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Feasibility of using a teleconsultation facility (Micro-Health Centre -MHC) in management of CRDs in remote rural area

THE UNIVERSITY *of* EDINBURGH

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Submitted for the degree of Doctor of Philosophy

University of Edinburgh

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Declaration

I declare that this thesis presented for the degree of Doctor of Philosophy of Global Health has

i. Been composed entirely by myself

ii. Been solely the result of my work

iii. Not been submitted for any other degree or professional qualification

iv. Some results of studies contained within this thesis have previously been presented in publication and abstract format as listed

Rutuja Patil

Executive Summary

Background

Chronic respiratory disease (CRD) is a major public health problem in India with high prevalence and mortality. However, remote rural places have often experienced inequity in access to health care facilities and services. Even where places are equipped with facilities, the availability of trained healthcare providers, particularly respiratory specialists, is challenging. These specialists tend to be concentrated in cities many hours travel from rural patients. Recent technological advances have enabled doctors to deploy telemedicine in remote locations, potentially allowing specialists to support local generalist clinicians. However, multiple barriers still exist to implementing and scaling such technology. It is unclear what services could be delivered and what equipment and clinical and support staff would be required. Nor is it known what the attitudes of specialists, generalist clinicians and patients would be to providing such a service. My study aimed to assess the feasibility of using an established teleconsultation facility (Micro-Health Centre) to provide remote specialist respiratory-physician support to rural primary-physician in CRD diagnosis and management in a resource-constrained rural area.

I sought the views and experiences of national and local opinion leaders in telehealth and service delivery in India and the perceptions of local specialist and generalist clinicians on using technology for specialist to non-specialist advice to strengthen existing underutilised teleconsultation services. I then explored how they felt the system and services worked and how they thought it could be further improved.

Research question

What are the barriers and facilitators to providing remote, specialist respiratory-physician support to rural primary-physician for CRD diagnosis and management?

Primary objective

To assess the feasibility of using an established teleconsultation facility (Micro-Health Centre) to provide remote specialist respiratory-physician support to rural primary-physician in CRD diagnosis and management in a resource-constrained rural area.

Secondary objectives

- To explore the evidence for the effective use of specialist to non-specialist teleconsultation in the management of CRDs in adults in remote areas
- To determine the requirements, including equipment and skills to support local primary physicians in remote CRD diagnosis and management
- To explore barriers to and facilitators of successful implementation of specialist to non-specialist teleconsultation at Micro Health Centre (MHC) in CRD diagnosis and management from the viewpoints of patients, opinion leaders, primary and respiratory physicians.
- Following the use of the teleconsultation service to understand the perception of the patients and health care providers of remotely supported consultations
- To facilitate the strengthening of the existing teleconsultation facility for CRD diagnosis and management

Methods

I used three main methods; a systematic review of the available literature; one-to-one interviews and focus groups with stakeholders to explore the barriers and facilitators to telehealthcare and what was required to run a successful telehealthcare service that could support local clinicians. I helped design an improved service and negotiated government support and local support based on this. A further series of qualitative interviews and structured questionnaires were conducted to determine the views of Primary Physicians (PP) and patients after they had experienced the system.

Systematic Review

I systematically searched for articles in Embase, Medline, PubMed and CAB Global health till November 2020, which focused on specialist to non-specialist teleconsultations for CRD diagnosis or management. With a colleague, I assessed the quality of relevant papers using the Joanna Briggs Institute's (JBI) tool. I used a descriptive and narrative approach to analyse these due to the heterogeneous nature of the selected studies.

Qualitative Study

I interviewed eight opinion leaders who included people already in telehealthcare, experts, researchers and policymakers working in teleconsultation in India. I interviewed healthcare providers, including six Respiratory Physicians (RP), ten Primary Physicians (PP), and 30 patients attending the teleconsultation clinics for respiratory ailments. The data from patients were collected at two time points, pre and post-teleconsultation. I also interviewed the PP coordinating the teleconsultation post their experience using telehealthcare services to consult specialists for patient treatment. Analysis was inductive and iterative.

Strengthening of the existing facility

The KEMHRC Pune runs a Micro Health Centre (MHC) that provides primary health care to the population. However, it was an underutilised centre that ran only face-to-face outpatient consultations by local PP despite the availability of teleconsultation. I aimed to improve the facility based on the literature and the views of stakeholders.

Results

In my systematic review, I found 1715 articles that met the initial search criteria, but after excluding duplicates and non-eligible articles, I included ten research articles of moderate quality. All but one of which were conducted in high-income countries. The teleconsulting systems used in the included papers primarily used audio or video modes. The included studies reported primarily non-clinical outcomes, including effectiveness of using the system, feasibility, acceptability, and usability of the teleconsultation systems and only three described the clinical outcomes. The teleconsultation was predominantly conducted in the PP's office, with the specialist located remotely. The review concludes that, despite the literature being limited and not generalisable, specialist to non-specialist teleconsultation for diagnosis and management of CRDs should be encouraged, particularly where face-to-face consultations are challenging or unavailable.

The results of my qualitative study informed the requirements for the set-up and implementation of a telehealthcare system for CRD diagnosis and management in remote areas. Further, I identified the barriers and facilitators in the diagnosis and management

of CRD using telehealthcare. I also documented the stakeholder perspective in using telehealthcare solutions for CRD diagnosis and management. According to the respondents, to be successful, a telehealthcare system must be appropriately located, ideally driven by interested leadership and particularly an inspired coordinator to run the centre with dedicated and motivated human resources and finance. Further, local stakeholder engagement and advertisement was considered essential. The training was observed as one of the most important requirements in the set-up and implementation of telehealthcare. The RPs further thought that primary physicians needed additional training in the diagnosis and management of CRDs, although the RPs did not consider they needed training for teleconsultation. However, not all respondents thought training would be acceptable by both primary physicians and specialists. A similar array of clinical skills and equipment required for a traditional face-to-face consultation was considered necessary for teleconsultation, including patient history, clinical examination and auscultation by a trained physician, and spirometry. Some participants also expressed the need for X-rays, electrocardiograms (ECG), and a facility for blood diagnostics. The participants said that the challenges of telediagnosis are ameliorated not only by training and adequate equipment but also by good record keeping and the ability to share electronic records with a specialist.

These findings iteratively informed the strengthening of the existing telehealthcare system. I arranged numerous institutional and regulatory approvals, and I arranged for the functioning of the teleconsultation service by appointing a bi-weekly visit by a primary physician and a technician. The primary physicians were further trained by the respiratory specialists at the tertiary care hospital (KEM Hospital) as the qualitative data informed the training needs for the PPs. Additionally, appropriate diagnostic tools were made available, and the telehealthcare system and software were updated as per the requirements suggested by the doctors and also because the then-existing system was due for maintenance and required repairs which the original service provider was unable to provide. Based on a comparative analysis of existing options I identified a start-up named A3RMT (Anytime Anywhere Access Remote Monitoring Technologies) (https://www.a3rmt.com/), incubated in the Indian Institute of Technology Bombay, which provides technology solutions for telehealthcare to undertake the upgrade. The A3RMT systems have facilities to capture clinical information and transmit this

information to doctors using internet connectivity. The installation funding was raised through donations. I also engaged the community by conducting face-to-face meetings with the community leaders and further advertised the facilities available at the centre. This process resulted in a higher patient load and a larger number of teleconsultations. This service was provided free to patients and based on goodwill from clinicians, and scaling would require payment arrangements to be negotiated for primary and secondary care, as would the proportion paid by patients.

In conclusion, my PhD has addressed the aim of the study and has generated data to understand the process of setting up and implementing a telehealthcare centre, especially for the diagnosis and management of CRD. The results will help create guidelines for establishing and managing a telehealthcare centre. The COVID pandemic has changed the scenario of the use of telehealthcare globally. The WHO strategy on digital health published in 2020 lays down general and specific principles to implement digital health globally. Telehealthcare will now be widely implemented in low-resource settings given the increase in infrastructure for digital health and the availability of updated technology. Given this background, my study has provided some practical implications for implementing telehealthcare centres for specialists to non-specialists teleconsultations in low-resource settings. These practical implications can be incorporated in the specific guidelines for functioning.

Lay Summary

Background

Chronic respiratory disease (CRD) is a serious public health issue globally and in India due to the large number of people who become ill and die as a result of it. The rural areas often do not have access to health care services. One of the reasons is the non-availability of trained doctors specialising in treating respiratory illnesses as they are usually located in cities far from rural villages. The advances in technology have enabled telemedicine use where a respiratory specialist from the city could help a general physician from the village remotely diagnose and manage CRDs.

However, implementing this technology has some challenges. There is a lack of understanding of the requirement, including equipment, staff, and other resources to implement this service. Furthermore, it is important to understand the users' opinions towards using this system, including respiratory specialists, general practitioners, and patients.

This study aims to assess if it is feasible to conduct specialist to non-specialist teleconsultation using an established (tele consultation) facility (known as a Micro-Health Centre) to diagnose and manage CRD. In my study, I ask, "What are the barriers and facilitators to providing remote, specialist respiratory-physician support to rural primary-physician for CRD diagnosis and management?"

Aims and Objectives

The purpose of my study is "to assess if it is feasible to use an established teleconsultation facility (Micro-Health Centre) to provide remote specialist respiratory-physician support to rural primary-physician in CRD diagnosis and management in a rural area."
To achieve this larger purpose, I planned to achieve the below secondary objectives-

- To explore existing knowledge in the subject using the published literature addressing use of specialist to non-specialist teleconsultation in the management of CRDs

- To identify the requirements, including human resources, equipment and skills to support local primary physicians in remote CRD diagnosis and management
- To explore the challenges and facilitators for implementing the service
- Once implemented and used, understand the patients' opinion on this system based on their experience
- To facilitate the strengthening of the existing teleconsultation facility for CRD diagnosis and management

Methods

I used three methods for this study to achieve the above mentioned purpose and objectives. I systematically searched for articles published until November 2020 in the online databases named Embase, Medline, PubMed and CAB Global health; and further arranged and presented the information in the systematic literature review chapter. I interacted with a range of stakeholders, including experts in the field who have worked in teleconsultation in India and doctors who intended to or were probable providers of the teleconsultation services at the MHC, specialists and general practitioners. Both the above exercises were further used to strengthen the MHC to conduct teleconsultation between the primary physician and the respiratory physician for diagnosis and management of chronic respiratory diseases. Once the centre was strengthened and functional, I interacted with the patients treated using teleconsultation for CRD to understand their perception about using the service before and after the teleconsultation was done. All the collected information was arranged using software and structured to give the data meaning.

Results

In the literature review, I found 1715 relevant articles, of which I systematically presented ten articles in the published paper and referred the remaining to increase my understanding of the subject. In general, the previous authors reported audio or video modes for teleconsultation, which reported non-clinical outcomes like effectiveness, feasibility, acceptability, and usability of the teleconsultation systems. The teleconsultation was predominantly conducted in the Primary Physician's office, with the specialist located remotely. This review concludes that, despite the literature being limited and not generalisable, specialist to non-specialist teleconsultation for diagnosis

and management of CRDs should be encouraged, particularly where face-to-face consultations are challenging or unavailable.

Further, when I analysed the information collected from the stakeholder, including the opinion leaders and the doctors, I listed the requirements for the set-up and implementation of a telehealthcare service, documented their perceived challenges and enablers for teleconsultation and understood their perceptions about the use of the system. According to the respondents, a telehealthcare centre must be appropriately located, ideally driven by interested leadership. It requires an inspired coordinator to run the centre with dedicated and motivated human resources and finance. Teleconsultation required similar clinical skills and equipment for a traditional face-to-face, including patient history, clinical examination and auscultation by a trained physician, and spirometry. Some participants also expressed the need for X-rays, ECG, and a facility for blood diagnostics. The participants said that what makes telediagnosis different from the face-to-face CRD diagnosis is documentation and records of all the items mentioned above and the facility of remote sharing these records with specialists without the patients needing to travel and providing access to healthcare to patients in remote rural area.

Further, local stakeholder engagement and advertisement and staff training were observed as one of the most essential requirements in the set-up and implementation of telehealthcare. Specialist clinicians' further thought that primary physicians needed additional training in the diagnosis and management of CRDs, although the RPs did not consider they needed training for teleconsultation. However, not all respondents thought such training would be acceptable by primary physicians and specialists.

The above findings were used to improve the existing teleconsultation centre continually. I secured various institutional and regulatory permissions and arranged a bi-weekly visit by a primary physician and a technician to operate the teleconsultation centre. The findings guided the training of the general practitioners by doctors specialised in respiratory illnesses. Additionally, diagnostic tools were made available, and the teleconsultation system and software were upgraded using a system developed by a startup named A3RMT (https://www.a3rmt.com/), which was established with support

from the Indian Institute of Technology Bombay (IIT-B) and provides telehealthcare solutions commercially. Donations were used to pay for the installation. I also reached out to the community by holding face-to-face meetings with neighbourhood leaders and advertising the centre's services. As a result of this process, the patients could access teleconsultation in rural areas. The patients were happy to use the service and found it generally reliable for accessing healthcare.

