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Mobile Swab Collection Vehicle; a Blend of Necessity, Innovation, and Technology in a Resource-poor Country

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ABSTRACT

Mobile Swab Collection Vehicle is a concept that has been innovated by a team of medical and non-medical personals based upon the dire need to perform throat or nasopharyngeal swab collections to do reverse transcription polymerase chain reaction 'RT-PCR' quickly, safely, and comfortably during this Corona Virus Diseases 2019, 'COVID-19' pandemic in a resource-poor country like Nepal. Inputs from the health care workers, beneficiaries, and engineers have been taken to construct this vehicle-mounted booth for swab collection. This vehicle is the 'first of its kind' in Nepal.

Keywords: COVID-19; Nepal; swab collection vehicle

INTRODUCTION

Response activities to corona virus diseases 2019 (COVID-19) have been a daunting task for frontline workers. Since the beginning of the outbreak, case identification, swab collection, laboratory test, case investigation along with contact tracing, isolation, quarantine of close contacts, and further testing have been a routine activity for all Health Care Workers (HCW). Frontline HCWs getting exposed during throat or nasopharyngeal swab collection not only reduces manpower but also can act as a potential source of infection and can spread the infection to other HCWs, family, and relatives. Similarly shifting of the clients to testing centres and hospitals also requires vast resources and has the risk of spreading the infection to others and contaminating the environment.¹ This gave rise to an ingenious innovation in the form of Mobile Swab Collection Vehicle (MSCV), using modern technology that could assist pandemic response in ways that are difficult to achieve manually

RATIONALE BEHIND MSCV CONCEPT

Swab collection teams from Epidemiology & Disease Control Division (EDCD)¹ Ministry of Health and Population, Nepal, and HCWs from COVID-19 Crisis

Management Centre (CCMC) have been deployed at different locations within the Kathmandu valley and outside.² During swab collection, a separate space is required for donning and doffing of Personal Protective Equipment (PPE), documentation and Viral Transport Media (VTM) in ice boxes. During conventional swab collection in community settings, the HCW wears full PPE to stay safe from infection thus minimising the risk of transmission.

Presently as COVID-19 cases are on the rise in Nepal, the Government of Nepal has decided to escalate swab collections in the coming days which is a big challenge for CCMC and EDCD and the nation as a whole. So, CCMC MedOps initiated various level of meetings with experts from Nepal Academy of Science and Technology NAST for this project.³ This led to devise techniques and find ways to ensure safety, minimise cross contamination, be able to reach out to the community and scale up testing.

SIMILAR TECHNOLOGY DEVELOPED OUTSIDE NEPAL

For easing swab collection, Singapore has developed a Mobile Swab Station (MSS) by the Defence Science and Technology Agency (DSTA), the Army's Maintenance and Engineering Support and ST Engineering.⁴ Ahmedabad-

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based Anant National University has designed a compact, effective, and contact-free mobile testing facility for swab collection and X-ray testing for coronavirus infection.⁵ Mobile COVID-19 testing vehicle launched in Alappuzha, India is equipped with a telemedicine facility and a public address system. It can go to remote areas to collect samples. Recently, China sent a Wuhan-style mobile virus lab to Beijing to help with mass-testing as the capital city battles new COVID-19 outbreak.⁶

FORMATION OF THE MOBILE SWAB COLLECTION BOOTH

The rear open part of pick up vehicle (Toyota Land Cruiser) was used to convert it into a swab collection booth, by mounting a closed chamber made up of an aluminium frame and iron base (Fig 1), covered with acrylic transparent material, 3 mm thick and an opaque part made of the aluminium baseboard. A tank (8 litres), with a motor system, was attached to it and fixed inside the chamber, which releases sanitiser on press of a button. Other accessories like microphone system with mike, portable exhaust fans, and lever for operating indicators were also attached. A tube with mist dispensing nozzles was fitted encircling vehicle, attached to a tank (outside the chamber) containing chlorine.

