COMMON RESEARCH AND TECHNOLOGY DEVELOPMENT HUB (CRTDH) AT IIT KHARAGPUR ON "AFFORDABLE HEALTHCARE"

A flagship initiative Sponsored by

DSIR, Government of India

PI- PROF. SUMAN CHAKRABOPRTY

सत्यमेव जयते

DSIR

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

भारतीय प्रौद्योगिकी संस्थान खड़गपुर

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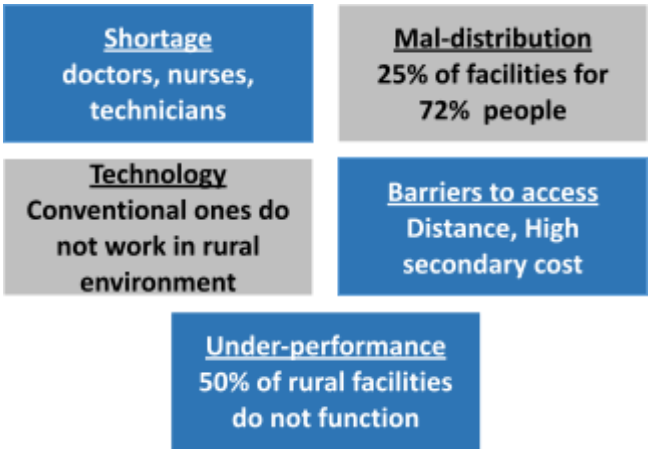
CRTDH@ IIT Kharagpur on "Affordable Healthcare" – A flagship initiative Sponsored by DSIR, Government of India

From the Desk of the PI (Prof. Suman Chakraborty, e-mail: suman@mech.iitkgp.ac.in)

The mission and vision

Access to health is one of the fundamental rights enshrined in the constitution over the world. However, almost 50% of the world's 7.5 billion people is forced to live at underserved locations without access to basic healthcare and health education and public health measures, due to a multitude of reasons. This results in accumulation of diseases among the most vulnerable segment, delayed presentation and intervention, and consequent need of specialty treatment at high secondary and tertiary cost and health-related poverty shocks. 100 million people globally have to choose between food and medicine every day. 39 million people fall below poverty line in India every year due to health-related expenses. This vicious cycle needs to be broken.



Access to reliable and affordable quality primary care is a great challenge for the rural population in India as well, similar to several other challenged nations. Primarily, this is due to shortage of doctors, nurses and healthcare workers, and lack of availability of affordable yet reliable technology-enabled solutions that may even be deployed in the green field. There are other issues related to mobilizing and keeping doctors in villages, administrative constraints and lack of essential resources for healthcare delivery. As a consequence, we have failing societal health indices - high incidence of anaemia among women of child-bearing age, under-nutrition among children, rampant diarrhoea and gastro-intestinal diseases, other deficiency diseases (vitamin and minerals) and ill-managed non-communicable diseases such as diabetes, renal failure and hypertension.

