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Commentary

Covid-19 Drive Through Testing - A Novel, Scalable, High-Throughput and Safe Sampling Model in the Covid-19 Pandemic

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Abstract

The beginning of 2020 also marked the beginning of the COVID-19 pandemic caused by SARS-CoV-2, which reiterated the key role of diagnostics in patient management, infection containment, planning, and implementation of control strategies. With the emphasis on testing larger populations, it became pertinent to develop a mass specimen collection site that could serve volumes more effectively and safely to meet the rising testing demands of the pandemic. In this article, we discuss the Drive-through model of swab collection for COVID-19 testing as an efficient, safe, effective & scalable testing model for the pandemic. Each wave of the pandemic taught us that change, and innovation are the only constant. The Drive Thru collection sites were setup for high throughput testing of patients for COVID-19. This innovative model helped us achieve excellent patient care by allowing faster specimen collection and thus a shorter sample-to-result turnaround time, more judicious usage of PPE, promoting increased patient safety and satisfaction along with minimizing the risk of transmission. We successfully implemented scalable and highly effective specimen collection sites for COVID-19 when testing was the key to flattening the curve. The entire process took about a few minutes for patients within the confines of their vehicles, keeping in mind maximum safety and minimum exposure to both the patient and healthcare personnel.

***Keywords:** COVID-19, Drive through,Sampling model*

1. Introduction

The World Health Organization (WHO) on March 11, 2020, declared the novel coronavirus (COVID-19) outbreak a global pandemic.[1] The first documented case in India occurred on January 30, 2020, followed by a surge of cases, leading to the announcement of a nationwide lockdown in March 2020. The novel virus is classified as a respiratory virus with a complex pathology, impacting multiple organ systems with the potential to cause a dysregulated immune response, known as a cytokine storm.[2,3]Due to the lack of vaccine at the outset, amongst other preventive strategies, high volume testing followed by isolation of people testing positive, was critical in mitigating the effects of this highly communicable disease. A community-based health care system in the capital city of India implemented a drive-through testing site, in an attempt to divert suspected cases of COVID-19 away from larger patient areas while protecting both healthcare personnel and patients. In this report, we discuss our team's experience, lessons learned, and challenges in developing a high volume COVID-19 testing site in the capital of India, the first of its kind in the country.

2. Rationale

As the pandemic hit the nation, and an unprecedented countrywide lockdown was announced in March 2020, diagnostic facilities across nations faced the biggest challenge from the perspective of testing huge populations in resource limited settings and also minimising transmission and maximising safety for both patients and the sample collection staff.[4] As per a Lancet report[4], millions of people started staying at home to minimize the transmission of COVID-19, although healthcare workers were primed to do the exact opposite.

Healthcare workers were at the frontline fighting this pandemic from its onset and were at the highest risk of contracting it. Figures from China's National Health Commission showed that more than 3300 health care workers had been infected as of early March 2020 and, according to local media, by the end of February at least 22 had died.

Italy reported that 20% of its healthcare workers had gotten infected, and even reported a few fatalities.[4] Reports from medical staff described physical and mental exhaustion, the torment of difficult triage decisions, and the pain of losing the patients and colleagues, all in addition to the infection risk. Along with concerns for their safety, healthcare workers were also concerned about passing the infection to their families.[4]

Another challenge of the pandemic as it accelerated, was the lack of access to personal protective equipment (PPE) for health workers, which became one of the key safety concerns.

During the pandemic, testing of individuals played a key role in identifying active cases. Across the globe, patient samples were collected by the various following methodologies:[5-7]

2.1 Walk-ins[8]- Patient walks into the healthcare facility; into a designated COVID-19 swab collection room to get their swabs collected. Only a limited number of patient sample collections were done in the process as it required considerable time for donning and doffing of personal protective equipment (PPE) and environmental disinfection. This also had the risk of fomite/surface transmission in the premises, although the risk is considered very low.

2.2 House to house collection[9]- Health care personnel visit the homes of patients requesting the test. While this is a labour-intensive and time taking process, it also adds to the hazard of the healthcare workers coming in direct contact with the patient and his/her surroundings.