In conclusion, the use of doctor to doctor teleconsultation for diagnosis and management of CRDs is feasible. My PhD achieved the research objectives and built data on understanding the process of setting up and implementing a teleconsultation centre for CRD diagnosis and management. The results will help create guidelines for establishing and managing a telehealthcare centre.

Thesis Structure

Chapter 1 introduces the thesis topic describing the existing problem and mentions the aims and objectives of the study. In the first section of this chapter, I lay down the information about the unbalanced distribution of healthcare personnel in rural and urban areas in Low- and Middle-Income Counties (LMICs), including India. I further mention the burden of CRDs in terms of prevalence and mortality and describe how the uneven distribution, especially pulmonologists, results in the lack of access to care for rural patients. This is followed by an explanation of how telehealthcare can fill this gap for CRD diagnosis and management. In this section, I later describe the teleconsultation process, its definition and its limitations. I further provide a rationale for specialists to non-specialists teleconsultation for CRD diagnosis and management. In the second section of this chapter, I outline the current burden of the CRDs in detail, especially in India and why I intend to work on specialists to non-specialist teleconsultation for CRDs. In this section, I hence provide a brief overview of the challenges in CRD diagnosis in the Indian context. I end this chapter by mentioning the aims and objectives of the thesis work.

Chapter 2 provides the contextual background for the thesis as I describe the Indian healthcare systems and the legalities and regulations around teleconsultations in India. I described the Indian health care system in the first section of this chapter for the readers to get an idea about the service delivery structure in both public and private settings, including medical education. As my thesis is based in India, most of my study findings are described in the Indian context. I felt that it is important for the readers to know about the Indian healthcare system such that the results could be better comprehended. Further, I have given a brief account of the legal aspects and regulations in India which might influence the teleconsultation process. This section provides the readers with a glimpse of the lawfulness and legitimacy of teleconsultation interventions in the Indian setting despite the contrasting media reports. I further describe the existing setup of teleconsultation, also known as Pabal MHC.

Chapter 3 primarily summarises the published systematic review. I have also inserted the published review in this chapter. I have tried to recapitulate the additional information around my thesis topic in subsequent sections. For me, the systematic review process was the most challenging yet best-learning experience when undertaking my thesis. This chapter addresses the first secondary objective, "To explore the evidence for the effective use of specialist to non-specialist teleconsultation in the management of CRDs in adults in remote areas."

Chapter 4 describes the overview of the methodologies with a focus on the theoretical overview and the methods I used to collect information to address the three secondary objectives

- "To determine the requirements, including equipment and skills to support local primary physicians in remote CRD diagnosis and management."
- "To explore barriers to and facilitators of successful implementation of specialist to non-specialist teleconsultation at MHC in CRD diagnosis and management from the viewpoints of patients, opinion leaders (OLs), primary and respiratory physicians."
- "Following the use of the teleconsultation service, to understand the perception of the patients and health care providers of remotely supported consultations**."**

This account of my work and reasoning of why I chose specific methods is supported by the philosophical background, Normalisation Process Theory (NPT), as underpinning theory and sampling. I further inform about the regulatory approvals, methods to identify the study participants, tools and methods used for the data collection. I have also described the data collection, management, transcription and translation process followed by the data analysis methods in this chapter and ended the chapter by stating my reflexivity.

Chapter 5 is a detailed account of the results I obtained and organised after analysing my qualitative data. First, I describe the participant characteristics and list the challenges I encountered when recruiting the participants. This chapter is further distributed in three major sections, including the requirement for strengthening a centre, the barriers and facilitators of the process, and stakeholders' perception towards the setting up and

implementation of the telehealthcare system for CRD diagnosis and management. Each of the above three sections are further distributed in multiple subsections. All this information is summarised in the frameworks which I have added in this chapter.

Chapter 6 describes the processes and actions I took to strengthen the existing teleconsultation system of the MHC. My thesis revolves around this MHC, where I tried to assess the feasibility of using specialists to non-specialist teleconsultation for CRD diagnosis and management. However, when I initiated my work, this centre was underutilised for its teleconsultation facilities, and a face to face clinic was functional at the place. Hence strengthening this centre was a crucial step in my thesis journey, which went on in parallel during the analysis of my qualitative data. This chapter presents an account of the many actions I undertook to strengthen the MHC, including obtaining administrative approvals, deploying and training human resources, managing the workflow, achieving stakeholder engagement, and identifying monetary resources. This chapter fulfils the goals of my last secondary objective, which is "To facilitate the strengthening of the existing teleconsultation facility for CRD diagnosis and management." In this chapter, I also explain the current status of the system and provide the results of the structured administered questionnaire conducted with the patient population to document their experiences pre and post-usage of teleconsultation services.

Chapter 7, which is the final chapter of my thesis, commences with the description of the strengths and limitations of my work. I further discuss the findings of the work done in light of the NPT and available published evidence. In this chapter, I also include the practical and global implications followed by some practical recommendations for setting up and implementing a teleconsultation centre for specialist to non-specialist teleconsultation and conclude the thesis with a brief conclusion.

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Contribution to Science

Peer-Reviewed publications

1. Patil R, Shrivastava R, Juvekar S, McKinstry B, Fairhurst K, RESPIRE,(2021) Specialist to non-specialist teleconsultations in chronic respiratory disease management: A systematic review', *Journal of global health*, 11(04019). doi: 10.7189/jogh.11.04019.
2. Patil, R. Agarwal, D, Kaur, H, et al (2021) 'Engaging with stakeholders for community-based health research in India: Lessons learnt, challenges and opportunities', Journal of Global Health, 11, p. 03072. doi: 10.7189/jogh.11.03072

Abstracts

1. Oral Presentation: RESPIRE ASM at Porto, Portugal on 31st May 2018. Feasibility of using teleconsultation in CRD management in remote area. Rutuja Patil.
2. Poster presentation: RESPIRE ASM at Kuala Lumpur Malaysia on 10-12 Seep 2019. Doctor to doctor telehealthcare interventions for managing chronic respiratory disorders. Rutuja Patil, Sanjay Juvekar, Brian McKinstry, Karen Fairhurst
3. Oral Presentation: 15th International Telemedicine Conference of Telemedicine Society Of India New Delhi India on 1st Dec 2019. Doctor to doctor telehealthcare consultations in Chronic Respiratory Disease management guided by experiences in other diseases: A systematic scoping review. Rutuja Patil, Sanjay Juvekar, Brian McKinstry, Karen Fairhurst

Other (Not directly related to thesis work)

1. **Patil R.** A joyful homecoming. Lancet Respir Med . 2018;6(12):904. Available from: http://dx.doi.org/10.1016/S2213-2600(18)30474-0
2. **Patil R**, Roy S, Ingole V, Bhattacharjee T, Chaudhary B, Lele P, et al. Profile: Vadu Health and Demographic Surveillance System Pune, India. Journal of global health. 2019;9(1):1–10. 10.7189/jogh.09.010202
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Abbreviations

ACCORD	Academic and Clinical Centre for Research and Development
AHP	Allied Health Professional
AI	Artificial Intelligence
ASM	Annual Scientific Meeting
AYUSH	Ayurveda, Yoga, Unani, Siddha and Homoeopathy
BAMS	Bachelor of Ayurveda Medical and Surgery
BHMS	Bachelor of Homeopathic Medicine and Surgery
CASP	Critical Appraisal Skills Programme
CDAC	Centre for Development of Advanced Computing
CHC	Community Health Centres
CHNRI	Child Health and Nutrition Research Initiative
CONSORT	Consolidated Standards of Reporting Trials
COPD	Chronic Obstructive Pulmonary Disease
COREQ	Consolidated Criteria for Reporting Qualitative Studies
COVID	Corona Virus Disease
CRD	Chronic Respiratory Diseases
CSIR	Council of Scientific and Industrial Research
CT	Computed Tomography
EC	Ethics Committee
ECG	Electrocardiogram
EMR	Electronic Medical Records
FGD	Focus Group Discussions
FRU	First Referral Units
GBP	Great Britain Pound
GDPR	General Data Protection Regulation
HP	Hewlett Packard
HRCT	High Resolution Computed Tomography
ICHGCP	International Conference on Harmonisation Tripartite Guideline for Good Clinical Practice
ICMR	Indian Council for Medical Research
IGIB	Institute of Genomics and Integrative Biology
IIT	Indian Institute of Technology
IMA	Indian Medical Association
INR	Indian Rupees
IPF	Idiopathic Pulmonary Fibrosis
ISRO	Indian Space Research Organisation
IT	Information Technology
JBI	Joanna Briggs Institute
KEMH	King Edward Memorial Hospital

KEMHRC	King Edward Memorial Hospital Research Centre
KII	Key Informant Interviews
LMIC	Low and Middle Income Country
MBBS	Bachelor of Medicine, Bachelor of Surgery
MCI	Medical Council of India
MD	Doctor of Medicine
MHC	Micro Health Centre
MoH&FW	Ministry of Health and Family Welfare
MRC	Medical Research Council
MRI	Magnetic Resonance Imaging
NASSS	Non-adoption, Abandonment, Scale-up, Spread, Sustainability
NDHB	National Digital Health Blueprint
NHM	National Health Mission
NICE	National Institute for Health and Care Excellence
NIHR	National Institute for Health Research
NMC	National Medical Commission
NPT	Normalisation Process Theory
OL	Opinion Leader
OPD	Out Patient Department
PHC	Primary Health Centres
PP	Primary Physician
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
RESPIRE	The NIHR Global Health Research Unit on Respiratory Health
RH	Rural Hospitals
RP	Respiratory Physician
SC	Sub Centres
SDG	Sustainable Development Goal
SES	Socio Economic Status
SMS	Short Messaging System
SPIDER	Sample, the Phenomenon of Interest, Design, Evaluation, Research type
SSH	Shirdi Sai Baba hospital
STROBE	Strengthening the Reporting of Observational studies in Epidemiology
TB	Tuberculosis
TSI	Telemedicine Society of India
UHC	Universal Health Coverage
UK	United Kingdom
US	United States
VRHP	Vadu Rural Health Program
WDTC	Women Development and Training Centre
WHO	World Health Organization

Glossary

Below is the list of some commonly used words throughout the thesis and the meaning as percivived by me when using these words throughout the thesis.

1. **Respiratory physicians (RP):** Respiratory physicians are those who are trained post-graduates in modern medicines and specialise in respiratory health. The term respiratory physicians include Pulmonologists, Chest physicians, specialists or respiratory specialist
2. **Primary Physicians (PP):** Primary Physicians are graduates and qualified and trained in either modern medicine (MBBS) or AYUSH (Bachelors in Ayurveda or Homeopathy). However, their knowledge and skills related to the diagnosis and management of CRDs vary. The term Primary Physician includes General practitioners, general physicians or primary care physicians
3. **Pharmacists:** Pharmacists are graduates or postgraduates trained in pharmacy and have the licence to run a pharmacy store and sell the medicines prescribed by a registered doctor.
4. **Specialist:** A specialist is a postgraduate trained in modern medicine in any speciality including but not limited to respiratory health. This generic term may also include gynaecologist, paediatrician etc. I have used this term when I intended to refer to any speciality and not just respiratory.
5. **Non-specialist:** Non-specialist is an inclusive term to describe graduate doctors, nurses, and technicians. However, in context of my thesis, I have used non-specialists to describe the Primary physicians who would receive the teleconsultation from the specialists.

Chapter 1. Introduction

1.1 Context and problem statement

The distribution of the health workforce across the globe is uneven and disproportionate, more evident in low and middle-income countries (LMICs) (World Health Organization, 2019)(World Health Organization, 2019). LMICs are the areas with the highest disease burden (World Health Organization, 2019)(World Health Organization, 2019). The World Health Organisation (WHO)- Global Health Observatory reports that over 40% of member countries of WHO, have less than one doctor per 1,000 population and these are all LMICs. The African population has access to only 3% of health workers and less than 1% of the world's financial resources to deal with more than 24% of the global burden of all diseases (World Health Organization, 2019)(World Health Organization, 2019). The unbalanced distribution of healthcare personnel by specialities adds to these disparities (Bangdiwala et al., 2011)(Bangdiwala et al., 2011). In India, 69% of the Indian population residing in rural areas are served by 22% of all healthcare providers compared with the 31% urban citizens who have access to 78% of trained healthcare professionals (Ministry of AYUSH Government of India, 2016; Rao, Shahrawat and Bhatnagar, 2016). Poor transport access and inadequate transport infrastructure in rural areas further aggravate the scarcity of the healthcare workforce, leaving a large proportion of the rural population without easy access to trained healthcare providers.