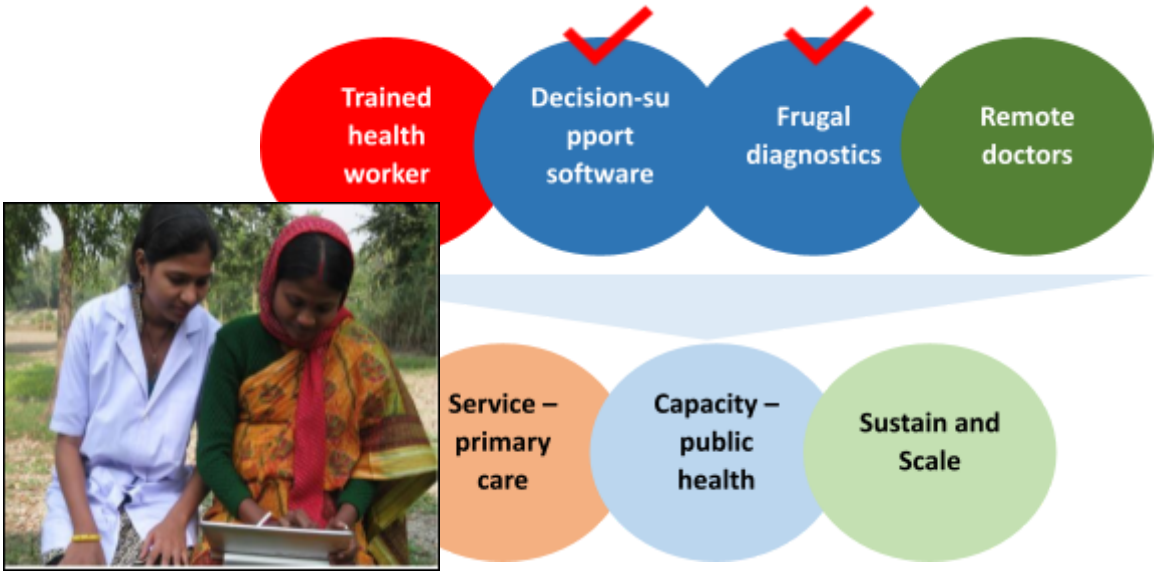
In a dire need to provide a disruptive intervention to these long-standing challenges in affordable healthcare, one pragmatic way out is to intermingle advancements and innovations in healthcare technology, including digital healthcare, with value added human resource development, which is the central principle adapted in the vision of our CRTDH at IIT Kharagpur. Strikingly, out of the 165 million rural youth in the age group of 16-24 years in India, less than 10% has access to beyond high school level. On the other hand, India has a shortage of over 5.0 million minimally-trained allied health professionals. While there is an upsurge in undertaking significant amount of innovative research on affordable healthcare technologies in the Institutions of higher learning in India, many of these have failed to reach to the bottom of the pyramid due to a significant disconnect with the practical needs and obvious barriers at underserved locations, economic and societal perspectives and lack of human-resource centric considerations. During the unprecedented COVID-19 pandemic, such compelling constraints have further been amplified by numerous challenges augmented by loss of job, massive imbalance in urban-rural distribution of health-facilities, shortage of healthcare professionals, and most

CHWs using software for primary care

importantly, non-availability of robust yet low-cost technologies that remain to be effective outside super-specialized labs.

The approach and target interventions

The CRTDH at IIT Kharagpur has envisioned to address the challenge holistically by leveraging technology disruption and linking the same with a sustainable socio-economic pipeline spearheaded by rural youth and women. The CRTDH has adhered to an "ecosystem" approach by interlacing human resources, technologies, entrepreneurship, financial and operational sustainability, systems training, social anthropology and behaviour-change communication. The CRTDH has thus attempted to combine all the pertinent elements and develop a complete eco-system that is sustainable, scalable, replicable, affordable, meets real needs of the people, enables multiple business models and produces social impact to scale in health indices. Healthy society and nation; thriving manufacturing sector in innovative healthcare technologies (as distinct from cheap copy manufacturing); employability and entrepreneurship among the underprivileged population, and a bedrock for future research have been the major emphasis towards advancing this vision via value-added interventions.



In the grass root level, the research team of CRTDH has partnered with 'Foundation for Innovations in Health – FIH' (a registered not-for-profit founded by two eminent doctors) and took up an initiative of establishing 70 clusters of e- health clinics (350 clinics; 5 in each cluster) in rural areas on a hub-and-spoke model, partially supported by the Government of west Bengal. To implement the concept into practice, community frontline health workers (middle school level girls trained and certified formally), who travel everyday along specified routes to deliver home healthcare to last-mile populations, have been empowered with certain value-added

CHW delivering healthcare Mobile unit

Online consultation at e-health clinic

propositions that may create all the difference towards making the initiative a functional success. The bicycles that are used by them as modes of conveyance are fitted with specially fabricated 'medical magic boxes' that contain various medical equipment, portable diagnostic kits indigenously developed, tablet computers, medicines, information and communication material and portable printers. A team of physical but remote doctors provides medical advice through a 'primary care software', which is interfaced by these frontline health workers who obtain structured clinical history from the patients and undertake limited physical examination (including simple smartphone imaging of visible locations in the body, recording basic body parameters like temperature, blood pressure etc.). The tablet-based elementary decision-support software system, advanced by the CRTDH team, works on low bandwidth, aims to mimic the doctors' mind to a large extent and is easy to use by the community health workers. This has culminated in the form of an integrated medical decision system by leveraging the outcome of programmed clinical evaluation, in-situ low-cost diagnostics and expert advice, mediated by key features of internet connectivity and data sciences. The software interface guides the health workers to document structured clinical history, thereby providing decision-support to the real 'remote' doctors who provide the actual clinical advice, including medicines and tests.

