts, detect any violations of CT directives, and alert of potential new close contact with infected cases using the proximity tools.

A hotline has been launched to provide contacts with advice on quarantine and eventual testing if needed, and to collect information on non respect of mandatory isolation/quarantine measures. Furthermore, follow-up calls are conducted periodically during the 14-day quarantine to check for symptoms and ensure compliance.

Isolation and quarantine

Confirmed or probable cases are isolated at least 10 days after last contact with a COVID-19 case, including the 24 hours before symptoms, while contacts are quarantined for 14 days. If contacts develop symptoms, they are instructed to contact a medical facility to receive medical advice. Testing is not organised systematically for symptomatic contacts unless they have comorbidities that classify them as high-risk contacts; otherwise, they are classified as a probable case and isolated. Contacts are not quarantined in collective facilities but sign engagement forms to ensure compliance with self-quarantine.

CT INDICATORS

Key COVID-19 CT indicators were collected from eleven governorates between 1 August 2020 and 28 February 2021 by the DGSC. Most of the governorates reported high proportion of contact follow-up through the mobile applications.

A total of 388 563 contacts for 62 649 probable and confirmed cases were followed up. The number of contacts under follow-up increased regularly from August 2020 to January 2021. In the meantime, the number of contacts per case has dropped from five at the beginning of the outbreak to around two in October 2020, then started to rise again from November 2020 to January 2021 (figure 1).

The monthly proportion of contacts who became suspect cases was stable around 50% in August–October 2020, then decreased and increased again to reach 50% in February 2021.

The monthly proportion of contacts who became confirmed cases was around 20% until October 2020 and then dropped to less than 10%.

A high proportion of new cases were under monitoring before they occurred: between 50% and 76% new cases were contacts under the follow-up (see figure 2).

The average time from symptom onset to case confirmation among contacts was 24 hours (see table 2).

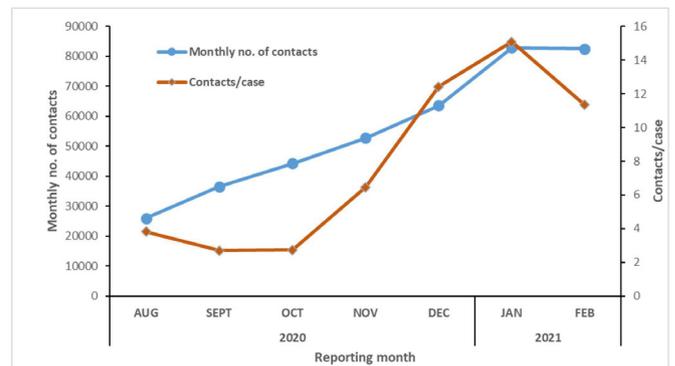


Figure 1 Numbers of identified COVID-19 contacts and contacts per case overtime, Oman August 2020–February 2021.

BEST PRACTICES

Community-centred CT

Community health workers (CHWs), volunteers and local authorities facilitate CT activities through sensitisation of the local community to the follow-up process to reduce COVID-19-associated stigma. Community engagement was also done via traditional media (television, radio), social media and proximity sensitisation in schools. In parallel, CHWs advocated for enhancing CT compliance within their respective communities. The capacity building of contact tracers was transitioned from the national to sub-national levels, permitting the rapid deployment of a high number of CT teams. MoH developed guidelines for community CT and deisolation throughout the pandemic. Globally, the deployment of CHWs for CT has proven to be ‘invaluable’, helping the MOH to overcome myriad CT failures, leading to more successful outcomes.¹²

Adaptable strategic CT guidelines

Early in the COVID-19 pandemic, Oman’s MoH developed National Contact Tracing Guidelines. These guidelines were flexible enough to adopt modifications in the duration of isolation and quarantine periods based on

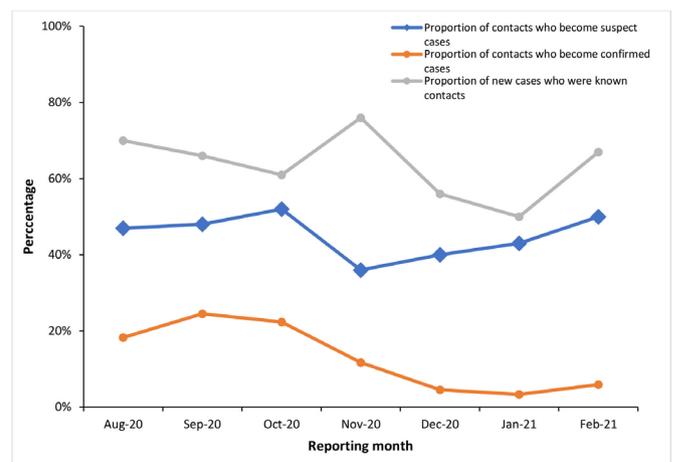


Figure 2 Contact tracing indicators, Oman, August 2020–February 2021

Table 2 Key contact tracing indicators for COVID-19 in Oman (August 2020–February 2021)