Chronic Respiratory Diseases (CRD), especially asthma and Chronic Obstructive Pulmonary Disease (COPD), are common public health problems. CRDs have high prevalence, disability and mortality rates worldwide (Ait-Khaled, Enarson and Bousquet, 2001; van Gemert *et al.*, 2011; Banda *et al.*, 2017; World Health Organization, 2017). Globally, asthma is the 14th most important disorder in terms of the disease burden (Global Asthma Network, 2014), and COPD is the third leading cause of death (Soriano *et al.*, 2020). Diagnosis of these CRDs is based on detailed patient history and clinical assessment, which is aided by specialised tests such as spirometry and peak expiratory flow readings. Interpreting the results of such tests, however, requires specialised training (Singh and Singh, 2017) and specialists are not always available in rural regions worldwide. A study conducted in the United States (US) reported that less than one-third of the rural population had access to a

pulmonologist within a 10-mile radius against nearly 98% of the urban American population (Croft et al., 2016).

In comparison, the situation in LMICs like India is worse. The Association of Chest Physicians of India lists 2423 (life members) respiratory physicians in a country of 1.3 billion people. More than 95% of these physicians are registered in large urban areas (*Indian Chest Society: List of Life members*, 2018). On the contrary, the American Thoracic Society comprises more than 19,000 registered members (nearly two-thirds are American), including physicians, researchers, advanced practise nurses and respiratory therapists (*American Thoracic Society: Membership*, 2020). The information on the numbers of respiratory physicians in this society is not publicly available however a study published in 2013 reported nearly 12400 pulmonologists spread across the United States of America for a population of 315 million (Croft et al., 2016).

The rural areas in LMICs, healthcare is primarily delivered by Primary Physicians (PP) or allied health staff, including Auxiliary Nurse Midwives (ANMs) nurses or pharmacists (World Health Organization, 2006). Lack of access to pulmonologists and other specialists involved in CRD diagnosis and management may be one of the factors contributing to delayed or misclassification of diagnosis and inappropriate disease management. The use of teleconsultation by specialists to remotely support PPs could improve the knowledge of these practitioners and promote accurate and timely diagnosis and management of CRD.

Advances in information technology can facilitate access to specialist services by overcoming the distance barrier and enabling specialists to provide remote consultations to patients and provide support to PPs and local health care providers (European Coordination Committee of the Radiological Electromedical and Healthcare IT Industry, 2011; Mathur *et al.*, 2017). Additionally, remote consultations have provided opportunities for continued access to healthcare and proved beneficial while maintaining social distancing during the global COVID pandemic (Smith *et al.*, 2020). Telehealthcare is thus one possible means of addressing the challenges related to uneven access to specialist health care in India and globally (WHO Global

Observatory for eHealth, 2016; Mathur *et al.*, 2017). Telehealthcare for CRDs has been used and presented by a number of studies focusing on self-care and doctor to patient consultations (Dasgupta and Deb, 2008; Hofstede *et al.*, 2014; Wodskou *et al.*, 2014; Rassouli *et al.*, 2016). However, reports of specialist to non-specialist remote consultation to obtain specialists' support for CRD diagnosis and management (Wallace, Wyatt and Taylor, 1998) (Liddy *et al.*, 2018) are rare.

Given the recent rise in the use of information technology for accessing healthcare, the Indian Medical Council has recently issued guidelines for the practice of telemedicine in India (Board of Governers In supersession of the Medical Council of India, 2020). The recent Indian guidelines for telehealth define telemedicine as "*The delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for the diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities.*" These guidelines have a separate yet overlapping definition for telehealth "*The delivery and facilitation of health and health-related services including medical care, provider and patient education, health information services, and self-care via telecommunications and digital communication technologies*" (Board of Governers In supersession of the Medical Council of India, 2020). For this study, I will use the more inclusive and holistic terms "telehealthcare" and "teleconsultations" as relevant.

However, there are limitations to the use of telehealthcare for the management of CRDs as it cannot entirely replace or match the efficiency of traditional face to face consultations or ultimately reduce the intensity or the episodes of distress (McLean *et al.*, 2011; Ure *et al.*, 2012; Fairbrother *et al.*, 2013; Kew and Cates, 2016; Arian *et al.*, 2018). Physical examination is an important element in CRD management which is completely missed in direct doctor to patient teleconsultation (McLean *et al.*, 2011; Ure *et al.*, 2012; Fairbrother *et al.*, 2013; Zhao *et al.*, 2015; Kew and Cates, 2016). Further, the patients in rural areas commonly lack the knowledge to use technology or have appropriate equipment for direct doctor to patient consultation. In addition, even if the technology is made available, the scarcity of specialists remains a challenge.

Nevertheless, telehealthcare might still prove beneficial for people who do not have easy and in-person access to healthcare to manage their respiratory disorders (Rassouli *et al.*, 2016). Technology can be used, for example, to provide healthcare access to rural populations for diagnosis and management of CRDs by leveraging the availability of PPs in rural areas remotely supported by specialist respiratory physicians (RP).

Telehealthcare provides opportunities to meet the rapidly growing needs of consumers (as patients) and healthcare practitioners (doctors, nurses, technicians, *etc*.). One potential benefit of providing telehealthcare services for long-term care is timelier access to specialised services that are not available within a facility close to where the patient resides, such as video conferencing (Wakefield *et al.*, 2004; Winters and Winters, 2007; Sorknaes *et al.*, 2013). Furthermore, video conferencing also allows a specialist provider the opportunity to offer their speciality services to multiple sites from a single location, enabling more access to these services, particularly to people who may have restricted mobility or poor access to transport such as the elderly and at times when the risk of contagion is a factor such as the current COVID pandemic (Wakefield *et al.*, 2004; Winters and Winters, 2007). In addition to video conferencing, remote specialist opinion can be obtained by exchanging investigational reports, including spirometry and X-rays, using email or standard messaging systems on teleconsultation devices. The audio and audio-video modes are more usually used in synchronous consultations, whereas the asynchronous consultations mostly rely on the text modes of teleconsultation (Board of Governers In supersession of the Medical Council of India, 2020).

My study is based on an existing telehealthcare centre, known as a Micro Health Centre (MHC), run by the King Edward Memorial Hospital Research Centre Pune (KEMHRC) in a remote village named Pabal. The MHC is a compact healthcare delivery and health research centre set up in cargo containers. A face-to-face digital clinic runs on the premises where the patient data is uploaded on a web portal. (More details of this centre are described in Chapter 2). The MHC is fully equipped for specialist to non-specialist teleconsultation, yet its capacities had remained underutilised until 2018 when I started my study.

Specialist to non-specialist consultation has the potential to help local clinicians in obtaining specialists' support for CRD diagnosis and management (Wallace, Wyatt and Taylor, 1998) (Liddy *et al.*, 2018). However, to my knowledge, no publication reports any study exploring its feasibility. My doctoral work evaluates the feasibility of using specialist to non-specialist telehealthcare in the management of CRDs in remote and rural areas in India. I used three approaches comprising a systematic review of existing evidence, strengthening of the existing underutilised facility and a qualitative study to assess the feasibility of using an established teleconsultation facility (Micro-Health Centre) to provide remote specialist respiratory-physician support to rural primary-physician in CRD diagnosis and management in a resource-constrained rural area.

The NIHR Global Health Research Unit in Respiratory Health (RESPIRE) is a global health research unit that focuses on undertaking applied respiratory health research in both communicable and non-communicable disorders in Bangladesh, India, Malaysia, and Pakistan (Sheikh *et al.*, 2018). RESPIRE conducted an internal process to identify research priorities based on the Child Health and Nutrition Research Initiative's (CHNRI) method. The feasibility of using telehealthcare for CRD management was rated in the first five priority questions. The rating was based on ten published criteria for assessing the research priorities (Rudan *et al.*, 2018).

1.2 Why Chronic Respiratory Diseases?

Globally, and historically CRDs, especially asthma and COPD, have high prevalence and mortality rates (Ait-Khaled, Enarson and Bousquet, 2001; van Gemert *et al.*, 2011; Banda *et al.*, 2017; World Health Organization, 2017). Chronic respiratory diseases accounted for 4.7 % of global DALYs (L Murray *et al.*, 2012). Asthma is the 14th most important disorder globally in terms of the extent and duration of disability (Global Asthma Network, 2014); WHO estimated 300 million people globally suffer from asthma (Bateman *et al.*, 2008), in 2019 asthma affected an estimated 262 million people globally (Safiri *et al.*, 2022) Another publication reports 5.8 deaths per 100,000 population and DALY rate of 273.6 due to asthma (Lozano *et al.*, 2012). Globally asthma represented approximately 1% of the total global disease burden, and its

prevalence has been increasing by approximately 50% every decade (Global Initiative for Chronic Obstructive Lung Disease, 2019). COPD is the third leading cause of death in the world (Lozano *et al.*, 2012) and ranks ninth in the global DALYs (L Murray *et al.*, 2012). Around 90% of all COPD deaths and 88% of all DALYs due to COPD occur in developing countries (Bateman *et al.*, 2008). Further most chronic respiratory disease-attributable deaths and DALYs according to the global disease burden study were due to COPD (Soriano *et al.*, 2020).

In India, CRDs were responsible for 10.9% of total deaths and amounted to 6.4% of total DALYs in 2016 (Salvi *et al.*, 2018). The prevalence of asthma in India varies from 5-10%. Around 70% of people living in India use biomass fuel for cooking and heating purposes, exposing a very large population to the risk of developing COPD (Bhome, 2012). Smoking is another major risk factor for COPD; India has an estimated 120 million smokers. Besides, high outdoor air pollution levels (from industry, fumes *etc*.) contribute to indoor air pollution, exposing a very large population at risk of developing COPD. COPD prevalence in India is about 5 to 7% (Salvi, Manap and Beasley, 2012). However, as per the recent report, COPD causes the largest proportion of deaths (32·5%) attributable to air pollution in India (Pandey *et al.*, 2021). A comparison of the Asthma and COPD burden is described in Table 1.

Chronic respiratory symptoms such as cough, phlegm, shortness of breath, chest tightness and wheeze are the important markers of CRD that contribute to significant hospitalisation, reduced lung function and poor health-related quality of life (Lainez *et al.*, 2009). A one-day time prevalence survey of 204,912 patients visiting PPs in India showed that out of the total symptoms reported, more than 50% were respiratory-related (Salvi *et al.*, 2015). However, only 5% of the population are diagnosed with any specific disease, such as Tuberculosis (TB), asthma, bronchitis or COPD (Banda *et al.*, 2017).

Chronic respiratory symptoms are thus common in the general population, but weak primary health care systems in resource-poor countries are often unable to diagnose the underlying disease conditions. Factors contributing to low diagnosis rates include limited access to, negative perceptions of (Jia et al., 2018), and lack of diagnostic

capability (Kaur, Aggarwal and Gogtay, 2016) in healthcare facilities so that in only a minority of cases, a diagnosis is established (Martins *et al.*, 2009). The burden is compounded by under or misdiagnosis and/or under-reporting at the primary health care level.

Table 1: Comparison of COPD and Asthma burden

COPD and Asthma burden		
Category	**COPD**	**Asthma**
Causes	Smoking and biomass pollution	An inflammatory reaction to allergens
Risk factors as reported	Residents of rural areas, Low Socio-Economic Status (SES), Male, >45 years of age, smoking, the duration of household exposure to tobacco smoke and cooking fuel used, poor education levels, low body mass index and dusty job for more than 10 years	Residents of rural areas, Low SES, Male, <45 years of age, Family history, smoking, the duration of household exposure to tobacco smoke and cooking fuel used
Progression type	Progressive	Reversible
Age group	Usually after 40 yrs	Any age group
International Classification of Disease-10 classification	J40 - 44	J44a - 46
Global Prevalence (per million)	274	339
Prevalence in LMICs (per million)	213	511
Prevalence in India (per million)	272	246

Estimated economic burden	> six billion dollars (2010–2011)	Information not available
Estimated economic burden (per patient)	$1300/year (direct and indirect)	$900/year (direct and indirect)

(Jindal, 2010) (Global Asthma Network, 2018) (McKay *et al.*, 2012) (Jindal *et al.*, 2012) (Adeloye *et al.*, 2022), (Institute of Health Metrics and Evaluation, 2019; Burney *et al.*, 2021)

Telehealthcare for CRDs has been widely suggested to be used for facilitating self-care, home-based care and patients' training. The use of telehealthcare may potentially help patients with diagnosis and management of CRDs where face-to-face consultations are not available (Pinnock and McKinstry, 2018). However, this requires access to technology, the ability to use it, and specialist doctors available remotely, which are difficult to find in rural India. One solution is to make use of technology to provide support by specialists RPs to PPs who are more numerous, employing their skills and, in the process, improving their training. Hence, good quality research to demonstrate the efficacy of the use of specialist to non-specialist consultation for managing CRDs is required. A strategy to build evidence to deploy telehealthcare to manage CRDs using specialist to non-specialist consultation will aid further research (McKinstry, Pinnock and Sheikh, 2009).

1.3 Aims and Objectives

1.3.1 Research question

What are the barriers and facilitators to providing remote, specialist respiratory-physician support to rural primary-physician for CRD diagnosis and management?