More than 1700 rural male and female health workers have been trained and multi-skilled by the CRTDH team, covering remote regions dominated by underserved rural population. These personnel have been trained to conduct basic point-of-care diagnostic tests using capillary blood draw, ECG etc. This unique training programme has been certified by an accrediting National body. By integrating micro-engineered and nano-engineered technology, frugal image analytics and machine learning, the CRTDH R&D team has empowered the frontline health workers with easy-to-use portable diagnostic devices. As specific example, two frugal diagnostic technologies that measure blood plasma glucose and haemoglobin at accuracy levels compatible with the established gold-standard pathology have been extensively validated in the field, in this manner.

Field visit at e-health clinic Balpai

Pivoted on the above envisaged ecosystem, the CRTDH has put up specific emphasis on the following target interventions:

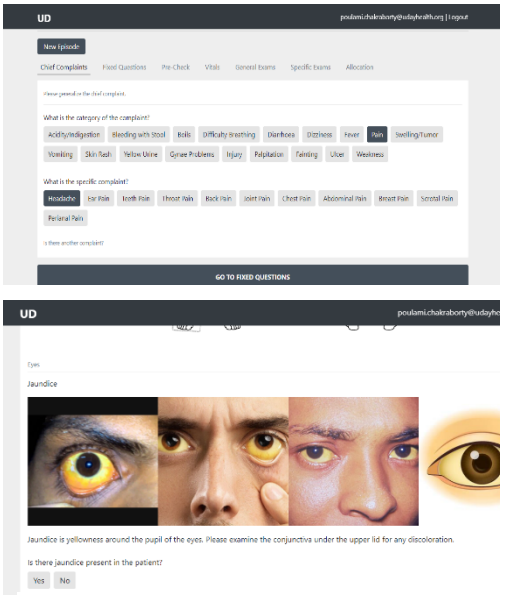
- Advancement of the efficacy of software-human interface in digital health framework for primary care
- Innovation and adaptation of multiple affordable easy-to-use diagnostic/therapeutic/screening healthcare technologies that address common needs in rural India.
- Promoting micro-small-medium scale enterprises in manufacturing of innovative affordable easy-to-use healthcare technologies, through technology transfer and training in capacity-building.
- Developing sustainable and scalable model for delivery of technology-enabled primary healthcare and public health, via active engagement and training of rural youth and women.

Various key elements of the CRTDH that have been established as structural and functional backbones are briefly summarized below.

Field trial and Clinical validation at Point-of-Care

Software

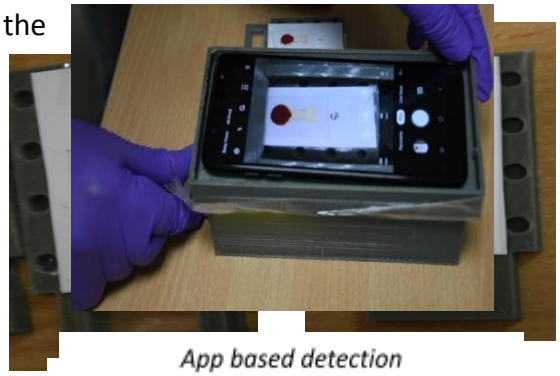
The CRTDH team, along with doctors from FIH, has developed comprehensive software, which algorithmically aims to mimic the doctor's mind and enables the connectivity between 'real' patients and 'remote' doctors mediated by frontline healthcare-workers. This interface has further been augmented to include the diagnostic reporting and recommendation as administered by the extreme-point-of-care devices introduced by the CRTDH research team. This not only ensures systematic recording of diagnostic data but also enables data management and analytics premised on common pathological and physiological parameters in an integrated framework for fostering public health recommendations and policies. Further advancements emphasizing more dynamic and interactive interfacing between the patient and the remote doctor with optimal numbers of intervening questions, augmented data security, privacy etc. are currently under way.



