Environmental and Toxicology Management 1 (2021) 37-41

Contents lists available at journal2.unusa.ac.id

Environmental and Toxicology Management

journal homepage: www.journal2.unusa.ac.id/etm

Appropriate technology adaptation to mitigate community transmission of SARS CoV2 virus in resourced challenged Bhutan and Bangladesh

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Abstract

The SARS CoV2 pandemic has a tremendous impact on both developed and developing countries. To mitigate against community transmission of SARS CoV2 in Southern Bhutan and Central Bangladesh, the development and application of appropriate technologies was undertaken. As an appropriate mitigation, hand washing station was constructed by a simple system. The system was operated using a foot pedal to limit cross contamination by direct hand contact, hand sanitizer utilization and disinfection application in Central Bangladesh. The study highlighted a local innovation in constrained environments to provide public health solutions for preventing the spread of SARS CoV2. The innovation and mitigation measures can be replicated in other resource challenged regions of the world as mitigations steps to limit community transmission of SARS CoV2.

Keywords :
Appropriate technology, local innovation and interventions, mitigation against SARS CoV2 community transmission, rural Bhutan and Bangladesh

1 Introduction

Since March 2020, COVID-19 had been officially announced as pandemic by the World Health Organization (WHO). During COVID-19 pandemic, human mortality has increased up to hundreds of thousands of people. Not only mortality, the pandemic also impacted on several sectors, such as aquaculture (Waiho et al., 2020), health (Ricci et al., 2020), social (Cassiani-Miranda and Campo-Arias, 2020), and economic (Tandon et al., 2020).

To face this pandemic, several mitigation resources had been advanced. The mitigation resources can be categorized into indirect and direct mitigation resources. Indirect mitigation measures had been developed through an integrated GIS/GPS based e-Governance platform (Patel and Patel, 2022), modelling study of phased university reopening (Rennert et al., 2021), and modelling study of stochastic (Cazelles et al., 2021). The indirect mitigation resources can be no applied directly in community. Thus, direct mitigation resources in need to be developed among the communities.

A number direct mitigation has been publicized, such as washing hand (Beiu et al., 2020), utilizing hand sanitizer (Shetty et al., 2020), and wearing mask (Li et al., 2020).This direct mitigation resources had been applied for preventing the spread of COVID-19 virus (SARS CoV2).

However, these direct mitigation resources still have numerous limitations, such as for washing hand, direct hand contact can be unavoidable. Furthermore, utilizing hand sanitizer frequently can influence atopic dermatitis (Shah et al., 2020). In addition, these mitigation resources are not able to apply on limited resources.

To cover these limitations, an appropriate technology has been progressed. A foot pedal innovation has been constructed using utilize local materials and local craftsmanship. It expected to gain successful mitigation and prevent community transmission of SARS CoV2 virus.

2 Method

The mitigation measures were evaluated in the college of Science and Technology Royal University of Bhutan (Figure 1) and a small village in central Bangladesh (Figure 2). The college is located in the city of Phuentsholing Southern Bhutan which is suspected community transmission of SARS CoV2 virus. The city of Phuentsholing is a vital gateway of Bhutan to India and a land port where goods from India enter Bhutan. Also, it is the vital life line for the landlocked country.

On the onset of the pandemic, the focus of the local authority was to take safeguard measurers to stop community transmission. Although the students were sent home on the onset of the crisis, the college was used as a training ground to recall retired soldiers and policemen, along with peace volunteers. The recalled personals and volunteers were trained and placed on the campus, thus, public health problems can be addressed immediately.

The village in Bangladesh, Sardi village, is in the periphery of Narayanganj a textile hub town in central Bangladesh. The women in the Sardi village household largely supported the whole of ex-

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Email Address : nadim.khandaker@northsouth.edu
https://doi.org/10.33086/etm.v1i2.2264
Received from 18 August 2021;
Received in revised from 29 August 2021;
Accepted 29 August 2021;
Available online 31 August 2021;

tended family by working in the Ready-Made Garments Industry. The town of Narayanganj was affected by the pandemic. In both locations, there were a need for appropriate viable mitigation measures that could be easily implemented by the community.

Figure 1 During onset of Covet crisis the College of Science and Technology Phuentsholing, Bhutan used as a training facility for army police and angles of peace volunteers.

Figure 2 Focus group meeting by councillor to teach village women how to properly use mask, care for reuse of mask, maintaining safe distance, and hand hygiene.