1.3.2 Primary objective

To assess the feasibility of using an established teleconsultation facility (Micro-Health Centre) to provide remote specialist respiratory-physician support to rural primary-physician in CRD diagnosis and management in a resource-constrained rural area.

1.3.3 Secondary objectives

1. To explore the evidence for the effective use of specialist to non-specialist teleconsultation in the management of CRDs in adults in remote areas

2. To determine the requirements, including equipment and skills to support local primary physicians in remote CRD diagnosis and management

3. To explore barriers to and facilitators of successful implementation of specialist to non-specialist teleconsultation at MHC in CRD diagnosis and management from the viewpoints of patients, opinion leaders (OLs), primary and respiratory physicians

4. Following the use of the teleconsultation service, to understand the perception of the patients and health care providers of remotely supported consultations

5. To facilitate the strengthening of the existing teleconsultation facility for CRD diagnosis and management

Chapter 2. Background

2.1 Indian healthcare system

The Indian health care system is a three-tier system. The first tier is based on primary care, which involves a mix of both public and private health care facilities (Chokshi *et al.*, 2016) and is similar to secondary and tertiary care. Both the public and private sectors are run by doctors trained in both modern medicine as well as in Ayurveda, Yoga, Unani, Siddha and Homoeopathy (AYUSH). The doctor-to-population ratio in India is 5.8 allopathic doctors and 1.3 AYUSH practitioners per 10000 population, which is less than one-third of the WHO-recommended ratio (Rao, Shahrawat and Bhatnagar, 2016). Moreover, the urban-rural distribution of the available trained healthcare providers is unbalanced. As mentioned in the introduction 69% of the Indian population residing in rural areas are served by only 22% of all health care providers. At the same time, 77% of the trained healthcare professionals are located in urban area (Rao, Shahrawat and Bhatnagar, 2016)(Ministry of AYUSH Government of India, 2016).

2.1.1 Medical Education

The National Medical Commission (NMC) governs medical education in India, aiming to *'improve access to quality and affordable medical education and ensure availability of adequate and high-quality medical professionals in all parts of the country'* (*National Medical Commission*, 2020). Further, the indigenous systems of medicines are governed by the AYUSH ministry, which focuses on education and research in AYUSH (Ministry of AYUSH Government of India, 2016).

Public-funded government colleges provide education for both the allopathy and traditional medical systems. Thus, these courses are offered at basic/nominal fees. However, a few private institutions also offer these courses at much higher educational fees. The admissions to these schools are based on the grades scored in the National Eligibility cum Entrance Test. The cut-off scores for the Bachelor of Medicine, Bachelor of Surgery (MBBS) degree is usually higher than for the dentistry and AYUSH degrees. The fee structure for these courses varies as per the course and there is a huge difference in the fees for public and private medical schools (Kulkarni, Pushpalatha and Bhat, 2019).

2.1.2 Healthcare delivery services

Healthcare delivery in India is managed by both the public and private sectors. The public sector, being hierarchical, delivers healthcare using a three-tier system (Bisht, Pitchforth and Murray, 2012). In the public health systems, primary healthcare is designed to provide basic diagnostic and treatment services such as simple medical care health education to the general population and achieve disease prevention, whereas secondary and tertiary-level healthcare is provided respectively through rural hospitals, sub-district hospitals and district hospitals. The private sector is unorganised yet is the backbone of Indian healthcare, accounting for approximately 75% of outpatient visits and 62% of inpatient expenditure in India (Jain *et al.*, 2015). The private allopathic providers are mainly located in urban areas due to financial viability and access to a larger population. Recently, private corporate hospitals have been set up in urban areas providing world-class medical services to the patients through their networks.

Public hospitals usually lack adequate human resources, equipment and consumables, including the drugs for treatment. In my anecdotal experience, they are not the first choice for the population to access treatment. The lower-income class access the public health sector, whereas the middle and more affluent classes, access the private sector. The private sector is primarily concentrated in the urban and peri-urban areas, where fee-paying patients mainly reside as they work on a fee-for-service basis, thus increasing the financial viability. In India, more than 80% of doctors practising modern medicine are engaged in private employment and around 85% of private expenditure in healthcare is paid out-of-pocket by the population (Raman and Björkman, 2000) (The World Bank, 2015). This indicates a higher level of dependency of the Indian population on the private sector for healthcare services which also underlines the fact that the public health systems, alone, are not geared up to address the needs of the country in terms of healthcare facilities.

Public Health System: Health is the responsibility of the state government in the Indian public health system. However, national policies are common and are implemented under the National Health Mission (NHM). The public healthcare system

consists of Sub-Centres (SC), Primary Health Centres (PHC), Community Health Centres (CHCs)/Rural Hospitals (RHs), and First Referral Units (FRU) (Chokshi *et al.*, 2016). These are described by the Indian Public Health Standard guidelines of the NHM (Ministry of Health and Family Welfare, 2019) as below.

1. A sub-centre (SC) is established in areas with a population of 5,000 (in the plains) or 3,000 people (hilly/ difficult to reach/ tribal areas), and it is the most peripheral and first point of contact between the primary healthcare system and the community. Each SC is staffed by at least one auxiliary nurse midwife (ANM)/ female health worker and one male health worker.

2. A primary health centre (PHC) is established in areas with a population of 30,000 (plains) or 20,000 people (hilly/difficult to reach/tribal areas) and is the first contact point between the village community and the medical officer. PHCs are envisaged to provide integrated curative and preventive healthcare. It is staffed by a medical officer supported by 14 paramedical and other staff.

3. A Community Health Centre (CHCs)/Rural Hospital is established and maintained by the State Government in areas with a population of 120,000 (plains) or 80,000 people (hilly/difficult to reach/tribal areas). It is staffed by four medical specialists, supported by 21 paramedical and other staff. It has 30 beds with an operating theatre, X-ray, labour room and laboratory facilities. It serves as a referral centre for PHCs within the block (a block is an administrative regional area) and provides obstetric care and specialist consultations. An existing facility (district hospital, sub-divisional hospital, CHC/RH) can be declared as a fully operational FRU only if it is equipped to provide round-the-clock services for emergency obstetric and newborn care, in addition to all emergencies that any hospital is required to provide.

Private Health System: The private health system in India consists of small clinics with or without inpatient facilities, hospitals and multi-speciality hospitals. These are accompanied by private sector providers practising modern medicine and AYUSH. Private healthcare is mainly clustered in urban areas, and through a self-organising

complex system that considers the ability to pay, serves both the poor and the wealthy population (Sharma *et al.*, 2016).

2.1.3 Rural Healthcare

In rural parts of India, where 60% of the Indian population live, the majority of respiratory healthcare is provided by Primary Physicians (PP), both from the public and private sector, as most of the RPs practise in urban areas (Barik and Thorat, 2015). These PPs are graduates and qualified and trained in either modern medicine (MBBS) or AYUSH (Bachelors in Ayurveda or Homeopathy). However, their knowledge and skills related to the diagnosis and management of CRDs vary. This is compounded by a lack of established guidelines for diagnosing and treating asthma/COPD. Therefore, while there is a demand for high-quality care for CRDs in rural areas, appropriate medical care may not always be available. The burden is further compounded by underdiagnosis or misdiagnosis and/or under-reporting at the primary healthcare level (Bousquet, Dahl and Khaltaev, 2006). In urban areas, there may be a lesser risk of misdiagnosis and under-reporting of CRDs as most respiratory specialists who practise in urban areas are well trained to diagnose CRDs.

2.1.4 Medical care for Chronic Diseases

Healthcare providers, both public and private, play an essential role in the diagnosis and management of CRDs (Kroll *et al.*, 2016). A patient with a chronic disease can choose to visit a specialist or a non-specialist. The choice of health care primarily depends on the affordability and access of the patient and/or caregiver. Cross practices between different medical systems exist; the AYUSH practitioners may sometimes prescribe modern medication and vice versa. However, these cross practices are not recorded systematically. Such practices make the healthcare system complex. These complexities in accessing healthcare services add to the complexities in the management of chronic diseases. Patients with chronic diseases who require continuous follow-up can change their doctor at any point in time, making the management of such chronic diseases challenging.

Indian healthcare providers, both public and private, may find it difficult to differentiate between asthma and COPD. More often, inadequately trained and less

experienced PPs diagnose, treat, and manage asthma/COPD interchangeably without distinguishing the difference. It is uncommon that asthma/COPD is treated only by private or only by public PPs; it is nearly always managed by both (Jindal, 2012). Due to the chronic nature of asthma and COPD, people tend to contact various healthcare providers for treatment (exploring treatment options available). This means that people access both private and public PPs. Private and public PPs have similar experience and training at an equivalent level in the diagnosis and management of the disease (Kaur, Aggarwal and Gogtay, 2016). Treatment compliance in CRDs is difficult, especially in COPD patients, given the ageing population who are dependent on the family members to access healthcare and affordability and limited availability of therapeutic options (Kaur, Aggarwal and Gogtay, 2016).

2.2 Regulations, legalities and governance of telehealthcare in India

As any upcoming field in the health sector, telehealthcare is an area that has come under legal and ethical scrutiny. Indian law has newly developed a legal and regulatory profile for telehealthcare practices in India (Department of Health & Family Welfare, 2018). Above all, the complexities in the implementation of telehealthcare in public and private and commercial fields have made it more challenging to structure the law & regulations around telehealthcare (Desai, 2017). Thus, currently, no single law governs the field of telehealthcare in India. However, recently, the board of governors in the supersession of the Medical Council of India drafted "Telemedicine Practice Guidelines" to enable registered medical practitioners to provide healthcare using telehealthcare in India (Board of Governers In supersession of the Medical Council of India, 2020). The guidelines were published in March 2020, anticipating the higher use of telehealthcare in light of the social distancing norms due to the COVID pandemic.

However, issues on this subject fall under various laws, including the Information Technology (IT) Act- 2000 (Ministry of Law Justice and Company Affairs, 2000) as well as the Medical Council of India (MCI) Act, 1956 ("MCI Act") (Indian Medical Council, 1956). Moreover, the Drugs and Cosmetic Act 1940 ("D&C Act") and the Drugs and Cosmetics Rules 1945 ("D&C Rule") (Ministry of Health and Family

Welfare (Department of Health), 1940) are also relevant when telehealthcare is used for prescribing medicines in India. In addition to the laws mentioned above, Article 21 of the Indian Constitution confers a fundamental right to privacy, giving patients the right to protect their health-related information.

The IT Act- 2000 does not directly concern healthcare services provided by the use of technology. However, the technology used for digital documentation and authentication for providing health care services falls under the purview of the IT act. Chapter-IV of this act includes all actions relating to attribution, acknowledgement and dispatch of electronic records which could be relevant to the storage and distribution or transmission of data generated using telehealthcare services. Other aspects, such as the use of digital signatures by medical practitioners prescribing medicines using the telehealthcare services, fall under the purview of Chapter-V, which pertains to the rules related to the security of electronic records and digital signatures (Ministry of Law Justice and Company Affairs, 2000).

The MCI Act deals with the registration, practice and conduct of the medical practitioner. The same rules of this act apply to the services provided by telehealthcare as those provided by a traditional medical practice in a face-to-face consultation. The rules of this act pertaining to the registration of doctors and standards of professional conduct of medical practitioners become relevant when practising medicine using telehealthcare services. Section 27 of the MCI Act permits interstate practice by a registered medical practitioner, thus allowing telehealthcare practitioners to practice in India without a geographical barrier (Indian Medical Council, 1956).

The D&C Act and rules regulate the manufacture, import and distribution of drugs in India. The D&C rules specify the types of drugs which can be sold only on presentation of a valid prescription signed by a registered medical practitioner. The D&C act requires a license for all drugs which are manufactured, imported and distributed in India (Ministry of Health and Family Welfare (Department of Health), 1940). This implies that for a prescription to be valid, the drugs prescribed should be licensed, and a registered medical practitioner should sign the prescription.

The Telemedicine Practice Guidelines published in March 2020, clarifies India's position on the legality of teleconsultation. These guidelines clarify that the consultation through telemedicine by the Registered Medical Practitioner under the Indian Medical Council Act, 1956 shall be permissible under the Telemedicine Practice Guidelines contained in Appendix 5 (of Code of Conduct). This reduced ambiguity in the legal status of teleconsultation and made it legal.

In contrast, however, in August 2018, the Mumbai High court charged a Mumbai based gynaecologist couple under the Indian Penal Code 304 (culpable homicide not amounting to murder) for prescribing medicine to a patient over the telephone. The case was filed after the patient, who was prescribed medicines over the telephone, died. The court noted, *"prescription without diagnosis would amount to culpable negligence. This amounts to gross negligence from the point of the standard of care and recklessness and negligence, which is a tricky road to travel."* The Honorable Supreme Court of India later granted the couple bail. This case indicates the misuse of telehealthcare, thus not amounting to any ban on telehealthcare in India per se. However, the Indian Medical Association (IMA) raised some concerns over this case, highlighted the then unavailability of guidelines or specific law for telehealthcare and urged the Medical Council of India to provide clear guidelines for telehealthcare use in India (Medical Dialogue, 2018). In the meantime, the IMA has celebrated 24th March 2018 as telemedicine day to create awareness and help increase the use of telemedicine (Telemedicine Society of India, 2018) in association with the Telemedicine Society of India (TSI) and Indian Space Research Institute (ISRO).