Screenshots from primary care software

Disruptive diagnostic innovations for use at extreme point of care

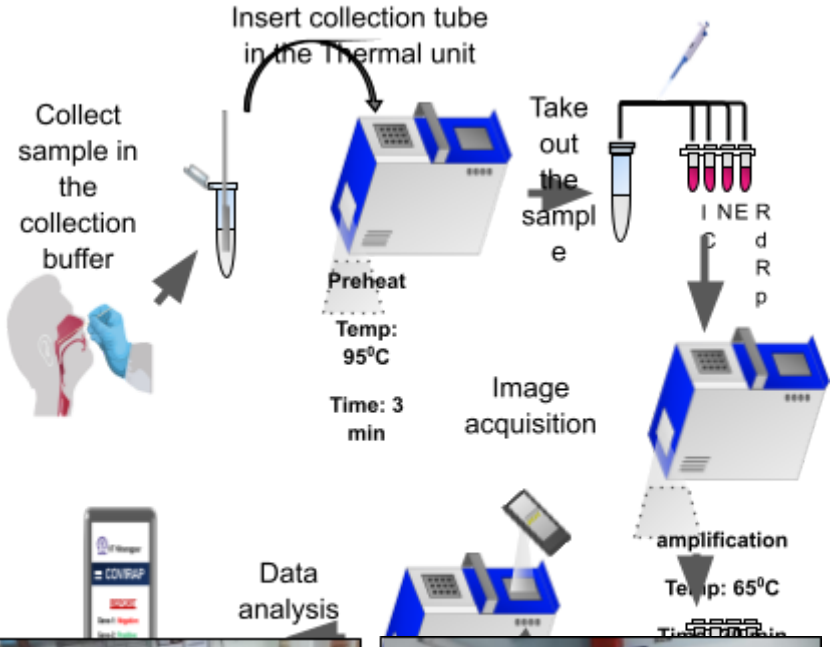
Recent initiatives in giving technology-enabled healthcare access to the most downtrodden population have brought in dramatic improvements in the well-being of the developing world. However, such efforts have so far been primarily constrained by the lack of affordable diagnostic technologies that can be deployed on the field, under extreme challenging conditions where sophisticated laboratory facilities and specially trained technicians are scarce, and cost-related constraints are ominous. Overcoming these constraints, the CRTDH has fostered the development of disruptive diagnostic technologies that have successfully been implemented as integral form of the digitally interfaced healthcare delivery models at extreme resource-limited settings. Specific examples include: ultra-low cost colorimetric detection of blood-borne parameters using a printed paper strip integrated with a smartphone and a simple plastic box fitted with LED light for holding the same and imaging simultaneously. Compared to other portable devices available in the market for similar purpose, this device innovated by the CRTDH team is of significantly low-cost, the method can be implemented without any trained personnel at rural settings and provides results as accurate as established pathological standards.



App based detection

The team has adopted a detection method which is virtually instrument free and requires only a smartphone. The device has already been tested in extreme challenging environments of remote villages, where there is uncontrolled dirt, dust and humidity, and there is no air-conditioned lab to work with, leaving apart the lack of trained personnel to do lab-based tests.

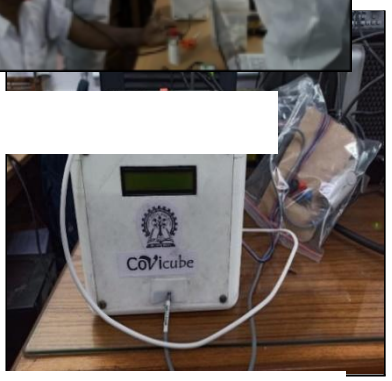
Came the year 2020 - the beginning of a year that would throw the entire world into a tumult, the likes of which this century had not yet seen. Outside the initial, hushed up outbreak in China, talk of a virus was akin to whispered rumours - nothing like the fevered discussion that came to the fore of the public conscious, a few months later. But for the CRTDH research group, this triggered all their endeavours to rise up to the occasion – and they were all working on making a breakthrough, turning the challenge of COVID-19 into an opportunity, by architecting a unique diagnostic device that has attempted to redefine the manner in which nucleic acid best tests may be conducted outside structured laboratory ambience.



Working principle of Covirap device

Clinical validation of Covicube device

With the gold-standard diagnostic tests (such as RT-PCR) turning out to be prohibitively resource-intensive and the common rapid-tests (such as Rapid Antigen tests) proving to be alarmingly inaccurate, there remained to be an unmet demand for low-cost novel diagnostic technologies for resource-limited settings with high specificity and sensitivity. However, the available rapid tests are either limited by compromised accuracy or are poorly performing outside a highly controlled laboratory ambiance. In response to this challenge, the CRTDH team developed a new piece-wise isothermal nucleic acid test (PINAT) as a platform technology for diagnosing pathogen-associated infections, including but not limited to COVID-19. Disrupting the perception that