2.3 Kiosk[10]- An innovative model in times of pandemic wherein swabs are to be collected from the confinement of a collection booth. While the kiosk or closed booth allowed testing of patients visiting on foot, it had the following major disadvantages: i) The inner surface of the booth had to be wiped with a disposable disinfecting tissue or a piece of cloth and a disinfectant solution, after which a post-disinfection ventilation period of at least 30 minutes had to be observed. However, most walk-in screening centres observed only 10–15 minutes of ventilation. ii) In the Kiosk centres, the same fixed set of gloves were used for every patient. For patient safety and to prevent cross-contamination of samples, it is important for a change of fixed gloves of the booth after screening every patient sample along with proper disinfection of the surroundings. To increase the sample collection speed with increased safety precautions at the walk-in screening centres, the number of booths were increased.

2.4 Drive Through[11]-A novel model of specimen collection where the specimen is collected by the healthcare worker while the patient is seated in their own vehicle. The advantage of the drive-through method is that it minimizes the contact between the patient and medical staff, as the specimen collection is done in an open environment, through the rolled down window of the car.

While the 1st two models of swab collection are conventional, healthcare innovations like the kiosk and drive-through models minimize the risk of contact of the healthcare workers with infected individuals as well as allow conservative use of PPE[10,12-14].

Evidence before this report suggests that drive-through testing centres had been successfully used in South Korea[10,15] and USA[16], and the current model was based on the same.

With the aim of achieving the highest safety standards for both the patient and healthcare workers, the high throughput drive-through model was adapted by our healthcare facility.

It became of primary importance, amidst the COVID-19 wave for the Government of India, to implement a mass testing drive in order to screen the infected individuals and isolate them. Various measures were undertaken, by setting up testing centres throughout the nation, of which the implementation of drive through testing became one of the models for high throughput and safe sample collection process.

The drive-through testing centers were functional worldwide after the onset of pandemic[17-19]. This article here gives a detailed insight into the first paperless drive-through as a screening center for COVID 19 in India. The implementation of these drive-through testing centers had major advantages during the peak of COVID-19 infection such as:

1. A design of extended roofing of these drive-through booths helped to protect both the specimen and the collection personal during the rainy season.

2. These drive-through centers were in the heart of the city and hence were easily accessible and if any critical patients were encountered at these sites, they were referred to the nearby hospital immediately.

3. Repeated reminder to patients prior to their appointment, to avoid crowding at the drive through centers ensured a seamless operation of the centers.

4. Provision of fans and heaters at the collection sites ensured comfort of healthcare workers during summers and winters respectively.

A few challenges encountered at the drive through centers:

1. Extreme harsh weather conditions made it tough for the collection personnel in PPE to withstand long working hours.

2. Eligibility for drive through testing was limited to individuals in vehicles, and thus limited the outreach.

3. Site planning

At the outset, only the National Institute of Virology in Pune, India was conducting COVID -19 RT-PCR tests in the country, but as the cases increased, the diagnostic landscape quickly changed to include other government and private laboratories to start testing. One of the biggest challenges in a pandemic was the availability of widespread community testing, which would be efficient, effective, safe, and convenient with a short turnaround time.

Drive-through testing has several advantages: it helps to maintain social distancing and does not require individuals to enter closed settings.[20]

A fortnight prior to 5 April 2020, our multidisciplinary group consisting of the infection prevention and control team, operations and facility managers, laboratory administrators, information technology (IT) specialists, and continual quality improvement advisors, set about developing a model for increasing volume and optimizing the use of limited resources via drive-through upper respiratory swab testing. The process was streamlined by demarcating the entry of vehicles into stations as shown in figure 1. At station 1, the vehicles were checked if they had a prior registration on our website and the government IDs were verified. Next station for the vehicle was the sampling station. The unidirectional workflow was maintained for smooth and seamless operations.

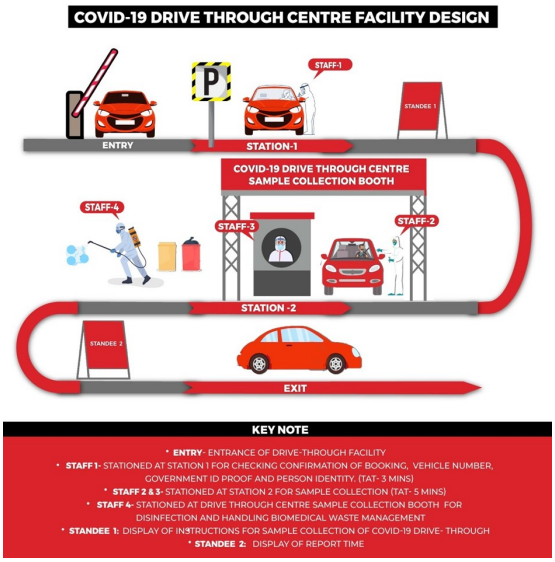

Figure 1. *Diagrammatic representation of workflow of COVID-19 specimen collection at all Drive-through centres*