Despite the prevailing complexities of a number of non-interacting laws that could govern India's telehealthcare practices, the Ministry of Health and Family Welfare (MoH&FW), Government of India promotes e-health or digital health. The MoH&FW wants to ensure the availability of health services on a wider scale and encourages the use of telehealthcare to provide healthcare services in inaccessible and remote areas (Department of Health & Family Welfare, 2018). To this end, the MoH&FW has published a National Digital Health Blueprint (NDHB) report, which details institutional mechanisms and action plans in implementing digital health in India. The NDHB has a huge potential to support Universal Health Coverage (UHC) by making

healthcare available as one of the mandates of National Health Policy 2017 (Ministry of Health & Family Welfare and Government of India, 2019). An e-Governance initiative of the government of India comprises various services and programs, telehealthcare being one of the six domains. MoH&FW has created a "National Telemedicine Portal" for e-healthcare delivery through national and regional resource centres. The national resource centre is located in the Sanjay Gandhi Post Graduate Institute of Medical Science, Lucknow and seven regional resource centres covering all territories of India, including the KEMH Mumbai. This portal is supported by India's premier IT research institutes, namely the Indian Institute of Technology (IIT) Kharagpur and the Centre for Development of Advanced Computing (CDAC) in creating various eHealth and mobile health electronic platforms (Mishra, Singh and Chand, 2011; Telemedicine Division and Ministry of Health and Family Welfare (Department of Health), 2017). These portals deliver teleconsultation between facilities and healthcare providers where practitioners from the district hospitals consult the specialists from the above-mentioned resource centres. Additionally, eSanjeevani, an initiative by the MoH&FW, offers online outpatient services. It is a home-based video consultation service for patients with a simple online registration developed by CDAC (Ministry of Health and Family Welfare GoI, 2020).

The government of India has been actively promoting telehealthcare, as highlighted by various examples. In early December 2018, a famous cardiologist in India performed the world's first-in-human telerobotic coronary intervention (Times news network, 2018) in Gujarat, applauded by the state government and witnessed by the Chief Minister of Gujarat. This procedure was more expensive than the traditional one by nearly INR 50000 (~GBP 500) but demonstrated the capacity to save time in critical life-threatening emergencies. Moreover, this incident demonstrated the acceptability of telehealthcare in India at high government levels.

The ISRO and TSI are two leading organisations in telemedicine in India that have worked closely with the government health facilities to spread and expand telehealthcare in India. Since 2001 the ISRO has been working on a telemedicine project with the objective to make healthcare available to the un-served, and the under-served population using a Satellite Communication (SATCOM) based telemedicine

program (A. Bhaskaranarayana, L.S. Satyamurthy, Murthy L.N. Remilla, 2009). The focus of ISRO has been to provide technology and connectivity for healthcare delivery using three main domains namely; connecting rural/remote healthcare units with the super-speciality hospitals for teleconsultation and treatments, continuous medical education (CME) through medical colleges and premiere medical institutes, and mobile telemedicine units for community health disaster management support for health care delivery during the disaster (Bhaskaranarayana, Satyamurthy and Remilla, 2009).

The eSanjeevani and national telemedicine portals are the functional telehealthcare services used by the government of India. Additionally, numerous private players, including the Apollo hospital and Hewlett Packard Foundation (Agrawal *et al.*, 2013), supplement the telemedicine revolution in India for commercial as well as community benefit purposes (Mishra, Singh and Chand, 2011; Mathur *et al.*, 2017). Although a range of organisations and people have been working in this field, none of these efforts has led to making telehealthcare a national priority. In addition to the known barriers of financial constraints, poor infrastructure, trained personnel, legal & ethical aspects and technology dependencies (Patnaik and Patnaik, 2015), corruption and unpredictable change in policies and regulations (Akhlaq *et al.*, 2016) are major hindrances in the implementation of telehealthcare practices in LMICs like India. The WHO recommends governments of member states to form national eHealth policies, including guidelines on data security, legal and ethical issues and governance (World Health Organization, 2010)

Internationally, in the framework of European Law, telehealthcare is governed by regulations for health services as well as information services. However, there are differences between individual countries which require harmonisation between countries. (Raposo, 2016). Commentators in South Africa have observed that telehealthcare has specific ethical and legal challenges in devising guidelines and these need to reflect in parts, particularly given the differences in resources between the developed and developing countries (Jack and Mars, 2008).

Kumar and Ahmad suggest that India needs to make political commitments in addition to the national strategies and legal guidelines for the standardised adoption of telehealthcare. Telehealthcare can change healthcare-seeking approaches in the public and the private sector due to the availability of healthcare options. With directed government efforts to set up standards and define the IT infrastructure for telehealthcare, the telehealthcare industry and services can be made ready to deliver public health solutions (Kumar and Ahmad, 2015).

The implementation of telehealthcare must occur in an evaluative framework so that any new learning can be fed back into the system and incorporated rapidly. This must involve all stakeholders, including patients, industry, government and private sector agents. It is also important to learn from the experience of other contributors nationally and internationally (Mishra, Singh and Chand, 2011; Akhlaq *et al.*, 2016; Mathur *et al.*, 2017).

2.3 The preliminary and existing set-up of the Micro Health centre

My study is based on an existing telehealthcare service, the MHC. It is run by the King Edward Memorial Hospital Research Centre Pune (KEMHRC) in a remote village named Pabal. KEMHRC is a sister organisation of the King Edward Memorial Hospital Pune (KEMH). KEMH is a tertiary care multi-speciality hospital with 550 beds and was established in 1912 and the largest private hospital in the Pune district. The KEMH has 17 speciality departments that provide healthcare services to patients and conduct research activities under the auspices of the KEMHRC. KEMH is located at a central location in Pune city and has patients from middle- and lower-income groups from all over the state. There are 17 departments, smaller units that are run by a senior doctor as head of the department (HOD) with multiple consultants and interns providing both out-patient and in-patient services. The doctors from KEMH are leading the healthcare delivery in their streams and are a pioneer centre of excellence for various specialities in the state.

The founding member of KEMH, Dr Banoo Coyaji, conceptualised KEMHRC in 1972 to strive for excellence and encourage clinicians and social scientists to conduct quality research. Established as a formal, not for profit organisation registered with the office

of Charity Commissioner, the KEMHRC has emphasised research linked to its ongoing medical and public health programmes. Its activities are focused on applied, problem-oriented and problem-solving research with emphasis on the vulnerable sections of the population.

In addition to the research activities of the 17 departments from KEMH, KEMHRC governs Vadu Rural Health Program (VRHP) and Women Development and Training Centre (WDTC) Pabal, which is located 23 km beyond VRHP. VRHP is a community-based setup/ department based approx. 35 km from Pune city. It has been conducting community health research over the last three decades. VRHP campus also houses a secondary care hospital named Shirdi Sai Baba hospital (SSH), governed by KEMH.

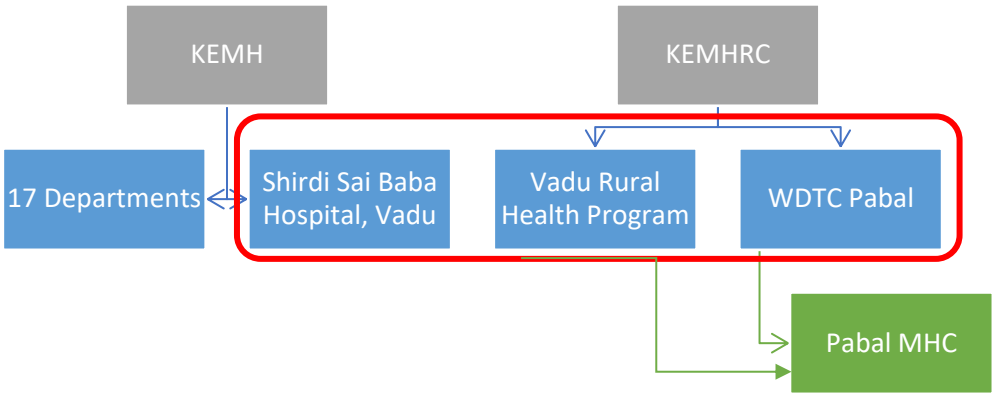

Figure 1: Organisational Hierarchy of Pabal MHC

KEMHRC has run the WDTC as a department since 1993 in Pabal village. Pabal is a remote village of almost 5500 people, mainly farmers. The WDTC, Pabal, maintains a long-established relationship with the community and serves nearly 70000 individuals residing in 20 villages around Pabal. The WDTC Pabal has always been a service delivery centre for KEMHRC Pune. It initially focused on providing women's welfare, health, and development training. This training included short term courses such as home-nursing, beautician training, food processing (pickling, drying *etc.*) and computer training. These programmes helped the local women and young girls from the nearby 20 villages to be self-supporting. The training has been funded through

various charitable organisations since the inception of WDTC Pabal. The institutional hierarchy is described in Figure 1.

Pabal and many other villages in the vicinity have limited access to healthcare services. The nearest town to Pabal is nearly 20 km away, which takes at least 45 minutes to reach due to bad roads. The frequency of public transport to reach town is limited, and the population depends on private transportation. The doctors practising in the nearby villages are primarily AYUSH practitioners; thus, the populations do not have access to specialists. The location of the Pabal MHC is described in Figure 2.

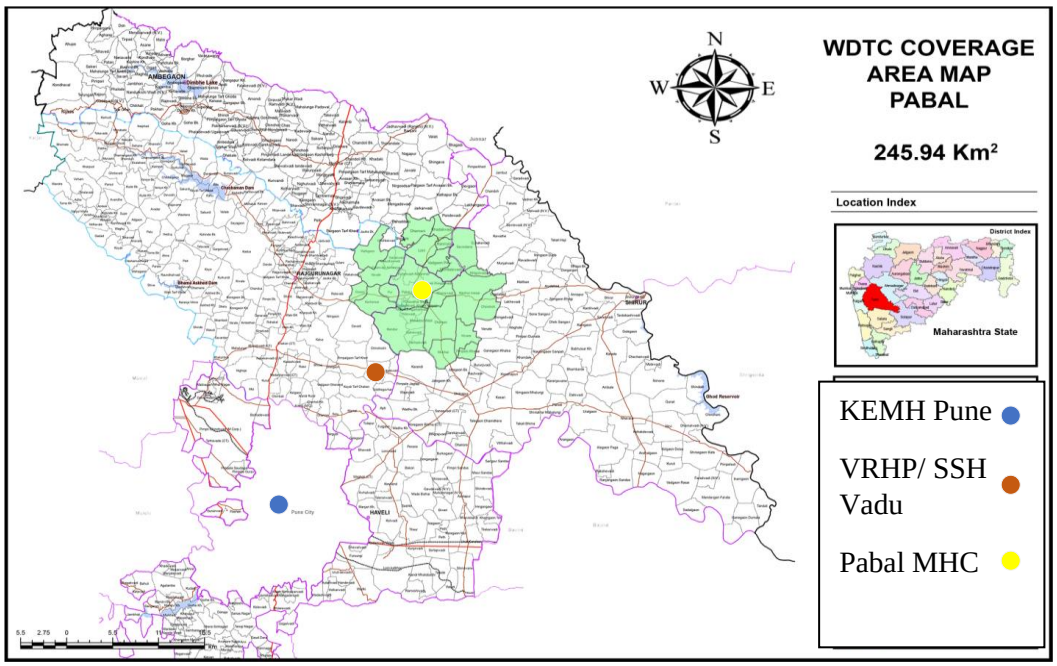

Figure 2: Location of MHC Pabal on Pune district's Map

In May 2015, the Council of Scientific and Industrial Research (CSIR) and Hewlett Packard (HP), India, together developed an integrated healthcare centre in old shipping containers designated as MHC. The MHCs intended to provide primary health care in a ready-to-deploy container. HP and CSIR collaboration installed nearly 110 such centres across India, and one of the first was installed in WDTC Pabal under the KEMH. WDTC Pabal is a remote location in the Pune district, and being associated with a tertiary care hospital could help in the centre's functioning. The leadership from IGIB had a keen interest in respiratory health which aligned with the KEMHRCs research focus. Hence when established, the primary objective of this centre was to

provide respiratory health care and conduct research to demonstrate an integrated health system for the delivery of community-based primary health care. This MHC also aimed to use a translational health research approach and strengthen the availability of first referral-level healthcare services to improve the community's health status.