Prototype of Covirap and covicube device

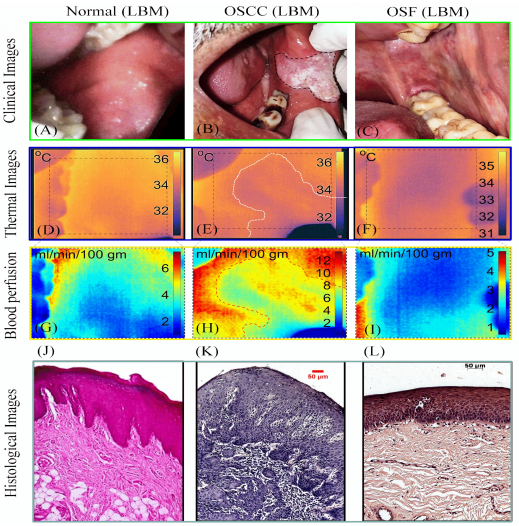
high-quality molecular diagnostics necessarily demands sophisticated technological and human resources, this diagnostic procedure is the first of its kind, highly accurate ultra-low-cost point-of-care nucleic acid-based test having the simplicity and user-friendliness of a common rapid test. The extremely low cost per test (~50 Rs. Per test gene), as well as the capability of operation outside laboratory settings, hallmarks its value the proposition as an affordable alternative to RT-PCR for monitoring the spread of infection at the community level, and an excellent option for routine screening at community locations including schools, shopping complexes, offices, etc. during the regularization phase of the common daily activities post-pandemic. While relying on the same basic backbone of isothermal nucleic acid amplification as several other recently-introduced tests that have otherwise failed to perform satisfactorily on-field, the exclusive test exemplified here could by far successfully deploy the detection method stably outside controlled lab settings in more than 1000 cases of a field trial in rural settings, without incurring carryover contamination despite strict laboratory controls not being adhered to. Overall, direct testing from swab/ saliva sample without formal RNA-extraction, and implementation by unskilled frontline-workers in uncontrolled environments are two exclusive unique technical features of this test, leaving apart the user-friendliness, rapidity, and low cost. This testing is being supplemented with a prima-face screening using another flagship device introduced by the CRTDH -‘‘COVICUBE’ , which can simultaneously measure respiration rate, oxygen saturation, and temperature that can be very effective for early screening of COVID-19 patients and constant monitoring of the infected patients as well.

Commercialization potential of the COVIRAP technology is immense – as already evidenced by

Field trial of Covirap device at BC Roy Technology Hospital at IIT Kharagpur

several technology transfers to commercial agencies engaged in operation in India as well as abroad. Currently, in India, there is no RNA-extraction free point of care nucleic acid test available in the market. The tests available in the Indian market are either resource intensive (like RT-PCR) or of limited accuracy (such as rapid antigen test) or cannot be made functional without including specialized procedures such as RNA extraction (like the commercially available LAMP-based tests in India). The availability of such easy-to-use, highly specific, and reasonably sensitive detection method as a generic platform technology has already been demonstrated to be successful in capturing commonly missed instances of early infection and asymptomatic disease presentation and reduce the opportunity for community-level transmission of COVID-19 infection, via the clinical trials organized at IIT Kharagpur Campus including participants from the surrounding rural community. This could result in dramatic improvements in disease management and epidemic/ pandemic control in several unforeseen events in the future in under-served rural settings. This innovation is also likely to open up new sources of self-employment of MSMEs through opportunities of large-scale device manufacturing and employing frontline health workers (especially rural girls and youth) for disseminating the test.

Researchers at the CRTDH have also developed a portable non-invasive device augmented with novel quantitative analytics for detecting oral cancer in resource-limited settings. The efficacy of the innovated device has been established via clinical trials on superficial cancer and pre-cancer lesion in the oral cavity, extracting the absolute values of blood perfusion data from the changes in the local thermal field of the imaged tissue. This innovation demonstrates the feasibility of real-time mapping of the cancerous trait as validated by an optical biopsy method applied in-vivo on human patients, reporting an exceptionally high level of sensitivity and specificity. To reduce the misclassification problem associated with variability with lesion microcirculation and among the patients, the CRTDH researchers have also integrated a robust machine learning model for automatic and reliable diagnosis of oral cancer and pre-cancer. It is envisaged that this method holds further potentials to achieve contrast-free, accurate and low-cost diagnosis of abnormal microvascular physiology and other clinically vulnerable conditions, when interpreted along with complementary clinically-evidenced decision making perspectives.