Standard procedure of the Drive- through testing centres:

i. Firstly, strategic locations were selected to cover larger geographical areas of the national capital. They were selected in such a way that they were easily accessible and yet isolated from residential complexes and traffic.
ii. 2 portable cabins were constructed in isolated parking lots at 2 different sites, after seeking permission from local government authorities and the state pollution control committee. Extended roofing was designed for the cabins to accommodate the rainy season.
iii. The area was divided into a separate demarcated PPE storage area, collection kit storage area (including materials for triple-layer packaging for transport), triple-layer packaging area, cool box shipment containers (2-8 degree Celsius) storage area, a proper color-coded biomedical waste disposal area (as per Central Pollution Control Board guidelines for COVID-19 waste) and a computer station.
iv. These satellite centres were provided electrical and Wi-Fi connections along with CCTV cameras for continuous surveillance from the central lab for quality control processes and real time monitoring of logistics.
v. The car stop area adjacent to the tent for sampling, was well demarcated as shown in the image below, to ensure a seamless and contact-free testing experience.
vi. All the paperwork including document submission, payment & result dispatch were made online for ensuring contactless high-throughput testing.

vii. Reports were available within 10-24 hours via email and on the lab's website portal.
viii. Leading up to the testing site, the lanes had properly installed signage to guide people. Once patients made their way to the sample collection booth in their vehicle, they were instructed to roll down their windows for nasopharyngeal and oropharyngeal sampling.

Image 1: Drive through sample collection booth.

3.1 Training

Intensive training sessions were conducted for all personnel involved at these satellite centres which included the technique of PPE donning & doffing, nasopharyngeal and oropharyngeal swab collection, triple-layer packaging, the importance of cold chain maintenance for storage and transport as well as for proper disposal of biomedical waste. The training material was taken from CDC (Centers for Disease Control and Prevention) Guidelines, ICMR (Indian Council of Medical Research), and MOHFW (Ministry of Health and Family Welfare), Government of India portal. Live demonstrations and audio-visual materials were used during these training sessions followed by post-training questionnaires to assess the staff. A timed assessment was then conducted for each team member prior to the launch, to ensure complete compliance with the protocols and a seamless workflow.

3.2 Staffing

The efficiency of the sample collection team was critical to the success of this model. The team consisted of 1 parking assistant, 2 swabbers along with 1 cleaning assistant. All were stationed at station 1 and station 2 respectively, at each of these drive-through centres. The working hours of each staff enrolled in all drive-through centres were 8 hours.

3.3 PPE

The swabbers wore a face shield, mask, full PPE, wrap around gown, and gloves. The gloves and wrap around gown were changed prior to sampling each patient.

3.4 Biomedical Waste Management

Stringent measures were taken for biomedical waste management at these collection centres, as per the latest Central Pollution Control Board guidelines (CPCB) and COVID-19 waste management revised guidelines. Complete compliance with all the requirements of waste management was ensured. Waste segregation followed by pre-treatment (whenever applicable) prior to handing over to authorized Common Biomedical Waste Treatment Facility (CBMWTF) was adhered to along with real time uploading of waste generation data on the CPCB COVID waste app.

3.5 Testing Eligibility

It was based on ICMR latest advisory on testing strategy, available on the domain https://www.icmr.gov.in/.

3.6 Phases of SARS-CoV-2 RT-PCR testing (pre-analytical, analytical and post-analytical)

As shown in figure 2, it was mandatory for every patient requiring the SARS-CoV-2 RT-PCR at the drive-through to fill a booking/test request form through the laboratory's official website, upload the necessary documents for getting tested following which the laboratory accepted the request of the patient, based on the eligibility criteria as per ICMR guidelines. A confirmatory email was sent to the patient about the appointment schedule including a GPS location, explanatory video demo regarding drive through testing and an FAQ sheet. Staff at the testing site received prior notification of patient details for a better preparedness. An approximate time slot of 5 minutes was allotted to each vehicle. On arrival of the patient at the site the support staff verified the patient details. Following this, the specimen was collected and packaged at the booth and transported to the main laboratory wherein the RT-PCR test was conducted. The reports were then sent to the patient along with real-time reporting to the ICMR database for contact tracing of all patients.