The Pabal MHC, when installed in 2015, was institutionally sanctioned with the approvals of the senior leadership at KEMH. The KEMH leadership with the CSIR officials formally defined and consciously planned the roles and responsibilities for the functioning of the Pabal MHC, which was intended to change the face of primary health care provision in the community. Although equipped with advanced technological infrastructure for treating CRDs using telehealthcare, this MHC has been under-utilised since its inception. A local AYUSH trained practitioner used to run a traditional face to face clinic at the MHC before I initiated my PhD study. The HP dashboard and data management systems were used only to remotely monitor key equipment and usage. The data storage and the Electronic Medical Records (EMR) were web-based and cloud-enabled. These facilities were subsequently enhanced with a studio for teleconsultation between the MHC and the secondary-level health centres/hospital. The original operational flow is described in Figure 3

However, by the time I initiated my PhD data collection, it was an underutilised system that ran only a face-to-face out-patient consultation by local PPs despite the availability of teleconsultation. Sporadic consultations were carried out using the teleconsultation set-up until April 2018 probably due to lack of formal organisational structure to deliver services Organisation barriers like lack of champion to collaborate with additional stakeholders might have added to the reasons of underutilisation of the system.

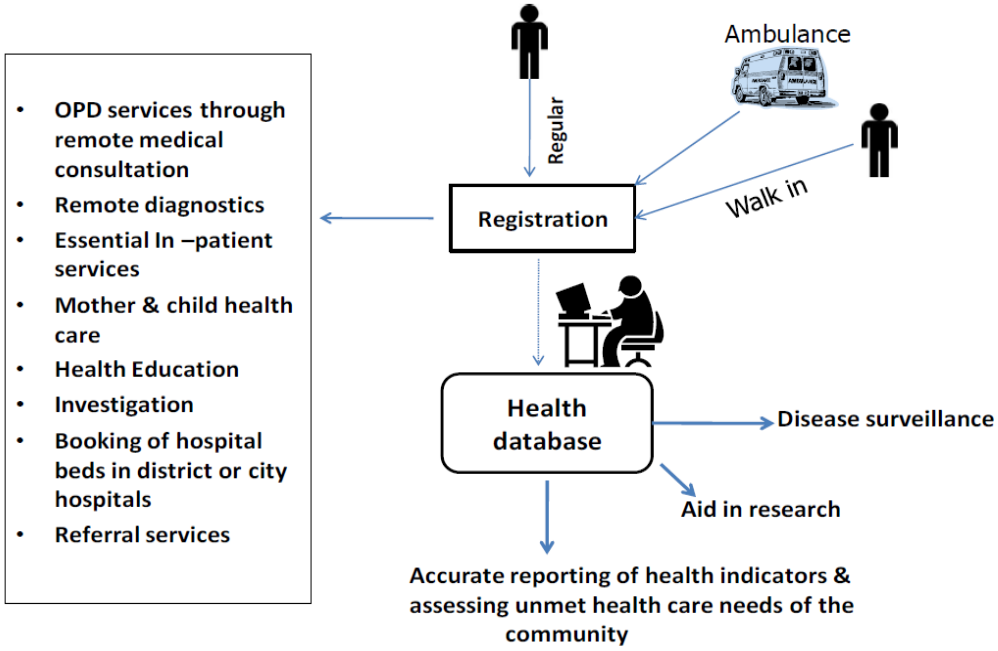

Figure 3: Operations at the MHC which describes the system

image adapted from (Agrawal *et al.*, 2013)

Chapter 3. Systematic Literature Review

This chapter briefly presents the methods and findings of the published systematic literature review describing specialist to non-specialist teleconsultations in chronic respiratory disease management. I conducted a systematic review to address the first secondary objective of my PhD study "To explore the evidence for the effective use of specialist to non-specialist teleconsultation in the management of CRDs in adults in remote areas". The systematic review was published in the Journal of Global Health in March 2021 (Patil *et al.*, 2021).

I further summarise relevant literature published since the initial review and other literature, which, while not meeting the inclusion criteria for the review, provided useful information for my thesis.

3.1 Aim of the Systematic Review

This systematic review aimed "to explore the evidence for the effective use of specialist to non-specialist teleconsultation in the management of CRDs in adults in remote areas and to document best practices and challenges; identify knowledge gaps and provide recommendations for future research".

3.2 Methods of the Systematic Review

3.2.1 Search

I used the SPIDER (sample, the phenomenon of interest, design, evaluation, research type) search strategy tool to design the search strategy. I performed an electronic search in February 2019 (Appendix 1) and later with an updated search strategy in November 2019 and repeated in November 2020 (Appendix 2). This second search criterion included additional search terms around specialist to non-specialist consultation, ex: Face to face consultation, referral, e-referral, doctor to nurse and other health care providers. The details are provided in Appendix 1 and 2. However, the published SR presents the data only from the last two modified searches.

3.2.2 Inclusion criteria

I included all types of research methodologies, including interventions and observational studies. During the first search and screening, I included teleconsultations between only doctors; however, I expanded my inclusion criteria to include all types of teleconsultations between specialists and non-specialists for CRD diagnosis or management during the second search. I included all non-specialists as some cross-references suggested that there was more literature available on non-specialists which was also relevant in terms of understanding the best practices and challenges; identify knowledge gaps and provide recommendations for future research which was the aim of this activity. The levels of work responsibilities of the nurse practitioners from the published accounts from the high-income countries possibly matched work responsibilities of the local Indian PPs for conducting the teleconsultations, hence including the extended literature could possibly help in achieving the objective of the systematic review. I later invited a colleague from KEMHRC to be a second reviewer and screen the title and abstracts during the second search with revised inclusion criteria.

I excluded the studies which focused on doctor-to-patient teleconsultations, systematic reviews, conference papers or abstracts. However, as the patients and health care providers are part of the specialists to non-specialists teleconsultations they were included as study participants from the studies which focused on the specialists to non-specialist consultations.

3.2.3 Data Extractions and analysis

Both my colleague and I conducted the title and abstract screening during the second search (see details in Appendix 2). We used a data extraction form created in Microsoft excel based on the STROBE (von Elm *et al.*, 2014), NICE (*NICE | The National Institute for Health and Care Excellence*, no date), CASP (Critical Appraisal Skills Programme (CASP)) and CONSORT (Consolidated Standards of Reporting Trials (CONSORT)) guidelines and included fields on the type and aim of the study, population description, disease condition, type of consultation, type of outcome and facility. We both extracted narrative data in summary tables, and I combined the

summary in one after resolving the discrepancies by discussions. We used the Joanna Briggs Institute's (JBI) tool for critical appraisal (*Joanna Briggs Institute*, no date) to assess the papers' quality as it is helpful in reviewing a range of studies with different methodologies. My review included studies which were three text and opinion papers, six analytical cross-sectional studies and one case report. The JBI tool has the facility to critically appraise all these study types and hence was used for this review.

3.3 Summary of findings of the systematic review

The second search yielded 1715 articles, of which 464 were duplicates, leaving 1251 papers. My colleague and I screened the abstracts of all these 1251 papers, of which we selected 77 papers for full-text screening based on the expanded inclusion criteria. We further chose only published articles and found ten relevant articles which included all three parameters of (i) teleconsultation, (ii) Specialist to non-specialist consultation (iii) CRDs. The PRISMA flow diagram for the second search activity is described in figure 1 of the attached paper.

The study populations in the selected ten studies primarily included two participant groups: the patients and the health care provider. The health care providers included the PPs, nurses and the RPs. All teleconsultations in these studies except one (Koizumi *et al.*, 2005) were asynchronous, *i.e.* the specialists responded to the non-specialists in a given time frame after the patient details and reports were sent to them. One study reported consultations between RPs and nurses (Raza *et al.*, 2009), and the remaining nine described consultations between PPs and RPs. Seven publications (Averame *et al.*, 2009; Bonavia *et al.*, 2009; Raza *et al.*, 2009; Bernocchi *et al.*, 2012; Thijssing *et al.*, 2014; Metting *et al.*, 2015; Wrenn *et al.*, 2017) resulting from six studies reported the teleconsultation location as the PP's office; one publication reported a home-based triage with the PP and RP (Koizumi *et al.*, 2005) and two studies (Fadaizadeh *et al.*, 2018; Weikert *et al.*, 2019) reported a tertiary care hospital as the location for specialist to non-specialist teleconsultation. With regard to the type of systems used, audio modes and audio-video modes dominated. Three publications from two studies described asynchronous telespirometry (Averame *et al.*, 2009; Bonavia *et al.*, 2009; Thijssing *et al.*, 2014), and one study was based on secondary data of High-Resolution

Computed Tomography (HRCT) scans (Weikert *et al.*, 2019). All except one study (Fadaizadeh *et al.*, 2018) were conducted in high-income countries.

Two studies addressed COPD (Koizumi *et al.*, 2005; Thijssing *et al.*, 2014), and three addressed both asthma and COPD (Averame *et al.*, 2009; Bonavia *et al.*, 2009; Metting *et al.*, 2015), general respiratory conditions were focused on in one study (Raza *et al.*, 2009) and two focused on multiple specialities, and pulmonology was one of them (Bernocchi *et al.*, 2012; Wrenn *et al.*, 2017). Fadaizadeh *et al.* investigated patients who had undergone thoracic surgery with multiple organ failure (Fadaizadeh *et al.*, 2018), and Weikert *et al.* included patients with suspected idiopathic pulmonary fibrosis (IPF) (Weikert *et al.*, 2019).

The included studies reported primarily non-clinical outcomes, which included: perceived effectiveness, reliability, improved patient access and acceptability. The use of doctor-to-doctor teleconsultation for CRD diagnosis and management was found to impact positively in all these areas. Only three of the ten studies described the clinical outcomes; all of those showed improved clinical outcomes (Raza *et al.*, 2009; Metting *et al.*, 2015; Fadaizadeh *et al.*, 2018). All the papers were either of moderate or low quality.

Although I have summarised the findings from the published systematic review, the detailed findings are described in the published article inserted below.

Electronic supplementary material:
The online version of this article contains supplementary material.

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PAPERS

Specialist to non-specialist teleconsultations in chronic respiratory disease management: A systematic review

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Background Chronic respiratory diseases (CRD), are common public health problems with high prevalence, disability and mortality rates worldwide. Further uneven distribution of the health workforce is a major barrier to the effective diagnosis and treatment of CRDs. Teleconsultation between a specialist and non-specialist could possibly bridge the gap in access to health care and decrease CRD burden in remote areas. This review investigates the evidence for the effective use of specialist to non-specialist teleconsultation in the management of CRDs in remote areas and identifies instances of good practice and knowledge gaps.

Methods We searched for articles till November 2020, which focused on specialist to non-specialist teleconsultations for CRD diagnosis or management. Two independent reviewers conducted the title and abstract screening and extracted data from the selected papers and the quality was assessed by Joanna Briggs Institute's (JBI) tool. A descriptive and narrative approach was used due to the heterogeneous nature of the selected studies.

Results We found 1715, articles that met the initial search criteria, but after excluding duplicates and non-eligible articles, we included 10 research articles of moderate quality. These articles were from nine different studies, all of which, except one, were conducted in high-income countries. The studies reported results in terms of impact on the patients, and the health care providers including primary care physicians (PCP) and specialists. The teleconsulting systems used in all the selected papers primarily used audio modes in addition to other modes like the audio-video medium. The included studies reported primarily non-clinical outcomes including effectiveness, feasibility, acceptability and usability of the teleconsultation systems and only three described the clinical outcomes. The teleconsultation was predominantly conducted in the PCPs office with the specialist located remotely.

Conclusions We found relatively few, papers which explored specialist to non-specialist teleconsultation in management of CRDs, and no controlled trials. Two of the included papers described systems, which were used for other diseases in addition to the CRD. The available literature although not generalisable, encourages the use of specialist to non-specialist teleconsultation for diagnosis and management of CRDs.

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The distribution of the health workforce across the globe is uneven and is often disproportionately lower in low and middle-income countries (LMICs) which are the areas often with the highest disease burden [1]. The World Health Organization (WHO)- Global Health Observatory reports that over 40% of member countries of

WHO, all LMICs, have less than one physician per 1000 population [1]. The African Region suffers more than 24% of the global burden of all diseases but has access to only 3% of health workers and less than 1% of the world's financial resources [1]. The unbalanced distribution of health care personnel by specialities adds to these disparities [2]. In India, while 69% of Indian population resides in rural areas and they are served by 22% of all health care providers compared with the 31% urban citizens who have access to 78% of trained health care professionals [3,4]. Poor access to transport and inadequate transport infrastructure in rural areas further aggravates the scarcity of health care workforce leaving a large proportion of the rural population without easy access to trained health care providers.

Information technology can facilitate access to specialist services, by overcoming the distance barrier by enabling specialist doctors to provide remote consultations to patients and provide support to general physicians and specialised local health workers [5,6]. Additionally, remote consultations have also provided opportunities for continued access to health care when maintaining social distancing during the global COVID-19 pandemic [7]. Telehealth care is thus one possible means of addressing the challenges related to uneven access to health care in India and globally [8].