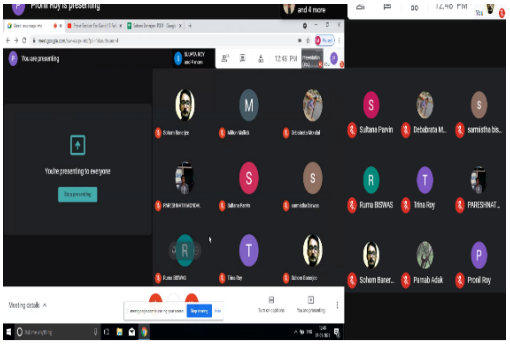


Point-of-care device for oral cancer detection

Manufacturing and MSME engagement/ mobilization

District-wise development of MSMEs, although growing steadily across the country, has been very lopsided, and, in general, have failed to make a significant mark in the healthcare industry due to poor manufacturing standards and failure to access the market. This has compounded the challenges in translating new designs of healthcare products which have demonstrated success in proof of concept, to scalable commercial production and off-the-shelf availability. Some critical inhibitors against successful indigenization of manufacturing of novel healthcare devices is the current reliance on centralized manufacturing, zonal warehousing and use of supply chain for distribution of completely boxed products or imported components (including consumables) or turnkey solution. Additional issues that offer compelling bottlenecks include the lack of design standard integration, inadequate adherence to quality standards and sluggish clearance from regulatory authorities. Crisis periods associated with natural calamities like floods or extreme weather conditions, political insurgency, or disease pandemic like COVID-19, offer challenges to the transportation of commodities over long distances thus disrupting the current model of supply chain delivery mechanism. Hospitals and care delivery units, which are hard pressed on delivery in such crisis periods, remain helpless on account of unavailability of serviceable stock of devices, equipment, etc.

Hands-on training to the MSMEs



As an intervention to this challenge, one key area of focus of the CRTDH is supporting the growth and development of precision manufacturing of innovative medical devices through emerging micro-small-medium scale Industrial enterprises so that India can reduce their massive burden of imported healthcare technologies

and spread the technology availability in the last-mile. The CRTDH has already established a template pilot plant to promote indigenously developed healthcare technologies for rural healthcare- solving a major problem for the common people, fostering manufacturing growth, creating rural jobs, and introducing advanced technologies into the ambit of public health.

Online training to the MSMEs

LFA manufacturing plant

As a demonstrative example, the CRTDH has established a unique manufacturing facility for fabricating diagnostic paper strips that may offer rapid, inexpensive, generic one-step detection platforms for community-level testing of disease burdens from body fluid samples at point-of-care. Because of manufacturing monopoly of these strips as enjoyed by overseas companies and their lack of customizability, there has been a compelling constraint of introducing these strips extensively in the Indian market as routine diagnostic test platforms. In response to this challenge, the researchers of CRTDH have established a generic, customizable technology for the manufacturing of diagnostic paper-strips. They have further established a simple recipe for seamlessly interfacing and interconnecting four different grades of porous materials to constitute lateral flow strips, namely, nitrocellulose (NC) membrane test pad, glass fiber conjugate pad, NC wicking and sample introducing pad. Uniqueness of the fabrication protocol is an elegant customization of the strip for high accuracy of detection for each specific target analyte in an exclusive way, rather than aiming for generic ones that are readily available off-the-shelf, mostly imported, albeit with compromised efficacy of detection. The CRTDH lab has also delved into the fabrication of rapid antigen test strips by immobilizing specific antibody to the test line and secondary antibody to the control line. The nanoparticle characteristics and functionalization as well as immobilization on the paper strip are being optimized to enhance the sensitivity and specificity of the test.

Bio-safety Room

As a flagship initiative of the CRTDH, a batch manufacturing unit for fabrication of paper strips as per

Pilot plant for paper-based manufacturing unit

custom-made design has been established – a paradigm that is currently non-existent in the Indian context. The outcome will not only disrupt the prohibiting supply-chain structure but also create indigenous manufacturing opportunities to a massive scale. This will subsequently evolve to a first-of-its kind generic batch manufacturing and scalable indigenous lateral flow strip developing unit for detecting pathogenic infections - an initiative bridging the gap between fundamental research and technology development for commercialization and social-need. All these activities are being attempted with a vision of a technologically-supreme make-in-India- initiative for indigenizing high-end paper-test-kit manufacturing technology in the backdrop of a scenario that most of the high-performance test-strips being currently deployed are primarily imported in nature.