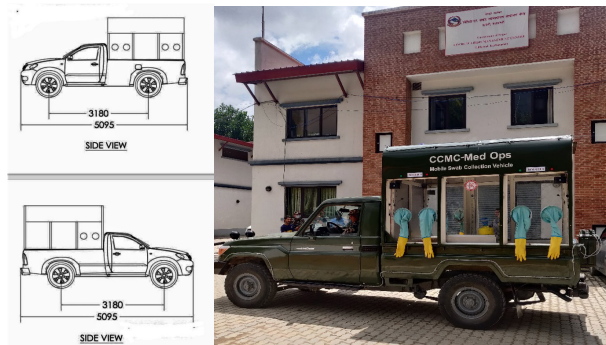


Figure 1. Mobile Swab Collection Vehicle (side view).

The positive pressure chamber is a common chamber with seating arrangements for three swab collection points (named as booths in the MSCV), meant to be operated two at a time unless the demand is too high given the crisis, and provides an outlet for swab collection through three pairs of holes with specially-designed and tailored gloves made of PPE clothing fabrics (thus creating three booths) at two opposite directions of the vehicle, facilitating specimen collection of three clients (Fig 2 & 3). Internal part of the chamber has positive pressure created by an inlet fan and duct mechanism attached to the HEPA filter system (Fig 4 & 5) for providing virus-free air to the inside of the chamber. There is a provision of an exhaust fan for air circulation and cooling. Working

inside the chamber eliminates the need for separate personal protective equipment like a gown, coverall, visor, goggle, N95 mask, high-performance gloves, shoe cover, and headcover. Ordinary surgical gloves and surgical masks would be adequate similar to a non-pandemic situation.

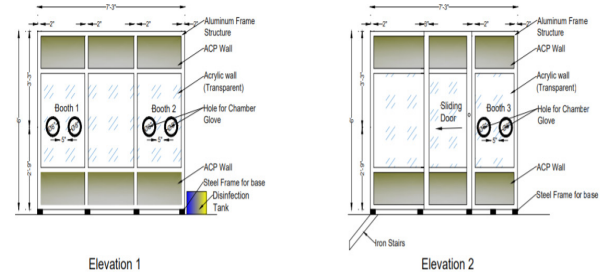


Figure 2 & 3. Schematic diagram showing labelled elevations of the booth (side view).

A ladder with 4-5 steps is used to climb the vehicle through the rear end. To gain access inside the closed chamber, a sliding door is used. It is a common chamber with seating arrangements for three swab collectors and provides an outlet for swab collection through three pairs of circular openings six inches in diameter (thus creating three booths) at different locations on the vehicle.

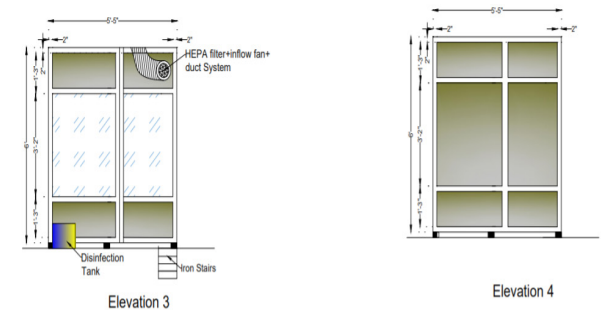


Figure 4 & 5. Schematic diagram showing labelled elevations of the booth (front/back view).

To ease communication between swab collector and client, a microphone system is mounted on the vehicle, both inside and outside the chamber. Each swab collection point (booth) has its microphone system. Individual booths have a footswitch to release sanitizer for disinfecting gloves after each number of swab collection. Automatically disinfecting gloves without any human assistance saves human resources accompanying the team of swab collectors. To maintain high standards of sanitation, the patient area comes with an automated sanitiser spray that is activated by four jet nozzles that thoroughly disinfect the area each time a patient leaves the chamber.

