श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेंद्रम, तिरुवनन्तपुरम - 695 011, केरल, भारत
SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM
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(एक राष्ट्रीय महत्त्व का संस्थान, विज्ञान और प्रौद्योगिकी विभाग, भारत सरकार)
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PROJECT COMPLETION REPORT

1.	**Project Number**	:	8230
2.	**Title of the Project**	:	Examination Booth
3.	**Funding Agency Name**	:	Technical Research Centre (TRC), Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum.
4.	**Project Reference Number provided by the Funding Agency:**		
	8230		
5.	**Principal Investigator (Name & Address) :**		
	Mr. Ramesh Babu V., Engineer 'G', Division of Precision Fabrication, Department of Medical Devices Engineering, Biomedical Technology Wing, SCTIMST		
6.	**Co-Principal Investigators (Name & Address):**		
	i.		Mr. Muraleedharan C. V., Scientist 'G' (Senior Grade), Division of Artificial Internal Organs, Department of Medical Devices Engineering, Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum.
	ii.		Er. Arvind Kumar Prajapati, Engineer C, Division of Artificial Internal Organs, Department of Medical Devices Engineering, Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum.
	iii.		Er. Saurabh S. Nair, Engineer C, Division of Artificial Internal Organs, Department of Medical Devices Engineering, Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum.
	iv.		Dr. Sivakumar K. G. V., Engineer 'E', Division of Artificial Internal Organs, Department of Medical Devices Engineering, Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum.
7.	**Implementing Institution**	:	Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum, Department of Science and Technology, Govt. of India
8.	**Collaborating Institutions**	:	Listed under translational potential
9.	**Date of Commencement**	:	28 April 2020
10.	**Duration**	:	23 days
11.	**Date of Completion**	:	21 May 2020
12.	**Objectives as approved:**		
	1. Protect health professionals from the risk of infection. 2. To generate technical know-how for manufacturers while meeting international regulations 3. Reduce the consumption of personal protective equipment (PPE)		
13.	**Deviation made from original objectives, if any, while implementing the project and reasons thereof:**		

None

14. Field/Experimental work giving full details of summary of methods adopted, data collected supported by necessary tables, charts, diagrams and photographs:

A summary of various methods used for each parameter is listed below.

1. **Negative pressure**

   An M2 Series Smart Manometer (M/s Meriam, USA) was used for pressure differential measurement. One limb of the manometer was held inside the booth while the other limb was routed outside the booth via a small hole made through a plastic sheet covering the glove-port opening. Measurements were taken with the booth door shut and the blower fan turned on.

2. **Air changes per hour**

   A DIGISENSE hotwire anemometer (M/s Cole-Parmer, USA) was used to measure the velocity of air exiting the HEPA filter. The telescoping hot-wire probe was placed at multiple locations above the HEPA filter, and the respective velocity was measured.

3. **UV doses**

   A set of four 254 nm UV lamps was fitted inside the top compartment (four sides) of the Chitra devices to disinfect the air in the top compartment. Measurements were performed at several locations near the HEPA filter. An 843-R (M/s Newport, USA) laser power meter with a thermopile detector (919P-003-10 (M/s Newport, USA)) was used for UV power measurements.

15. Detailed analysis of results:

A detailed analysis of the experimental outcomes is given below.

1. **Negative pressure**

   The measurements obtained using a Smart Manometer resulted in an average negative pressure differential of 12 ± 1 Pa, which was four times the limit set by the Centres for Disease Control and Prevention (Centres for Disease Control and Prevention 2003).

2. **Air changes per hour**

   The exhaust air velocity above the HEPA filter was measured to be 0.4 ± 0.2 m/s. The flow rate of air exiting the filter was calculated using the formula: $A*v*3600\ m^3/h$

   where average velocity, $v = 0.4 \pm 0.2$ m/s.

   HEPA filter area, $A = 0.30 * 0.30\ m^2 = 0.09\ m^2$

   The flow rate of air exiting the filter was 129.6 m3/h, which translates to 30 air changes per hour, with a chamber volume of 4.32 m^3, which was 2.5 times the limit of air changes per hour in air born infection control isolation set by CDC guidelines (Centers for Disease Control and Prevention 2003).