	Proportion of contacts who become suspect cases	Proportion of contacts who become confirmed cases	Proportion of new cases who are known contacts	Time from symptom onset to case confirmation
August-20	47% (12 299/25 906)	18% (4738/25 906)	70% (4738/6769)	Average 24 hours
September-20	48% (17 589/36 534)	25% (8960/36 534)	66% (8960/13 575)	
October-20	52% (23 087/44 284)	22% (9901/44 284)	61% (9901/16 231)	
November-20	36% (19 185/52 750)	12% (6175/52 750)	76% (6175/8174)	
December-20	40% (25 265/63 554)	5% (2876/63 554)	56% (2876/5116)	
January-21	43% (63 554/82 934)	3% (2753/82 934)	50% (2753/5500)	
February-21	50% (40 898/82 601)	6% (4873/82 601)	67% (4873/7284)	

the new and emerging evidence to limit unnecessarily prolonged isolation and overuse of limited laboratory resources. Furthermore, guidelines were adjusted to reflect the adoption of digital CT as a complement to traditional CT. Such agility and dynamicity of the CT response were pivotal to the outcomes achieved.

Redeploying workforce

CT is undertaken by primary healthcare staff in collaboration with the DGDSC team at the governorate level. It is the responsibility of the above-designated team to identify, follow and monitor the contacts. Initially, staff such as school nurses were mobilised to assist with CT activities at the governorate level. Subsequently, as community transmission set in, these staff were repurposed and assigned to COVID-19 treatment centres to help with case management.

Local digital solutions

Three apps were developed to support the CT activities. *Tarassud plus* application was developed by MoH, Medical Scout application was developed by a global company (Al Burkan Company), and HMushrif application was developed by a local company (E Mushrif Company). They were launched to replace paper-based data management systems. All three platforms were linked by a unique code (civil registration number) to facilitate interoperability. A significant strength of this data management platform is its accessibility to users. Community members can freely access the platform to update their information and view their COVID-19 test results or vaccination status. Another advantage is the ease of access by key stakeholders such as private hospitals, laboratories, etc. This allows for intersectoral collaboration and reduces the work burden on MoH staff. Before being implemented in Oman, this approach was not widespread in the EMR. However, similar approaches for CT were being used worldwide with each having their own tools to ensure the most feasible level of data protection possible.¹³

Ethical considerations

Anticipating concerns raised by digital CT, Oman's MoH trained platform operators on the importance of privacy and confidentiality. Moreover, measures for data

protection included; geographical restriction of access and voluntary user data sharing using a one-time pin. Oman MoH is the owner of the applications, and the only people that could access the data for health-related purposes.

CHALLENGES

One of the main challenges encountered revolved around contacts data management, given the limited offline operability of the applications. In areas where internet connectivity is low, operators relied on a two-step approach, first collecting data on paper and subsequently entering it into the system.

In addition, Oman MoH lacked national risk communication guidelines to address community concerns and widespread rumours. Fatigue associated with the implementation of COVID-19 PHSMs tended to increase a feeling of distrust which manifests itself with a larger proportion of responders expressing fear, anxiety, distrust and who can at times be aggressive or reluctant to cooperate. However, community leaders played a great role in quelling such situations and facilitating access of tracers to cases/contacts within their communities.

Another issue is that the system is highly centralised, with all data stored on a single server. This leaves the system vulnerable to privacy breaches (piracy) and raises ethical concerns. However, measures have been put in place to restrict access of operators and their supervisors. At the moment, access restrictions have been put in place based on geographical location, that is, district level operators can only see data of cases within their district, governorate level supervisors only manage data of their governorate, and finally, the national level operators serves as system administrators.

CT INDICATORS AND LESSONS LEARNT

Proportion of contacts seen and proportion of contacts lost to follow-up

All of the identified contacts of COVID-19 cases that occurred between August 2020 and February 2021 were followed up. Despite this high value, it is worth mentioning that the number of identified contacts per

case decreased progressively from five at the beginning of the outbreak to around two on October 2020, then started to rise again until January 2021. With all these changes in the situation, the system was efficient enough to keep the 100% completeness of contact follow-up. This could be attributed to the role played by the digital solutions that accommodated the increasing number of contacts over time, in addition to the acceptance and compliance of Oman population to the implemented follow-up modality.

Proportion of contacts who became suspect and confirmed cases

The monthly proportion of contacts who became suspect and confirmed cases ranged from 36% to 52% and 3% to 25%, respectively. These figures are highly dependent on the national COVID-19 testing strategies in Oman. It is worth mentioning that a progressive decline was observed in the monthly proportion of contacts who became confirmed cases as the monthly number of newly confirmed cases decreased.

Proportion of new cases who are known contacts

The proportion of new COVID-19 cases who were identified among contacts ranged from 50% to 76%. This demonstrates the importance of Oman's CT strategy in early detection and isolation of secondary cases. This also means the contact history of 24%–50% has not been identified and may have played a role in spreading the virus and the persistence of community transmission of COVID-19. This proportion was a little bit higher than what was reported by the Virginia Department of Health in the United States, where the percent of cases with known contact history was almost around 50%.¹⁴

CONCLUSION

The COVID-19 pandemic has posed a significant burden on health systems worldwide. For this reason, the utilisation of digital technologies has become a necessity in managing the pandemic. Oman implemented a robust CT system for COVID-19 supplementing traditional CT with digital tools. In a bid to share its experience with other countries within the EMR, we have described their methodology, the main functions of the system, challenges encountered and lessons learnt. Although the implementation of CT remains a challenging process, Oman's experience was remarkable as an evidence-based model adapted to the dynamic nature of the pandemic and could be replicated in other countries.