In a resource constraint environment, the mitigation steps were (1) providing a hand washing station that was built with a simple lever system and operated a faucet by foot pedal, (2) making hand sanitizer water that referred to Centre for Disease Control United States of America hand wash water recommendation, (3) making protective shield for medical staff by using plastic file cover and overhead transparency sheet, and (4) providing disinfection and reusing of surgical mass using direct sunlight in rural Bangladesh village for ready-made garments factory women workers (Rundle et al., 2020). These four examples are case studies in local ingenuity in a resource constrained environment be it in a landlocked Himalayan country where self-reliance against adversity quite often is the norm and a resource challenged village near the hub of the ready-made garments industry in Central Bangladesh, both countries in South Asia.

3 Result

3.1 Case study 1: foot operated faucet for hand wash station innovation

The challenge was simple operation of faucet with no hand contact. If the water faucet was closed by using hand, contamination was not avoided. To overcome this problem, a foot operated faucet operating assembly was constructed using wooden planks, inner tube, twin-rope and a guide pulley (Figure 3). The principle was simple, a wooden foot pedal attached to the faucet. A pulley guide would pull the handle of the faucet to the right allowing the faucet valve to open as long as the foot is pressed down on the would plank peddle. As soon as the foot is removed from the peddle the elastic band made from a cut out section of an inner tube would recoil back and close the valve of the faucet. The system was placed on a wooden frame and constructed from two by four soft wood lumber locally available in plenty. The elastic system for the recoil of the faucet handled to operate the faucet valve which was made from a cut out section of a waste tire inure tube. The constructed system was placed in the entrance gate of the college of Science and Technology, Royal University of Bhutan, Punshelling, Bhutan. The engineering principle is simple that can be conveyed to any carpenter and plumber and replicated readily in a resource challenged environment. As cases of community transmission of the SARS CoV2 virus increase in the Indian Subcontinent, communities need to face resource challenges. Thus, this innovation could be a solution preventing community transmission having hand wash stations with foot operated faucets.

3.2 Caste study 2: face shield made out of translucent plastic file folder and overhead transparency sheet

The face shields were not available for purchase, but was required as a personal protection gear for the College Health Assistant. The ingenuity ageing went into effect when using translucent discarded file cover and overhead transiency sheet a face protective shield was re-constructed. The front of the shield was made with the transparency sheet which is highly translucent and easy to see through. It was measured from below the chin up to the neck line. The side flaps were fitted to go past the ear and round bottom to cover the contour of the face and ears. All peace was glued together using over the counter superglue and for measure of safety all seams were covered with tape to ensure complete seal. A waste elastic ban was fitted to cover the circumference of the head and stitched. The elastic band was then attached to the fabricated face shield by hand stitching with needle and thread. The seam of the stich line was again covered with tape to ensure that there were no holes from stitching exposed for possible penetration by aerosolized particulate matter. This served as a personal protection gear for use when there was none available commercially. The Figure 4 below is the picture of the fabricated face shield that was actually used by the stakeholders.

3.3 Case study 3: sodium hypochlorite hand sanitizer produced from off the shelf liquid bleach

Bhutan became a landlocked country supply of alcohol-based hand sanitizer. The supply was short and restricted for frontline workers. To provide it, sodium hypochlorite was diluted to make hand sanitizer to protect against COVID-19 virus. The active ingredient, sodium hypochlorite, was prepared 6% of initial concentration. It was diluted in tap water to achieve 0.5% of sodium hypochlorite concentration to produce hand sanitizer. The pH was measured and identified 5.8 to ensure the safety and the effectiveness of the disinfectant agent (Block and Rowan, 2020). At pH 6.5 and below, the predominant species is the most effective hypochlorous acid (Viessman and Hammer, 1999).

In application, the formulated HOCl solution was placed in an old water bottle with a perforated hole in the cap to dispense the handwashing solution (Figure 5). The concentration formulation was also based on the Centers for Disease Control (CDC) guidelines for hand washing solutions using hypochlorous acid. To ensure no reduction in disinfection efficacy, fresh batches were prepared daily for dispensing. In addition, the old solution was discarded as a recommendation from the United States Centers for Disease Control.

Figure 3 (a) Foot operated faucet hand was station under construction, (b) installed foot operated hand was station, and (c) location of installed hand wash station at the gate of the college.