3. **UV Power Density**

	The UV power density was measured in the proximity of the HEPA filter in the four corners inside the top compartment. The average power density observed was 0.24 ± 0.07 mW/cm^2. The International Ultraviolet Association recommends a UV dose of 40 mJ/cm^2 for the disinfection of viruses on flat, ideal surfaces. The proposed device accumulated a UV dose of 43 mJ/cm^2 in within 3 minutes.
16.	**Summary sheet of not more than 2 pages under the following heads : (Title, Introduction, Rationale, Objectives, Methodology, Results, Translational Potential)**

Title: Design and Evaluation of Chitra Swab Collection Booths for Health Professionals in the COVID-19 Pandemic

Introduction

The 2019 novel coronavirus (SARS-CoV-2), officially named COVID-19 by the WHO, had spread to more than 180 countries, and the confirmed coronavirus cases had reached around 10 million with 0.6 million deaths by the end of June 2020. Moreover, there was no sign of a sustained decline in cases in any country until August 2020. The continuous rise of positive cases had instilled fear in people, society and even health professionals. Around 22,073 COVID-19 cases of healthcare professionals were reported to the WHO as of Wednesday, 8 April 2020, by Jin (Mil Med Res 7:24, 2020).

Rationale

Infection to health professionals was a serious concern not only because they are valuable frontline workers but also because of the risk of spread to coworkers and non-Covid patients. Three models, examination booth, Chitra swab collection booth and Dual chamber Swab collection booth, were developed to (1) protect health professionals from the risk of infection (2) to provide technical know-how to manufacturers to produce booths using locally available materials while meeting international regulations and (3) reduce the consumption of personal protective equipment.

Objectives

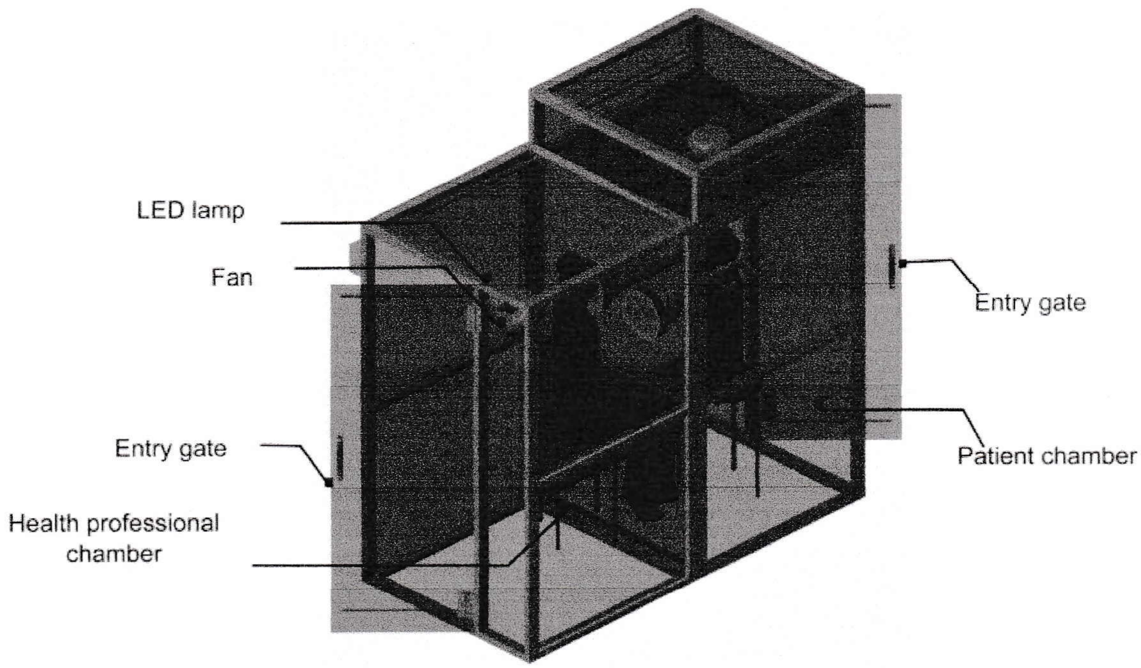
Three objectives were proposed.