Telehealth care is variously referred to as telemedicine, telehealth, telecare, telemonitoring, tele(discipline), teleconsultation and also eHealth in assorted contexts including mobile application based care, self-management with the help of remote monitors, doctor-to-patient remote consultation and also doctor-to-doctor consultation [9]. COCIR, the European Trade Association, representing the medical imaging, radiotherapy, health ICT and electromedical industries suggests a simpler definition that: "*Telemedicine includes all areas where medical or social data is being sent/exchanged between at least two remote locations, including both Caregiver-Patient/Citizen as well as Doctor to Doctor communication*" [5]. This definition is most applicable where telemedicine seems to have widened its scope to a variety of health information exchange for managing health and well-being of the population. For this systematic review, we will refer to this as 'Teleconsultation'.

Chronic respiratory diseases (CRD) especially asthma & Chronic Obstructive Pulmonary Disease (COPD) are common public health problems with high prevalence, disability and mortality rates worldwide [10-13]. Asthma is the 14th most important disorder in the world in terms of the disease burden [14], and COPD is the third leading cause of death, worldwide [15]. Diagnosis of these chronic respiratory diseases is based on detailed patient history and clinical assessment, aided by specialised tests such as spirometry and peak expiratory flow readings. However, interpreting the results of such tests require specialised training [16]. Specialists are not always available in rural regions worldwide. A study conducted in the US reported that less than one-third of the rural population, but nearly 98% of the urban American population had access to a pulmonologist within a 10-mile radius [17]. The situation in low- and middle-income countries (LMICs) like India is comparatively worse. The Association of Chest Physicians of India lists 2413 chest physicians in a country of 1.3 billion people, more than 95% of these are registered at in large urban areas [18] as compared to American Thoracic Society comprising of more than 16000 registered members including physicians, researchers, advanced practice nurses, respiratory therapists which serves nearly 331 million population [19]. The rural areas in LMICs are primarily served by primary care physicians (PCP) or allied health staff including Auxiliary Nurse Midwives (ANMs) nurses or pharmacists for delivery of primary health care [20]. Lack of access to pulmonologists and other specialists required for the diagnosis and management of the CRDs may be one of the factors contributing to the misclassification or delayed diagnosis of CRDs and inappropriate disease management. Use of teleconsultation to remotely support the PCPs by engaging specialists could help in scaling up CRD diagnosis and treatment.

The objective of this systematic review was to explore the evidence for the effective use of specialist to non-specialist teleconsultation in the management of CRDs in adults in remote areas and to document best practices and challenges; and identify, knowledge gaps and provide recommendations for future research.

METHODS

Search strategy

A search strategy tool SPIDER (sample, the phenomenon of interest, design, evaluation, research type) [21] was used to design the search strategy. We consulted a librarian when creating the search strategy. The Search terms included variations of "Telehealth", "Telehealthcare", "eHealth", "Remote consultation", "Satellite consultation", "Remote diagnosis", "Remote management", "Teleconsultation", "Tele- opinion", "Tele- diagnosis", "Remote medical consultation", "Telemedicine", "Primary care", "Remote clinic", "Satellite clinic", "videoconfer-

ence", variations of "Chronic Respiratory diseases", "Chronic obstructive pulmonary disease", "asthma", "Face to face consultation", "doctor to doctor consultation", "physician to physician", "referral", "consultation" (Appendix S1 in the Online Supplementary Document).

Database

We used *Embase*, *Medline* (through Ovid), *PubMed*, and CAB *Global Health* to run our search terms. RP handsearched citation lists to identify potentially relevant papers within retrieved papers and review articles.

Search duration

We searched for papers up to November 2019 and later the search was repeated in November 2020. We did not restrict the start date, although first publication in the search appeared in 1975.

Inclusion and exclusion criteria

We considered all types of research methodologies including interventions as well as observational studies. All types of teleconsultation between specialists and non-specialists for CRD diagnosis or management, including but not limited to email, videoconference, telephone etc. were included. We excluded articles, which were focused on home-based care, mobile health, doctor to patient consultations, molecular outcomes, pulmonary rehabilitation, telephone surveys, post-hospitalisation follow-ups, telemonitoring and tele-training. We also excluded reviews, systematic reviews and conference abstracts and the search was not restricted to any particular language.

Data extraction and analysis

The title and abstract screening followed by data extraction from the selected papers was independently conducted by two reviewers (RP and RS). The search results from all databases were imported into Mendeley (1.19.5) [22] and the duplicates were removed. The titles and abstracts were screened for all the papers. We selected studies mainly on two criteria. The first criteria is the disease condition, including at least one chronic respiratory illness, and the second criteria is consultation type, where a specialist provided consultation to non-specialists or a PCP, to either diagnose or treat the chronic respiratory disease.

Data extraction into Microsoft excel was developed based on the STROBE [23], NICE [24], CASP [25] and CONSORT [26] guidelines and included fields on the type and aim of the study, population description, disease condition, type of consultation, type of outcome and facility. The discrepancies were resolved by discussions between RP and RS. The narrative data was extracted using summary tables independently by two authors (RP and RS) which were later combined by one reviewer (RP) into one sheet and all authors reviewed this sheet regularly. Mendeley (1.19.5) [22] was used to manage references and MS-Excel (Microsoft Inc, Seattle, WA, USA) was used for data management. The quality assessment of the papers was carried out using the Joanna Briggs Institute's (JBI) tool for critical appraisal [27] by two reviewers (RP and RS). The discrepancies were resolved by discussion.

The study designs of the selected papers were heterogeneous thus a narrative approach to data synthesis was used rather than a meta-analysis.

RESULTS

The identified papers, the screening process, and the final number of studies included are detailed in the PRISMA flowchart (Figure 1). In summary, we found 1715 papers in the above-mentioned databases, of which 464 were duplicates, which were excluded, leaving 1251 papers. We screened the abstracts of all these 1251 papers of which 77 were selected for full-text screening based on the inclusion criteria. We further selected only published papers hence we did not include 21 meeting abstracts/conference papers. We found 10 relevant papers which included all three parameters of (i) teleconsultation, (ii) Specialist to non-specialist consultation (iii) CRDs.

Study population

The study populations in the selected studies primarily included two groups namely the patients and the health care provider including PCPs and specialists. Some studies also conducted secondary data analysis thus indirectly including patients as study participants [28,29]. The demographic characteristics of the study population were not described in any of the papers. The available details including a description of the recruitment methods in the included studies are described in Table 1.

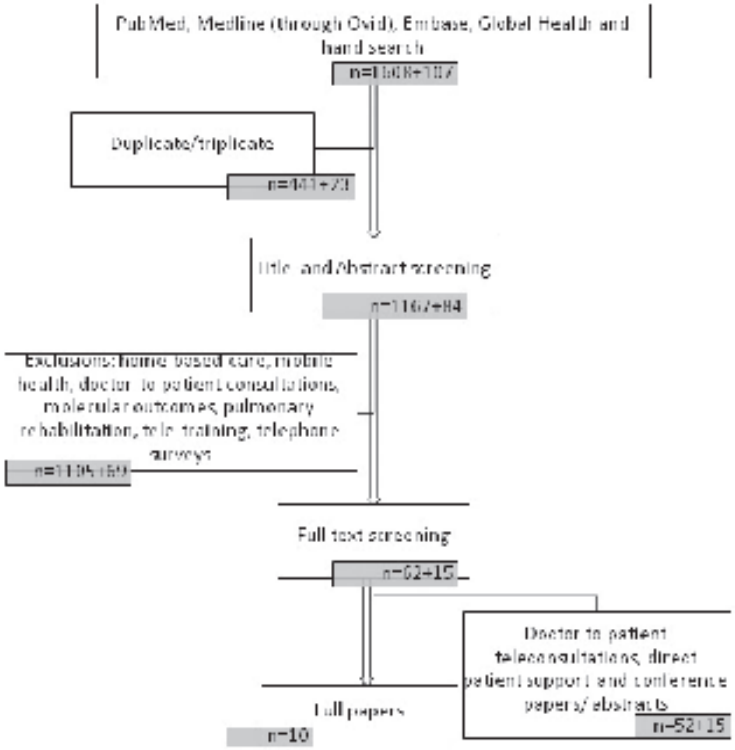

Figure 1. PRISMA-flow diagram for the selection of papers.

Table 1. Study population and selection criteria

Report title	Population description	Recruitment methods	Sample size	Sampling details/ technique
Koizumi et al [30]	Patients: The subjects were two patients with chronic obstructive pulmonary disease (COPD) receiving home oxygen treatment. Healthcare providers: Specialists at tertiary care hospital and primary care doctors from the local hospitals	The patients were selected after their treatment policy was decided which included home oxygen treatment. This treatment was assigned to the local hospital doctor through regular hospital visits who shared the patient's information with the specialist	Patients: 2 Chronic Obstructive Pulmonary Disease (COPD) patients. Healthcare providers:	Purposive who received treatment at Shinshu University Hospital
Raza et al [28]	Patients: the patient at the Iron Mountain clinic Healthcare providers: Pulmonary specialist at the Milwaukee site and the ancillary provider (nurse or respiratory technologist - RT) at the Iron Mountain.	Pulmonary specialist categorized the patient referral in urgent and non-urgent. The Non-urgent patients were eligible for teleconsultation.	Patients: 314 patients in 684 clinical encounters	All patients presenting at the spoke site were interviewed by Nurse for complaint medication and diagnostics if any. All patients who received pulmonology teleconsultation during the study period of seven years. Only non-urgent patients were considered suitable for telemedicine. The program provides outpatient teleconsultations (pulmonary, rheumatology, endocrine, mental health, and infectious disease). However, the paper presents data on pulmonary teleconsultations from one spoke site located 354kms away from the hub.
Averame et al [31]	Patients: requiring telespirometry. Healthcare providers: Primary Care Physicians (PCP) s and pulmonary specialist.	PCPs from all regions of Italy who were willing to participate and perform the spirometry were involved. Fifty-one pulmonary units distributed throughout the country were asked to participate in the study. However the methods do not describe how the participants were approached	Patients: 9312 patients. Healthcare providers: 638 PCPs 51 pulmonologist.	Not mentioned for PCPs and pulmonology units. The participants were enrolled by the PCPs from his/her general practice in the following categories of subjects: (1) current or ex-smokers without respiratory symptoms; (2) subjects with respiratory symptoms (3) subjects with a pre-existing clinical diagnosis of bronchial asthma; and (4) subjects with a pre-existing clinical diagnosis of COPD.

Table 1. Continued

Report title	Population description	Recruitment methods	Sample size	Sampling details/ technique
Bonavia et al [32]	Patients: requiring telespirometry. Healthcare providers: PCPs and pulmonary specialist.	PCPs from all regions of Italy who were willing to participate were involved	Patients: 17910 patients. Healthcare providers: 937 PCPs trained by 51 pulmonologists.	PCPs who were willing to conduct telespirometry. Pulmonology units identified by a steering committee. Subjects on whom the PCP conducts telespirometry. The paper mentions that the details are described in another publication describing this study [31] however, no more details are mentioned about the recruitment methods
Bernocchi et al [33]	Patients: Patients who were screened for eligibility before hospital discharge and who consented. Healthcare providers: PCPs and pulmonary specialist	Patients at the PCP clinic. Before discharge from the hospital all patients were given instruction on their respective disease conditions (CHF or COPD). Patients were given pointers for recognizing signs and symptoms of decompensation/worsening. Patients with CHF were provided with a portable 1-lead electrocardiogram (ECG) device (Card-Guard 2206). Patients with COPD received a pulse oximeter (Vitalaire, Italy) device	Patients: 4925 patients Healthcare providers:	Not mentioned
Thijssing et al [34]	Patients: Patients who were considered suitable for the telepulmonology consultations by the PCP. Healthcare providers: PCPs and pulmonary specialist	All PCPs registered in the Netherlands and in possession of a spirometer that could be linked to a computer were eligible. PCPs opted in to join the teleconsultation system	Patients: 1958 tele pulmonology from 1828 patients. Healthcare providers: 158 PCPs and 32 pulmonologists.	All PCPs registered in the Netherlands and in possession of a spirometer that could be linked to a computer. Participating PCPs decided on suitability of tele pulmonology consultation. All telepulmonology conducted during the study period were included.
Metting et al [35]	Patients: Patients suspected to have obstructive airway disease (OAD) Healthcare providers: PCPs and pulmonary specialist	Patients are decided by PCPs. All PCPs in study area. Pulmonologist who has assessed more than 300 patients were approached for the service	Patients: 11401 patients Healthcare providers: 360 PCPs and 10 pulmonologists	Not mentioned.
Fadaizadeh et al [36]	Patients: Thoracic surgery patients who consented for teleconsultation Healthcare providers: Physicians and nurses at the hospital and Consulting physician at remote location	Patients selected for teleconsultation were mostly complicated thoracic surgery cases with multiple organ failure for whom transportation was not only infeasible, but also contraindicated. Physician located in remote hospital and long distance travel was required to perform visit	Patients: 58 patients. Healthcare providers: one consulting physician	All patients who consented to participate in the study during the study period
Weikert et al [37]	Secondary data analysis no study population	Partner hospitals located in Central Eastern Europe and Asia were eligible to participate in the cross-border teleradiology program for a structured expert consensus reading of CTs with the clinical question of IPF Partner hospitals located in Central Eastern Europe and Asia were eligible to participate in the cross-border teleradiology program for a structured expert consensus reading of CTs with the clinical question of IPF	703 HRCT scans Data from 239 hospitals located in 46 cities in 12 countries	Not mentioned
Wrenn et al [29]	Patients: Patients attending the service and who completed the teleconsultation. Healthcare providers: PCP from eight adult primary care sites at the University of California, San Francisco (UCSF), USA	First 200 teleconsultations during initial months of program	Patients: 195 patients. Healthcare providers: 86 PCP	Not mentioned

Consultation type and facilities used

We included studies where a specialist communicated with a non-specialist by teleconsultation for either diagnosis or management of the patient's condition. In one study, consultations were conducted in real-time [30], the others were stored and forwarded consultations, which meant the specialists were sent the patient details and reports by the non-specialists and the specialists provided their opinion to the non-specialists within a stipulated time frame.