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Annex 1: Key informant interview questionnaire

Theme	Questions
1. Setting	Describe the institution(s) or organization(s) that manage(s) contact tracing activities
2. Methods and procedures for COVID-19 contact tracing	What is the definition of a case that will generate contact tracing activity?
	Are contacts prioritized for follow-up and quarantine? If yes, what algorithm is used?
	What is the definition of a contact who should be quarantined?
	What is the duration of quarantine for a contact?
	Are there standard operating procedures to identify contacts (including investigation form)? If yes, can you share
	Who investigates contacts (contact tracers, clinicians, other)?
	How are contacts investigated (direct face-to-face, telephone, web application, others/specify)?
	How are contact data collected (paper-pencil, direct entry into system, other devices)?
	What platform is used for data entry and management and why was that platform selected?
	Are digital tools utilized for detecting and/or monitoring COVID-19 contacts?
3. Human resources for COVID-19 contact tracing	Has there been an increase in resources to adjust to the current epidemic?
	Are communities/CHWs engaged in workforce surge for contact tracing?
	What is the average number of contacts per case?
	Are there contingencies for contact tracing priorities in case community transmission is re-established?
4. Isolation and quarantine	Are there written standard operating procedures for isolation and quarantine? If yes, can you share a copy?
	How is compliance with isolation or quarantine monitored?
5. Data management and analysis	What platform(s) are utilized for entering and managing the case and contact data?
	Are there levels of privilege in order to protect the privacy of cases and contacts?
6. Information technology	Do cases or contacts have access to an online platform to update their data or find information?
7. Communication and ethical aspects	Are there communication guidelines (procedure for contacting cases or contacts, questioning, explaining recommendations and procedures)? If yes, can you share a copy?
	How are communities communicated with in regards to contact tracing activities and their role in supporting their success?

Annex 2

Methods of Data Collection with Key Informants

In this case study, a mixed-methods design was used to describe CT activities in Oman. The process included the following:

- 1) Key informant interview (KII): an invitation email was sent to Oman Ministry of Health (MoH) to request nomination of a focal point (epidemiologist or other public health specialist) who met the following criteria:
 - Oversees CT operations at the National level within the MoH.
 - Has at least one year of experience performing COVID-19 CT activities.
 - Has a good knowledge of local COVID-19 CT strategies and guidelines.
 - Has access to COVID-19 CT database and clearance to share information on CT key indicators.
 - Can dedicate time to pre-fill the questionnaire and provide answers during the KII conference call.
 - Has a good mastery of the English language.

The key informant interviews (KII) were conducted virtually. A semi-structured questionnaire was adapted from the WHO-HQ questionnaire for qualitative assessment of CT systems (see Annex 1)

- 2) A quantitative tool was sent to the key informant to extract information on six key indicators of CT activities (Table 3). These indicators were extracted from the WHO global guidance to CT in the context of COVID-19.[2]

Gray Literature and Dashboard Review

1. Document and dashboard review: the interview was complemented by reviewing the relevant documents, policies, and guidelines developed by Oman MoH as well as EMRO dashboards and databases which included:
 - [Household & community contact tracing & de-isolation guideline for COVID-19](#): covers several areas such as case classification, actions taken as per case classification, CT among healthcare workers (HCWs), tracing and monitoring of close contacts, risk assessment and geo-tagging using artificial intelligence and management of symptomatic and asymptomatic contacts in addition to de-isolation criteria.[6]
 - [Guideline for Home/ Institutional Isolation For COVID-19](#): describes the types of isolation (home and institutional) with the necessary instructions to implement both types.[7]
 - [EMRO COVID-19 dashboard](#): presents the number of new and cumulative confirmed cases and deaths, number of tests per 100 000, and cumulative case fatality ratio reported from the 22 countries in the EMR countries.[8]
 - [EMFLU database](#): in which case-based forms for confirmed COVID-19 cases from different countries in the EMR are stored.[9] Oman has maintained an updated database since the outset of the pandemic.

Table 3: Key contact tracing indicators

Indicator	Definition
Proportion of contacts seen	# contacts seen / # contacts to follow
Proportion of contacts lost to follow up (arbitrarily defined as not seen for >2 days)	# contacts not seen for >2 consecutive days / # contacts to follow
Proportion of contacts who become suspect cases	# new suspect cases among contacts / # contacts to follow

Proportion of contacts who become confirmed cases	# new confirmed cases among contacts / # of contacts to follow
Proportion of new cases who are known contacts	# newly confirmed cases among contacts / # newly confirmed cases
Time from symptom onset to case confirmation	Average number of hours/days between symptom onset among contact and case isolation/confirmation by PCR