Individual booths have a lever for green and a red light indicator for the clients to be notified if the booth is ready for swab collection after the disinfection and it is also foot-operated. When the indicator is green; it denotes “Approach the booth for swab collection” and Red indicates “Swab collection in progress”. A time gap is recommended after each swab collection to allow the disinfection to be effective or when there is rush, a long plastic disposable gloves (that is disposed after every use) can be used over the PPE gloves for extra safety.

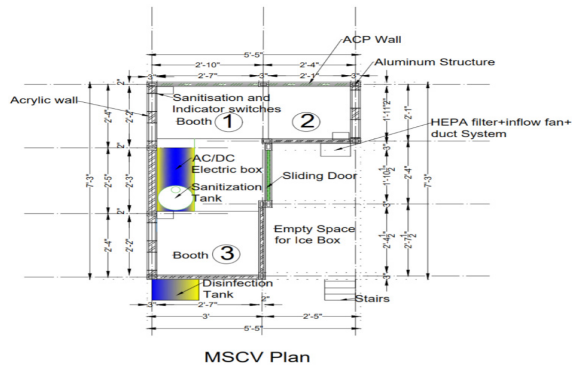


Figure 6. Schematic diagram showing the labelled sectional plan view of the booth.

The vehicle is encircled by a cable fitted with mist dispenser nozzles to spray sodium hypochlorite solution stored in a tank mounted at the rear end of the vehicle. In between many swab collections or at the end of the swab collection day, the entire vehicle and its surroundings can be disinfected automatically, by pressing a lever placed at the dashboard in front of the driver's seat. This lever, when pressed to “on”, activates the aforementioned cable system encircling the vehicle to spray hypochlorite solution automatically through the mist dispenser nozzles that are around 35 in number along the top and bottom rows round the vehicle. Such disinfection doesn't require separate human resources. This method of automatically disinfecting at the site of sample collection prevents the vehicle itself from being a potential source of contamination and reluctance of designated human resources for decontaminating such vehicles in hospitals, garages, or other areas.

While being tested the client registers oneself at the registration table nearby, collects the VTM, swab stick, and the biohazard pouch, and proceeds towards one of the booths. The HCW from inside the booth instructs the client to either open one's mouth for a throat swab sample or asks one to tilt their head for nasopharyngeal swab collection. After taking the sample the HCW again requests the client to open the VTM, dips the swab stick into it and breaks the tip to fit the stick, and tells the client to close the VTM, put it inside the biohazard

pouch, and drop the sample into the icebox at the back end of the vehicle and then cleanse the hands with sanitizer provided. All this process is done outside the booth of the vehicle thus protecting the HCW against cross-contamination by the suspected client.

Limitations with this vehicle are the difficulty of service seekers to provide a sample when it rains, as there is no provision for sunshades at swab collection sockets. Regulations in our country do not allow attachment of a sunshade that extends beyond the dimensions of the vehicle.

CONTENTS OF THE MOBILE SWAB COLLECTION BOOTH

Chairs/Stool x 3, Icebox, Ladder with 4-5 steps, Medical Waste Collection Bin, Sanitiser stand, Fan with duct mechanism for creating positive pressure inside the closed chamber, HEPA filter- for air filtration inside the chamber, exhaust fan for circulation of air and cooling the chamber, microphone system for communication between swab collector and client, tank with a motor system for storing sanitiser (Inside the chamber), tank for storing chlorine solution (Outside the chamber), tube cable system with mist dispenser nozzles for disinfection of vehicle, indicators (green and red) for proceeding towards the booth for swab collection.

CONCLUSIONS

As rightly said “Necessity is the mother of invention”; this innovation is a result of conceptualisation and field experience of CCMC-MedOps, aided by technical Research & Development inputs from NAST. This is greatly benefitting the process of swab collection in terms of reduction of logistic demand and human resource needs along with the safety of HCWs. It is recommended that the stakeholders involved in swab collection be equipped with such vehicles for effective response and mitigation of COVID-19. Such innovations using locally available materials and resources, which come at a reasonable price and are easily available and also makes swab collection safe and effective in low income and resource-poor countries like Nepal. This MSCV is the “First of its kind in Nepal”.

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