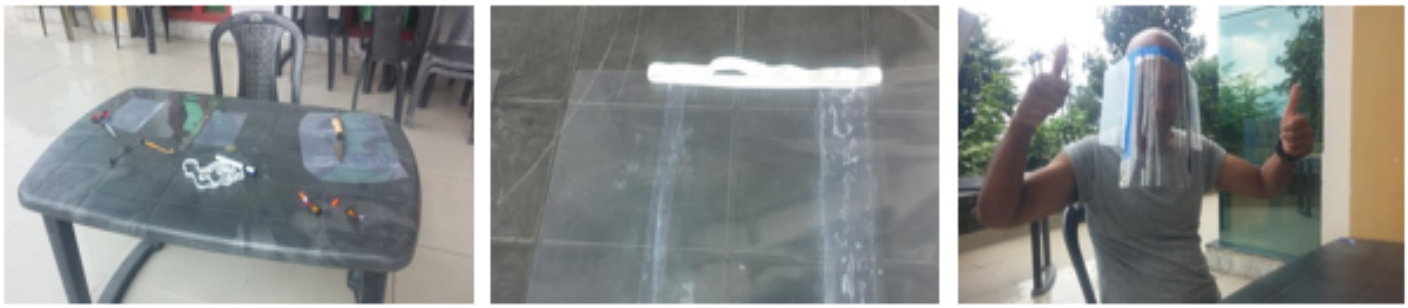

Figure 4 Pictures (a) through (c) shows he different stages of making the face protection shield from overhead transparency and file cover.

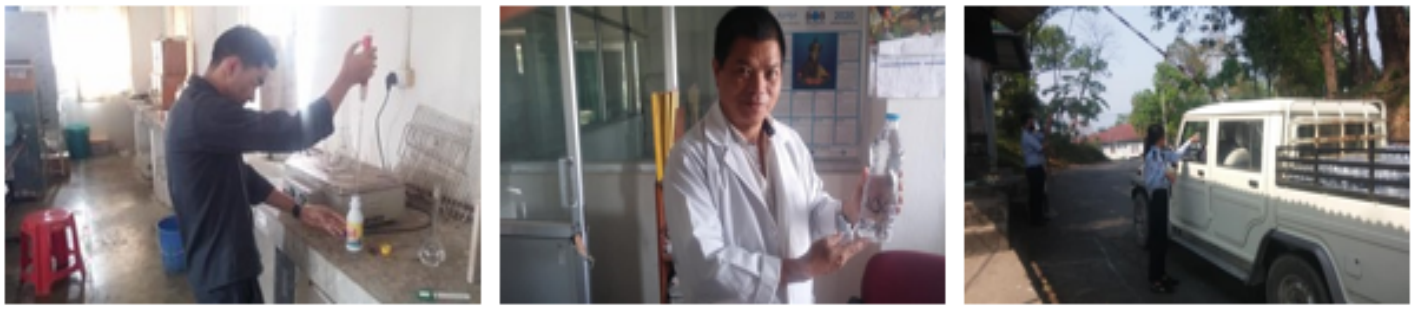

Figure 5 (a) The hypochlorous acid-based hand sanitizer being formulated in the laboratory, (b) health assistant receiving the hand sanitizer, and (c) hand sanitizer being used at the gate for vehicle passengers hand sanitization prior to entry to campus.

The HOCl hand sanitation concept was also being implemented in rural Bangladesh in a village called Sardi in the Bangladesh division of the Naringanj mosque (Muslim house of worship) which did not allow the use of alcohol-based hand sanitizers (Yeasmin et al., 2021). With the help of local non-governmental organizations, the Hanum Health Development Foundation's Mosque imams (prayer leaders and mosque custodians) had been trained to produce HOCl-based cleaners for use in their congregations. The use of non-alcoholic hand sanitizers is the disinfection option for Muslim-majority Bangladeshis when hand washing and rinsing with soap and water are not feasible. For instance, at Friday prayers, many people gather in the mosque for the midday prayer. In this situation, washing hands with soap and water is not possible for village mosques which do not have sufficient handwashing stations to handle many people at once. In addition, hand HOCl solution can be a viable alternative to reduce the spread of the SARS CoV2 virus in the community.

3.4 Case study 4: natural air drying under direct sunlight in high humid and temperature weather to disinfect surgical and KN95 masks for reuse

The population in general in Bangladesh is in a compromised position due to limited resources and having to reuse surgical masks and KN95 masks. In general, people reuse masks without taking the initiative to disinfect them. It can be a potential health hazard especially for the millions or more women working in the ready-to-wear garment industry who have to reuse masks to go to work every day. Washing with soap destroys the efficacy of masks. However, there is peer-reviewed literature concluding that the SARS CoV2 virus has a short half-life and viability with high temperature, humidity, and direct natural sunlight.

This could be a potential solution in the context of Bangladesh which the climate has humidity and sunlight intensity during the

day. In central Bangladesh, the average maximum ambient temperature was around 30.5 ^{o}C ranging between 26 ^{o}C in December to 34 ^{o}C in April. The percentage of the humidity was relatively around 65.8 per year. It was between 45% on March and 79% on June and July, with an average twelve hours of daily sunlight. Estimated surface decayed at the lowest temperature and humidity of 26 ^{o}C and 45% (Haque and Rahman, 2020). 99.99% decay of the SARS CoV2 virus was estimated in 5 days.