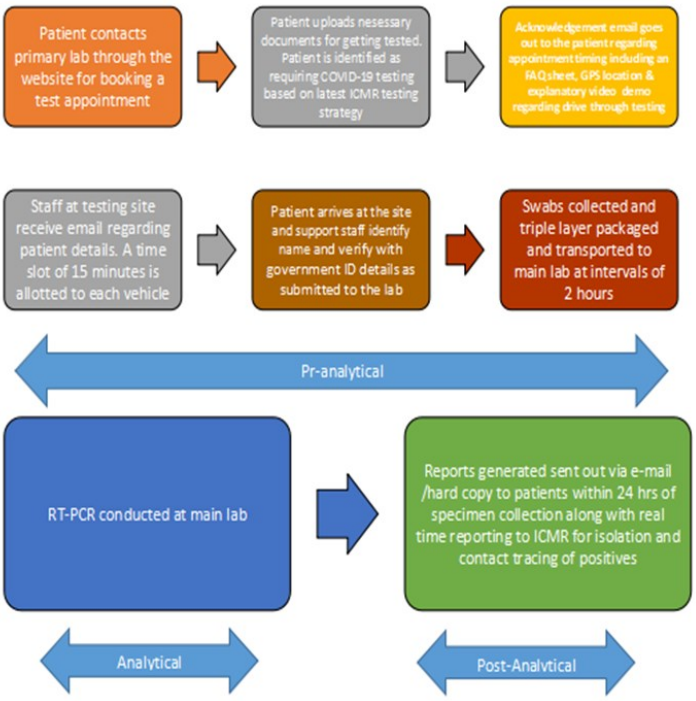

Figure 2. *The above figure demonstrates the laboratory work flow (Pre-analytical, analytical and post analytical phase of SARS-CoV-2 RT-PCR testing)*

4. Discussion

In this commentary, we discuss the planning, implementation, challenges, triumphs and learnings in a high-volume community-based COVID 19 drive- through testing facility. The innovative model helped us achieve excellent patient care by allowing a faster specimen collection and thus shorter sample-to-result turnaround time, more judicious usage of safety gear, i.e., PPE while promoting increased patient safety and satisfaction along with minimizing the risk of transmission. Below we have enlisted various salient points of the drive-through model of COVID testing:

4.1 Ensuring a seamless Pre-analytical workflow design

We designed a facility aiming at "minimal- to- zero" waiting time for patients. Prior appointment slots were given to each vehicle as a measure to control the incoming traffic in a more effective manner. In addition, a dedicated online COVID-19 drive-through testing request web page was created to make online bookings along with a helpline number for any queries. The website contained a drive-through demonstration video and FAQ page for easy understanding of the standard operating procedure by the patients. It was ensured that there was no overlap between the appointments, to enable us to serve better. Every vehicle was given a slot of 5 minutes. Both nasopharyngeal and oropharyngeal swabs were taken to increase the analytical performance of RTPCR testing. A maximum of 4 patients per vehicle was allowed for testing purposes. The average swabbing time per vehicle varied from less than a minute for a single patient to a maximum of 5 minutes for 4 patients in a single-vehicle. A total of 26,934 samples were taken in the period April-December 2020 at the drive-through collection sites, with maximum specimen collected in November (i.e. Count 6219) as shown in figure 3.

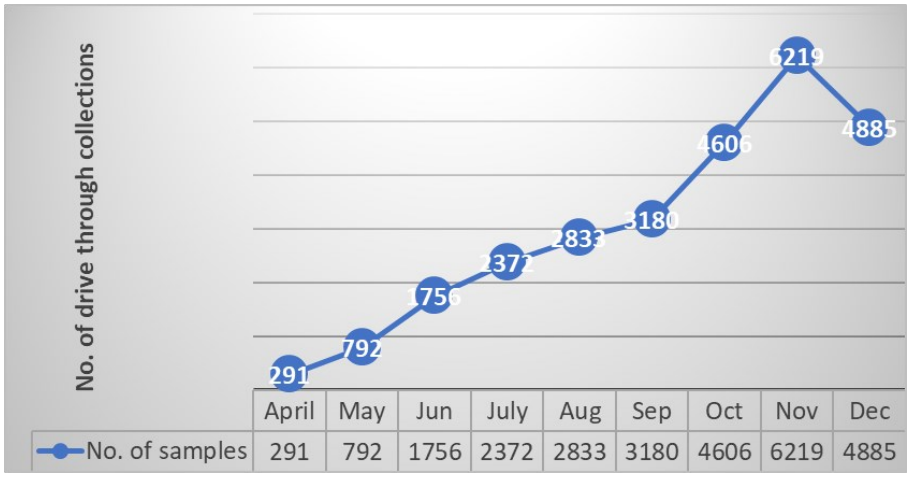

Figure 3. Graphical representation of monthly (April-December 2020) drive through collections at all drive through centres.