1. To protect health professionals from the risk of infection.
2. To generate technical know-how for manufacturers while meeting international regulations
3. To reduce the consumption of personal protective equipment (PPE)

Methodology

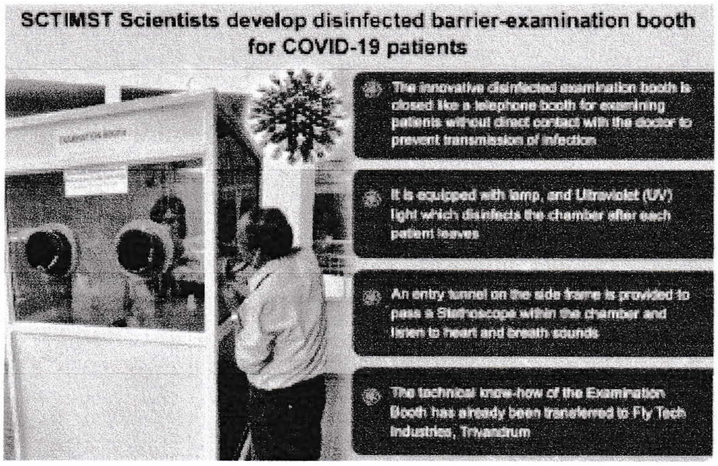
The design provided a physical barrier for health professionals during swab collection (Nasopharyngeal swab/Oropharyngeal swab)/examination of potentially infected persons. The bottom compartment was developed for the patient or a suspected case and had a 1.8 m^2 area and 2 m height. This compartment was maintained under negative pressure to minimize the spread of the virus to the outside environment. It had long-sleeved gloves to be worn by health workers while reaching the patient for the collection of swab samples/examining the patient. Neoprene or latex gloves were used with periodic replacement. These gloves were attached to a cylindrical tube provided on the bottom compartment using hose clips, which can be tightened onto the cylindrical tube, providing an airtight seal. The patient entry gate faced the glove side of the compartment. A wireless portable interphone was installed for easy communication. All consumables necessary for swab collection/patient examination were provided in the bottom compartment. Additionally, the Health professional and patient chamber was equipped with customized seating arrangements (e.g. chairs and tables) to improve the working conditions.

The air from the bottom compartment was drawn into the top compartment, which had provision to disinfect air before being let out. To enable this, the top compartment was made of aluminium composite or extruded PVC panels, equipped with a high-efficiency particulate air filter (HEPA) (0.3-micron nominal cut-off) with 100–150 m3/h airflow capacity against 50 Pa differential pressure. Further, a set of 4 UV-C lamps and a conventional blower (100–150 m3/h) matched to the HEPA filter to generate the pressure differential was attached to the chamber. A well-defined operating protocol was also developed as a part of this work.