In the situation of stakeholders reusing the same masks every day without disinfection, a viable option is to have several masks and use one mask one day and the next several days in the sun exposing the mask during sun hours on the clothesline. If there is a large supply of masks, it can be ensured that they are exposed to sunlight for 5 days before use (Figure 6). This concept has been introduced to Sardi village in Narayanganj district in central Bangladesh by Hanum Health Development Foundation to village stakeholders along with promotion of safe distance and hand hygiene to reduce transmission of SARS CoV2 virus in the community.

Figure 6 Garments factory worker holding her mask pole to be place under direct sunlight for disinfection by direct sunlight

Disposable surgical masks cost around US$0.01 and can be cheaper to obtain by disinfecting them in the sun for five days. Thus, by rotating the use of masks, people can have protective masks without compromising their safety and not having to throw them away as disposable which is unaffordable for Bangladeshi villagers and also unfriendly to the environment.

4 Discussion: community adaptation of the mitigation procedures as a success marker

The success of any appropriate technology development is adaptation within the targeted focus group. All mitigation public health initiatives to reduce the community spread of CoV2 have been well adapted in target communities in a sustainable manner. Evidence of adaptation is narrated and highlighted with several figures. The first mitigation measure of a simple foot-operated faucet was successfully placed at the entrance of the institution and two other strategic locations in the College of Science and Technology as hand washing stations for staff and student use. Subsequently, this idea was submitted to WaterAID Bangladesh to adapt it for application in Bangladesh. WaterAID Bangladesh improved and promoted the concept of these foot operated water faucets as hand wash stations for public locations. The deployed system in Bhutan at the College of Science and Technology and in Bangladesh at a public part in Gulshan Lake Park, Dhaka the Capital of Bangladesh. This is an example of a good idea being picked up and applied. It is also an example of regional transfer of appropriate technology idea in the countries of South Asia.

The face shield fabrication concept is used by the faculties of The College of Science and Technology to make their own face shields. Its unique features are overhead transparencies and the plastic from file cover. It is a practical application of appropriate technology using locally available materials. Besides, it is also cost-effective for CoV2 mitigation.

The HOCl based hand sanitization concept as mentioned earlier was adapted in the Collage of Science and Technology as an option of hand sanitization for all incoming passengers of vehicles entering the College. The concept was also adopted in rural Bangladesh at a village called Sardi in Naringanj division of Bangladesh. A junior school in rural Bangladesh was using the HOCl based handwashing solution tha is dispensed by mug from a bucket of freshly prepared solution. It was utilized for sanitization of the students as an alternative way. The community was also motivated to the idea of using HOCl sanitizers for common sanitizing areas, such as toilets and tables, to mitigate against the spread of CoV2. However, HOCl solution was used for hand washing in Both College of Science and Technology Bhutan and the village school in Sardi Bangladesh.

The use of masks has been mandated in Bhutan and Bangladesh (Sangkham, 2020). Not wearing a mask in public or even outdoors can be fined in both countries. In offices and establishment of commerce, people were wearing surgical masks and KN95 masks that are locally available as mentioned earlier. People tend to wear it over and over again. Washing the masks ruin the fibber; the fibres from the mask flakes off. We are promoting that people buy multiple masks and wear them in rotation. the masks not in use is sundried on cloths line. This is based on the premise that high humidity prevailing in Bangladesh and the ample sunlight inactivated CoV2 virus, thus by rotation use and by sunlight drying the masks would be virus inactivated if exposed. This idea is plausible to the public that are working in focus groups. It had been adopted in the school at Sardi village and the Bangladesh army engineering Brigade. The concept of rotation uses of mask with sunlight drying before reuse was also promoted.

Communities in Bhutan and Bangladesh who have resource challenges need to learn to live a new normal. The majority of people may not be able to afford vaccines or vaccine availability will take longer in developing countries than in developed countries. The survival of the community requires alternative measures to reduce the spread of CoV2. The method in this paper, about innovation and application of appropriate technology, can reduce the spread of the CoV2 community.

5 Conclusions

A simple and effective mitigation measures was applied and reported in this paper to limit community transmission of SARS CoV2 virus in Bhutan and Bangladesh. A simple a lever system was constructed a faucet using a foot pedal. Hand sanitizer was produced using locally available chemicals. Protective shield production and disinfection technique were also provided to cover community transmission of SARS CoV2. This simple mitigation measures can be replicated in other resource challenged regions of the world as mitigations steps to limit community transmission.

Declaration of competing interest

The authors declare no known competing interests that could have influenced the work reported in this paper.

Acknowledgments

The author thanks the Health Assistant, Laboratory Technician, and Technicians at the College of Science and Technology, Royal University of Bhutan. The contribution of field coordinator of Hanum Health Development Foundation, Bangladesh is also appreciated.

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