4.2 Creating a reproducible model for scaling up testing

As the COVID -19 infection rates increased, we realized the need for scaling up testing. The drive-through design could easily be replicated at multiple sites to cater to higher volumes.

As India ramped up testing, to begin with, there was a limited supply of PPE. The drive-through model allowed a judicious usage of the same, requiring only a change in a part of the PPE coming in direct contact with the patient, instead of the entire PPE.

The first drive-through model was replicated at 4 other centres to serve patients who required to get tested. The sample – to – result time was approximately 4-5 hours. The transit time between the collection point to the PCR lab varied from 20-90 minutes. The specimen collection steadily increased in these centres and showed a sharp increase from September 2020. This was also the period when the pandemic reached it's peak in India. A maximum number of 6219 samples were collected cumulatively in these facilities in November 2020 with an average of 100-150 samples each day.

The scalable high-volume testing deployment was cutting edge, since specimens were transported in timely regular batches to the main testing lab to ensure a turnaround time of less than 24 hours. The shortest turnaround time was 4 hours in RT PCR testing.

4.3 Testing pediatric population

Swabbing in children requires patience and expertise, especially in the age group of less than 12 years. Therefore, families with children in the above age group were given an extended time slot, and highly skilled collection personnel were appointed at the sites especially for the same. A maximum number of 317 children were tested in November 2020. (As shown in figure 4)

Figure 4. Graphical representation of number of children's sample tested on drive though facilities.

4.4 Testing emergency patients

CB-NAAT SARS CoV-2 test with Cepheid GeneXpert was specially deployed for emergency patient testing under: -

4.4.a. Pregnant females undergoing an emergency procedure on physician's request.

4.4.b. Severely ill patients on physician's request

4.4.c. Any patient requesting for urgent report

Emergency samples were immediately transported to the main testing lab without delay.

CBNAAT on Cepheid GeneXpert has an analytical run time of 45 minutes for negative samples and a shorter cycle of reporting positive samples within 30 minutes with the early assay termination feature[17]. The overall shortest sampling to result time in such emergency patients was within 1 hour to a maximum of 3 hours. For CBNAAT testing, samples were collected in our drive-through premises and a turnaround time of 3 hours was committed to patients. Temperature-regulated vehicles were used for sample transport. Dispatch was ensured within 5 minutes of sample collection and transit time was at an average of 20 -90 minutes to the testing facility.

Drive-through and CBNAAT combined together helped us cater to emergency patients in a more effective manner and thus achieve excellent patient and clinician satisfaction.

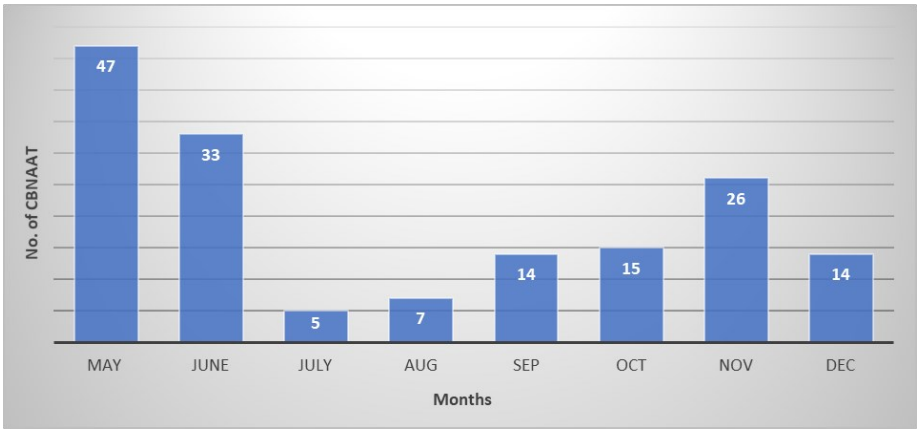

Figure 5. *Graphical representation of monthly CB-NAAT test conducted from samples collected at drive through centres.*