Women empowerment and contribution to rural livelihood

Face-mask designing

The CRTDH & its implementation partner, FIH, has pioneered clusters of technology-enabled e-health clinics in remote villages where even primary healthcare centers do not function. This has fostered a silent socio-economic revolution where certified community health-workers deliver healthcare-support to last-mile populations. Large numbers of rural women have been trained to work as an interface between the patient, 'remote' doctor and the invented frugal diagnostic-technologies, enabling the establishment of their self-esteem and sustainable livelihood in the process. Empowered by a 'primary-care software', this has led to all-in-one real-time data-driven clinical decision support system allowing for screening and risk-assessment of patients vetted by remote doctors to ensure high-quality evidence-based tailor-made advice. These centres make genuine medicines available to the rural population (where spurious medicines are sold in an unchecked manner), deliver basic physiotherapy services, undertake school & community-based health education and awareness activities; including manufacturing of simple health products such as Sanitizer, Face mask, Oral Rehydration Salts, Sanitary Napkins etc.

Manufacturing of hand sanitizers

As a part of this flagship initiative, "E-health West Midnapore Sabang Cluster A", a partnership firm formed by 20 (including females and males in comparable proportions) rural youth at the village of Balpai, Sabang, East Midnapore, has evolved recently. They were earlier trained formally at "School for Skills: Allied Health Sciences" and certified after assessment as "Frontline Health Worker" by National Skill Development Corporation (NSDC) supported by the Government of India. At Balpai, they have set up a cluster of E-health Clinics consisting of one (1) fixed centre and four (4) cycle-borne mobile units.

The health Launch at Sundarban

Subsequent to the success of this program, there are now five (5) more such 'clusters' functional at Ghatal, Rajnagar, Nanoor, Joynagar and Sunderban; covering 3 districts of West Bengal. Shortly, two (2) more clusters will become operational at Jhargram and 24-Parganas (N). Plans are in place for further expansion beyond state boundaries into Assam.

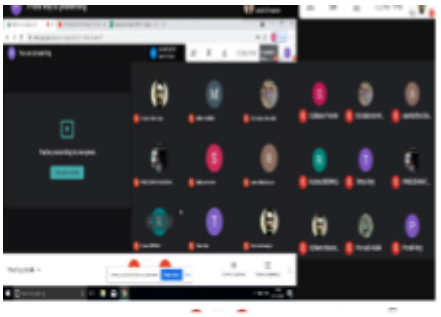
Under the ambit of CRTDH, numbers of economically and socially-challenged rural entrepreneurs have also been trained with the knowhow of manufacturing of frugal-medical devices and kits developed by the research team. This umbrella manufacturing cum electronic assembly hub is currently engaged in imparting free-of-cost on-job training with stipend provided to promote technology-empowered entrepreneurship of persons below poverty-level. This has uplifted their prospective standards of living and enabled them to envision generating earnings towards a self-sustainable livelihood. This has just been the beginning, and a massive scale-up of this manufacturing ecosystem via MSME engagement, including the technology licensees, is being planned via a systematic approach.

Socio-economic implications and self-sustenance

Technology training to CHWs

The various initiatives under CRTDH have thus promised to create variety of new jobs and self-employment opportunities locally, thereby reducing the need for mass migration of population to centralized hotspots for machinery manufacturing, consumables and pharmaceutics, software, information systems and analytics etc. Reduction in job associated migrant population would also allow for local and regional developments when people tend to stay longer in their place of bringing up, arresting the need for mitigating migrant population movement during times of crisis. Further, this will generate local small scale enterprises, strengthening a distributed local ecosystem of micro, small and medium enterprises for serving healthcare needs, thereby strengthening self-reliant local economic growth. This will further stimulate localized economy of small scale jobs across spectrum of skills, fostering locally sustained economy, minimizing the variance in spectrum of regional per capita income across the country.