Schematic showing the different parts of the dual-chamber swab-collection booth

	Results The prototypes developed were tested for safety and efficacy in accordance with the guidelines of the Centers for Disease Control and Prevention, Atlanta, USA. The device also received the registration for commercialisation from the Central Drugs Control Standard Organization, Ministry of Health, Government of India, as a non-notified medical device. **Technology transfer** All three technologies were transferred to multiple industry partners through expressions of interest. The list of technology partners is given below. 1. M/s. HLL Lifecare Limited, Thiruvananthapuram 2. M/s. HMG (India), Mumbai 3. M/s. JADRO Steel LLP, Panchla, Howrah, Kolkata 4. M/s. Sivapriya Exim Pvt.Ltd, Annanagar , Chennai 5. M/s. TVS Supply Chain Solution Limited, Indiranagar, Bengaluru 6. M/s. Kanjikode Industries Forum, Kerala 7. M/s. Kerala State Drugs and Pharmaceuticals Limited.
17.	**Contributions made towards increasing the state of knowledge in the subject:**
	The research conducted has made a significant contribution to our understanding of the Covid-19 virus. As a result, a technology has been developed for its management. The outcome of this research has also helped other researchers to gain a better understanding of the virus, as evidenced by the number of citations in related articles.
18.	**Conclusions summarising the achievements and indication of scope for future work:**
	This translational work played a pivotal role during the testing of the COVID-19-infected patients. Chitra swab collection booth emerged as a groundbreaking solution, enabling safe and more efficient sample collection. These booths expedited the testing process as well. They were sold more than 84 units across India. This work resulted in two patents and a publication and received media coverage with societal impact. 1. Recognition of technology by the **Department of Science and Technology**, Govt. of India as **" SCTIMST scientists develop disinfected barrier-examination booth for examining COVID-19 patients"** https://dst.gov.in/sctimst-scientists-develop-disinfected-barrier-examination-booth-examining-covid-19-patients



2. NDTV News Coverage "**Kerala Scientists Develop Disinfected Barrier-Examination Booth To Check COVID-19Patients**" https://www.ndtv.com/education/kerala-scientists-develop-disinfected-barrier-examination-booth-to-check-covid-19-patients-2208460
3. Economic Times news coverage, "**SCTIMST develops examination booth for testing covid-19 patients".**
https://government.economictimes.indiatimes.com/news/technology/sctimst-develops-examination-booth-for-testing-covid-19-patients/75047867

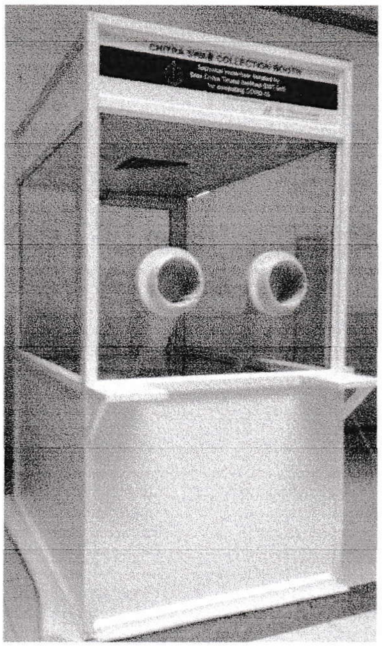


Fig.1. Examination booth

Fig.2. Swab collection booth

Fig.3. Dual-chamber swab collection booth

19.	**Science and Technology benefits accrued :**	
	a.	**List of research publications with complete details :**
		Nair SS, Prajapati AK, Venkatesan RB, Vayalappil MC, Kishore A. (2020). Design and Evaluation of Chitra Swab Collection Booths for Health Professionals in COVID-19 Pandemic. Transactions of the Indian National Academy of Engineering, 2020 Aug 31;5(4):643–648.
	b.	**Manpower trained on the project :**

		i.	**Research Scientists or Research Fellows**	: None	
		ii.	**No. of PhD's produced**	: None	
		iii.	**Other Technical Personnel trained**	: None	
	c.	**Patents taken, if any**		: None	
	d.	**Products developed, if any**		: None	
20.	**Abstract: (In 300 words for possible publication in ...... Bulletin)**				
	a.	**Background:**			
		Published			
	b.	**Materials:**			
		Published			
	c.	**Results:**			
		Published			
	d.	**Conclusion:**			
		Published			
21.	**Procurement/Usage of Equipment:**				
	a.	**Details of Equipment:**			

		Sl. No.	Name of Equipment	Make/ Model	Cost (Rs.)	Date of Installation	Utilisation	Remarks regarding maintenance breakdown
-		-	-	-	-	-	-	-

	b.	**Suggestions for disposal of equipment(s):**
		None

V. Ramesh Babu 07/11/2023

V. Ramesh Babu

(Name and Signature of PIs with date)

Routing: *Signed copy of "Project completion Report" by PI → root@sctimst.ac.in, rpc@sctimst.ac.in*