4.5 Continued training

For effective implementation and smooth functioning as per SOP, it was ensured that constant training of the staff was done. As 2020 saw a surge in cases, guidelines were being issued and updated on government portals on a regular basis. Team of doctors and IT personnel were constantly updated on the latest available guidelines on COVID-19 and gave training to the ground staff. Amongst the many guidelines which were revised or new, some of them are enlisted below:

4.5.a. Uploading data to RT-PCR App on a real-time basis: The app is a hand-held tool for healthcare personnel at sample collection centres across the country. An intimation was sent through the app to ICMR by the sample collection facility sending the sample to the concerned ICMR labs conducting SARS-CoV-2 RT-PCR test. With the successful registration of any sample, the collection centre user could also view the specimen collection details.

4.5.b. Constant updates on COVID-19 Biomedical waste management: (https://cpcb.nic.in/covid-waste-management/) - 4 revisions until July 2020.

The Central Pollution Control Board of India came up with a mobile application in May2020, following directions from the National Green Tribunal (NGT).

User may feed the various details i.e. name of waste generator body, details of waste collector and waste treatment operator etc, in mobile application that could be tracked and monitored in backend.

(https://cpcb.nic.in/covid-waste-management/) 4 revisions until July 2020.

4.5.c. Continuous revision of testing strategy for molecular testing-6 versions until September 2020 (https://www.icmr.gov.in/cteststrat.html)

On-site training was organized for personnel every time there was a revision in the guidelines or a new guideline was issued. The training materials used were taken from the above-mentioned sources and the necessary changes were made in the SOPs.

4.6 Patient feedback for drive-through testing

Patient satisfaction is an essential quality indicator[18]. The feedbacks received from the patients tested were excellent in terms of quality of reporting and short turnaround times. One of the chief concerns of patients while requesting for the test was the privacy of testing and most patients were anxious about home collection, because of the social stigma associated with the disease along with the risk of transmission if they used any other option of sample collection (Kiosk/ Home collection)[19]. This model of specimen collection addressed their concern as it ensured the confidentiality of testing.

5. Challenges

5.1 The major limitation for medical staff in these drive through was to work outdoors for long durations when the weather was very cold, hot, or windy. To troubleshoot the same, trained medical staff was deployed to work in 8 hourly shifts.

5.2 Dealing with the backlog of vehicles in peak COVID-19 times- As we hit the peak of COVID-19 cases in the country, we also faced queuing up of vehicles in the facilities. We deployed personnel specially to guide the traffic flow around the specimen collection sites to maintain the turnaround time and seamless workflow.

5.3 Vehicles at the testing site without a prior appointment- In spite of ensuring prior appointments for all undergoing testing, there were a few patients arriving at the drive-through station without prior appointments. Testing was not denied to them if they fell under the latest testing strategy criteria and registrations were done on-site for such patients.

5.4 Communication of results and patient counselling- The COVID-19 disease diagnosis is associated with social stigma, fear, and anxiety apart from the symptomatic manifestations of the disease[14]. Moreover, since the majority of cases may remain asymptomatic, it was difficult for such patients who tested positive to accept their results. Our team of doctors ensured a proper counselling of patients telephonically to help them understand the results, precautions to be taken and seeking medical help.

5.5 Constantly keeping up with the evolving Guidelines-Training of all dedicated personnel was key to staying updated with the latest guidelines.

6. Learnings

The lessons learned from the current drive-through testing site development resemble those reported from other testing services globally involved in widespread community testing in larger population areas and in different patient subpopulations.[14,15,16,20]

7. Implications of all available evidence

The drive-through testing sites continue to be active screening centres with the anticipation of increasing cases across the globe. We successfully adopted a strategy to create a scalable and highly effective specimen collection site for COVID-19 when testing was key to flattening the curve. The entire process was found to be safe, effective, efficient and convenient to both the patient and healthcare personnel. Such innovative models can be implemented in the future to deal with pandemics or community outbreak investigations and strengthen public health systems.

Conflict of Interest

The authors declare no conflict of interest.