Production of face-mask



Training of MSMEs at CRTDH Facility

The CRTDH-supported e-Health centers are all planned to migrate eventually to a self-sustaining mode at the end of the Project tenure. The various revenue sources earned from the operation of the Rural Technology Cluster including E-consultation fee, diagnostic tests, sale of generic medicines, physiotherapy,

sale of hand sanitizer and masks made by the health workers etc. are being pulled up in the form of a collective resource to meet up the operational and maintenance expenses and also provide a reasonable margin for monthly emoluments to be provided to the human resources associated. This will enable meeting up regular expenditures include salaries of the health workers and manufacturing/ assembling technicians, establishment and maintenance expense of the brick-and-mortar centers, consumables, internet and telephone, travel and related to various promotion and community awareness activities. In addition, each frontline health worker will be offered with some percentage of the profit margin of point-of-care diagnostic tests administered by them. On a stand-alone basis, it has been estimated that each center will achieve financial self-sustainability at about 10 patients/ day, which is not a high number. But when one considers other expenses such as doctors' salary and monitoring-supervision costs, the break-even is achieved at around 20 patients/day, which will demand more extensive outreach including value added quality services provided to the underserved community with not much compromise as compared to the quality standards offered by high end clinics.

Household survey for women and children health

Environmental Impact

Activities of the CRTDH also envision reduction in NOx and Carbon emission associated with long distance transportation of boxed products and turnkey solutions, reduction in medical waste, where only the expired sub-component of a product can be systematically discarded or re-conditioned for re-use locally or by manufacturing without dumping of full packaged products including non-biodegradable packaging units which do not have expiry, reduction in waste generation associated with packaging material associated with unit product packaging, etc.

Alignment with National Missions

Skill India, Make in India, National Health Policy, Digital India are the several National missions with which the CRTDH activities are extremely well aligned.

Overall learnings and way forward

The learning, so far, from the CRTDH initiative has been an eye opener. The work elements undertaken have provided the confidence that it is possible to train local youth having limited formal education as Health Assistants to operate primary E-Health clinics including the most advanced diagnostic procedures in a user-friendly format. Trained healthcare workers have been found to easily adopt innovative technologies as long they are simple to use. Frugal technologies have ushered promises to operate at harsh weather conditions and unfavorable supply chain with results comparable with 'gold standard' devices, albeit at a lower cost. A simple clinical decision-support system has been proven to enable a remote doctor to provide safe and evidence-based patient care to facilitate timely clinical decision making as a life-saving measure at occasions. Patients have accepted the service and are willing to pay if they perceive 'value' in it. Further, the approach has promoted culturally congruent and ethnographically acceptable, all-rounded health solutions from the individual to the community.

The ongoing pandemic has exposed the challenges due to scarcity of technology-enabled healthcare solutions that are accurate yet low cost, accessible, user-friendly and amenable to massive manufacturing scale-up and parallelization. The availability of easy-to-use and reasonably sensitive detection methods for community level testing, in such backdrop, for example, holds the potential of capturing the commonly missed cases of early infection and asymptomatic disease presentation and reduce the opportunity for community-level transmission. Such compelling needs, along with other prevailing public health challenges, have paved a clear way forward of the technology wing of the CRTDH towards advancing further on novel diagnostic technologies that essentially offer an amalgamated approach with a trade-off between the scientific standards of high-end laboratory based tests with the elegance of common rapid tests. This paradigm appears to be the future of diagnostics, targeting specific public health measures towards catering the underserved, with no distinction between consumers having expected variabilities in economic barrier, and in the process 'democratize' disease diagnostics by bringing high-end lab tests to the ambit of the bottom of the community pyramid in the green field with no differential treatment of the rich and the poor. Further, by engaging women power as frontline health workers in a sustainable ecosystem and bringing them in the ambit of rural employment generation, the CRTDH has shown a specific approach of establishing gender equality in the underserved community by promoting healthy and economically-supportive livelihood for all. In addition, the empowerments of micro-small-and medium scale enterprises towards participating in manufacturing the most technologically advanced yet deceptively simple medical products have opened up a new paradigm of employment generation under difficult circumstances.

Glamorous scientific innovations have always been hallmarks of highly-resourced labs all around the globe. However, those innovations are invariably challenged by complex methods of manufacturing, expensive raw materials, poor performance outside controlled lab-environment and unfavourable-sensitivity to uncontrolled dust, dirt, humidity. Disrupting this paradigm, the innovations advanced by the CRTDH have touched their reach to the last-mile of the underserved-population, with unprecedented fusion between deep science and compelling responsiveness for public-health, with a dream of nullifying any differential access to quality primary healthcare of the haves' and the have-nots'.

CHWs showing e-health app on their tablet

The CRTDH will democratize healthcare through equitable access, affordability for everyone, evidence-based quality standard and micro-entrepreneurship for sustainability.