References

1. WHO Declares COVID-19 a Pandemic, Acta Biomed 2020 Mar 19;91(1):157-160.doi: 10.23750/abm.v91i1.9397.
2. Andrews M A, Areekal B, Rajesh K R, Krishnan J, Suryakala R, Krishnan B, Muraly C P, Santhosh P V. First confirmed case of COVID-19 infection in India: A case report. Indian J Med Res 2020;151:490-2
3. Ye Q, Wang B, Mao J. The pathogenesis and treatment of the 'Cytokine Storm' in COVID-19. J Infect. 2020;80:607-613. [PMC free article] [PubMed] [Google Scholar]
4. Lancet T (2020) COVID-19 protecting health-care workers. Lancet 395(10228):922. https://doi.org/10.1016/S0140-6736(20)30644-9
5. Jacob Lee .COVID-19 Screening centre: How to Balance between the Speed and Safety? J Korean Med Sci. 2020 Apr 20;35(15):e157 https://doi.org/10.3346/jkms.2020.35.e157
6. James, C.A., Barfield, M.D., Maass, K.F. et al. Will patient-centric sampling become the norm for clinical trials after COVID-19?. Nat Med 26, 1810 (2020). https://doi.org/10.1038/s41591-020-01144-1
7. Jaiteerth J. COVSACK: an innovative portable isolated and safe COVID-19 sample collection kiosk with automatic disinfection. Trans Indian Natl Acad Eng. 2020 Jul 5 : 1–7.

8. Gan WH, Lim JW, Koh D. Preventing intra-hospital infection and transmission of COVID-19 in healthcare workers. Saf Health Work. 2020 doi: 10.1016/j.shaw.2020.03.001.

9. Paul E. Molling1, Tanner T. Holst1, Benjamin G. Anderson1,Kevin Fitzgerald1, Megan Eddy1, Bradley D. Weber1, Brenda Schwan1,Chris J. Heiderscheit1, and Andrew R. Jagim. Drive-through Satellite Testing:An Efficient Precautionary Method of Screening Patients for SARS-CoV-2 in a Rural Healthcare Setting. Journal of Primary Care & Community HealthVolume 11: 1–6.

10. Kwon KT, Ko JH, Shin H, Sung M, Kim JY. Drive-through screening centre for COVID-19: a safe and efficient screening system against massive community outbreak. J Korean Med Sci 2020;35(11):e123.

11. Flynn, EF, Kuhn, E, Shaik, M, Tarr, E, Scattolini, N, Ballantine, A. Drive-through COVID-19 testing during the 2020 pandemic: a safe, efficient, and scalable model for pediatric patients and health care workers [published online May 28, 2020]. Acad Pediatr. doi:10.1016/j.acap.2020.05.018.

12. https://www.fda.gov/media/136314/download

13. Prakash B. Patient satisfaction. J Cutan Aesthet Surg. 2010;3(3):151-155. doi:10.4103/0974-2077.74491

14. Chopra KK, Arora VK. Covid-19 and social stigma: Role of scientific community. Indian J Tuberc. 2020 Jul;67(3):284-285. doi: 10.1016/j.ijtb.2020.07.012. Epub 2020 Jul 15. PMID: 32825854; PMCID: PMC7362777.

15. Shah, A, Challener, Douglas, et al. Drive-through testing: a unique, efficient method of collecting large volume of specimens during the SARS-CoV-2 (COVID-19) pandemic. Mayo Clin Proc. 2020;95:1420-1425.

16. Elly Lee, Nurul Yaqeen Mohd Esa , Tong Ming Wee , Chun Ian Soo. Bonuses and pitfalls of a paperless drivethrough screening and COVID-19: A field report. Journal of Microbiology, Immunology, and Infection (2021) 54, 85-88.

17. Amir- Behghadami M, et al. The importance of designing and implementing participatory surveillance system: An approach as early detection and prevention of novel coronavirus (2019-nCov). Letters to the Editor / American Journal of Infection Control 48 (2020) 725–732.

18. Angie N. Ton, et al. COVID-19 drive through testing: An effective strategy for conserving personal protective equipment. Letters to the Editor / American Journal of Infection Control 48 (2020) 725–732.

19. Kwon K T, Ko J-H , Shin H, et al. Drive-Through Screening Center for COVID-19: a Safe and Efficient Screening System against Massive Community Outbreak. J Korean Med Sci. 2020 Mar 23;35(11):e123.

20. Araz O M, Ramirez-Nafarrate A, et al. The importance of widespread testing for COVID-19 pandemic: systems thinking for drive through testing sites. HEALTH SYSTEMS 2020, VOL. 9, NO. 2, 119–123.

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