The case studies conducted in Japan described a setup which comprised of equipment at three locations which included the home of two patients with chronic respiratory failure, the hospital of the attending PCP, and the hospital of the pulmonary specialist [30]. No other study reported home-based specialist to non-specialist teleconsultation.

The primary care centres or PCPs offices were used as the site of the teleconsultation in six studies which were reported in seven papers [28,29,31-35] where the consulting specialist was located at a remote location. These studies could be categorised as the hub and spoke where multiple PCPs were provided with an opinion by specialists for either diagnosis or management of CRDs. In one study reported from the USA, the hub was located at Milwaukee Veteran Affairs Medical Centre (VAMC) pulmonary telemedicine clinic which was located away from the spoke centre at Iron Mountain VAMC [28]. Five other studies had similar approach where the teleconsultation was conducted at the PCPs office and the specialist provided an opinion for the diagnosis or management remotely [29,31,32,34,35]. The teleconsultation was conducted between specialists at local hospitals and specialists at a tertiary care hospital in two studies [36,37] (Table 2).

Table 2. Study characteristics

Report title	Year of publication	Country in which the study is conducted	Type of study	Disease condition	Consultation type
Koizumi et al [30]	2005	Shinshu University Hospital, Japan	Case study	COPD	Real-time communication between patient at home, attending primary care physicians (PCP) at hospital and pulmonary specialist at another hospital once a week.
Raza et al [28]	2009	United States	Retrospective analysis for description of a telepulmonology clinic	Pulmonary conditions	Pulmonary Specialist to Nurse or respiratory technologist
Averame et al [31]	2009	Italy	Observational study	Asthma and COPD	Training to PCPs by pulmonologists followed by PCPs performing spirometry in their clinic which was checked for quality by the gen at the central office providing teleconsultation and further offered an interpretation of the results which was faxed to the PCPs' office.
Bonavia et al [32]	2009	Italy	Observational study	persistent respiratory symptoms, or a previous diagnosis of asthma or COPD	Training to PCPs by pulmonologists followed by PCPs performing spirometry in their clinic which was checked for quality by the specialist at the central office and further offered an interpretation of the results which was faxed to the PCPs' office.
Bernocchi et al [33]	2012	Italy	Description and assessment of an ongoing project	Chronic Heart Failure, Skin, Diabetes, Chronic Obstructive Pulmonary Disease	Second opinion for the PCPs in Cardiology, Dermatology, diabetology and pulmonology
Thijssing et al [34]	2014	Netherlands	Intervention study	COPD	Pulmonologists to PCPs
Metting et al [35]	2015	Netherland	A cross-sectional baseline description and longitudinal results	Asthma, COPD and overlap syndrome - obstructive airway disease	PCPs refer patients to service and tests are conducted in laboratory. Pulmonologists inspect the data through the internet and send the PCP diagnosis and management advice
Wrenn et al [29]	2017	USA	A retrospective descriptive analysis	Cardiology, Endocrinology, Gastroenterology/hepatology, Haematology, Infectious diseases, Nephrology, Pulmonary medicine, Rheumatology	Specialist provided teleconsultation to patients via the PCPs
Fadaizadeh et al [36]	2018	Iran	Cross-sectional Interventional	Patients who have undergone thoracic surgery with multiple organ failure	Pulmonologists to PCPs
Weikert et al [37]	2019	Partner hospitals in twelve Central Eastern Europe and Asia from the collaboration framework with Boehringer Ingelheim	Description and analysis of Intervention	presence of Usual Interstitial Pneumonia (UIP)-pattern in patients with suspected Idiopathic Pulmonary Fibrosis	Radiologist and a pulmonologist reported the diagnosis of HRCTs to another pulmonologist or a referring physician

Details of the systems used for teleconsultations

The specific teleconsultation systems used in all the selected papers varied; broadly they primarily used audio modes but some use a mixture of audio-video. Three papers from two studies focused on diagnosis using telespirometry.

Koizumi et al. shared clinical information, using a remote biological information transmission device which was installed at the patient's home. Equipment to measure arterial blood oxygen saturation and blood pressure was set up on the patient's finger along with three electrodes for Electrocardiogram. The remote consultation management device was set up at the attending PCPs hospital. Besides, another device for consultation management and monitoring was set up at Shinshu University Hospital, where the pulmonary specialist was located [30].

Another study described a hub-and-spoke model where the nurse or respiratory therapist (RT) at the spoke site recorded the clinical history and conducted a focused pulmonary physical examination. Medical consultations at the hub site were conducted via the live, two-way audio and video conferencing system. The physician at the hub site viewed chart notes and images of Electrocardiogram and radiographs and further prescribed diagnostics, medicines and suggested if the patient needed face to face consultations [28].

The Italian Alliance study published two papers in 2009 focusing on telespirometry for diagnosis of CRDs. One pulmonary specialist provided education and training on spirometry and diagnosis of obstructive airway diseases, to a group of PCPs in a six-hour education session. Each PCP was equipped with a simple, portable pneumotachograph (Spirotel, MIR, Roma, Italy) to measure the main indices derived from a maximal forced expiratory manoeuvre, the reports of which were transmitted to a central office. The operator at central office established a real-time communication and commented on the quality of the spirometry traces, invited the PCP to perform additional expiratory manoeuvres in the same subjects, and offered an interpretation of the results of the single patient. Then, the report was sent by fax to the PCPs office [31,32].

The descriptive paper on the TELEMACO project narrates that a service centre provided support to PCPs during daily in-office or home visits and for pulmonology consultations, PCPs contacted the service centre using a real-time telephone only and no special service was used [33].

An intervention study focused on telepulmonology consultations used a hypertext transfer protocol secured, web-based teleconsultation system for communication between PCP and pulmonary specialist. PCPs accessed a secured web-based teleconsultation system (KSYOS Telemedical Centre, Amstelveen, The Netherlands) where they completed the patient personal data, added up to four PDFs of the spirometry results and optionally added additional relevant clinical information. This information was sent to the local pulmonary specialist who had to answer within two working days [34].

Another study which focused on providing asthma and COPD services used an Electronic diagnostic support (EDS) system. After referral of a patient by the PCP to the asthma COPD services, a trained lung function technician conducted spirometry and along with the patient completed the patient information and clinical history in the EDS. This information was accessed by a Pulmonary specialist for assessment within five days which was then reported to the PCP who further decided on disease management [35].

A similar store and forward system was used by Fadaizadeh et al. for patients who have undergone thoracic surgery with multiple organ failure. The receiving PCP provided all necessary documents (the patient's history, tests, ECG, radiology documents) and transfer to the specialist via store and forward, and then discussed the case online via videoconference. Fibre optic communication; and web conference software was used for a simultaneous audio-visual connection. Tele-examination devices and equipment were provided including a camera for examining the ear, eye and also digital stethoscope for heart and lung examination. A communication network for specialised consultations was established among seven specialised hospitals [36].

The study which described the use of High-Resolution Computed Tomography (HRCT) scans for identifying Usual Interstitial Pneumonia (UIP)-pattern in patients with suspected Idiopathic Pulmonary Fibrosis with clinicians performing the Chest HRCT scans locally at the referring hospitals. The HRCT scans were sent for a centralised expert consensus reading by a radiologist and a pulmonary specialist. After registration, a pulmonary specialist in partner hospitals received a personalised upload link valid for a single patient who had consented and for short period. All data for the patient were uploaded to the central expert reading site. A radiologist and pulmonary specialist together generated report for the patients and the reports were sent back by encrypted email to the referring PCP in the local hospital [37].

A retrospectively described study used eConsult services, where the PCPs at the point of referral, had the option to submit an eConsult request, using a structured template, if they believed the specialist could address

the clinical question without an in-person evaluation. Specific structured referral templates for the most common clinical problems referred to each speciality, which incorporated relevant laboratory data from the EHR, allowed PCPs to identify if relevant imaging data were available, and asked the PCP to provide a recent assessment and a specific clinical question [29].

Study outcomes

The included studies focused primarily on non-clinical outcomes including effectiveness, feasibility, acceptability and usability of the teleconsultation systems. Three of the 10 studies described the clinical outcomes more clearly [28,35,37] one study which described observations of patients' assessment as clinical outcomes [30] did not provide sufficient details to assess their methods. The description of the study methods used to collect the data and respective study outcomes are listed in Table 3. We further describe the common conclusions from all the 10 selected papers.

Effectiveness

Two papers described the effectiveness of the existing system. Koizumi et al. describes that the system was effective for establishment of appropriate treatment, provided the cooperation between the pulmonary specialist and attending PCP was established and further suggests that a similar system could be considered useful and promising for further use [30]. Fadaizadeh et al. studied teleconsultation between physicians and nurses at the thoracic surgery hospital and consulting physicians, in thoracic surgery patients in intensive care unit and concluded that teleconsultation improved decision-making in thoracic surgery ICU patients through time saving and accelerating off-site consultations [36] (Table 4).

Reliability

The use of specialist to non-specialist teleconsultation was considered reliable in terms of technical feasibility [28,29,33,35,37]. However, concerns were raised in one study that the pulmonary specialist relied primarily on medical history, medical data from tests including radiology, and a limited physical exam performed by a trained nurse or respiratory therapist to arrive at clinical diagnosis [28].

Improved patient access

The systems utilised in multiple studies were reported as improving health care access to patients. Referred patients were able to receive medical subspecialty care closer to home, obviating the need for long-distance travel to receive an in-person medical consultation [28,33,35] (Table 3).

Use of teleconsultation for diagnosis

Three papers primarily focused on disease diagnosis [31,32,35]. The Italian Alliance study shows that telespirometry in the primary care setting could reliably demonstrate spirometric abnormalities and detect airflow limitation even in asymptomatic patients who are at risk of suffering from CRDs [31,32]. Another study also supported the finding that teleconsultation was feasible, effective and efficient in supporting PCPs to diagnose and manage asthma, COPD and overlap syndrome patients [35] (Table 3).

Acceptability

Specialist to non-specialist teleconsultation is highly dependent on the collaboration between health care providers and how acceptable they found the systems. Fadaizadeh et al. reported high physician satisfaction and acceptance of teleconsultation by the specialists [36]. Further, telespirometry was well accepted and could be easily performed by a large number of PCPs [31,32]. The rate of acceptable spirometric tests can be improved if the tests are performed under the supervision of trained technicians rather than by the PCPs [28,33,35]. One study showed that the service was perceived to stimulate cooperation between primary and secondary care, and deliver support to patients locally which is important in rural areas [35]. Telepulmonology, by improving the collaboration between PCP and pulmonary specialist, may prevent unnecessary face-to-face referrals thus saving time, and aiding in preventing under and misdiagnosis of COPD [34].

Disease conditions

COPD was addressed in two studies [30,34], both asthma and COPD in three studies [31,32,35], one study focused on general respiratory conditions [28] and two studies on multiple specialities, pulmonology being one of them [29,33]. Fadaizadeh et al. specifically investigated patients who had undergone thoracic surgery

Table 3. Methods and outcome

REPORT TITLE	METHODS FOR DATA COLLECTION	STUDY DURATION	ANALYSIS	CLINICAL OUTCOMES	OTHER OUTCOMES	STUDY LIMITATIONS AND CRITIQUE
Kotzumi et al [30]	Attending PCPs took the medical history. Patients measured the Blood Pressure, Electrocardiogram and heartrate and oxygen saturation which was recorded in the system and partial pressure of expiratory carbon dioxide was reported to the physician verbally.	One year for patient 1 and for patient 2 not mentioned. Weekly communication within all three parties	No analysis is presented in the paper	1. Depression; 2. Other health issues; 3. Respiratory symptoms were observed and discussed; however, the paper does not mention clear clinical outcomes neither the methods which were used for measuring these clinical outcomes	Effectiveness of system connecting multiterminal. The trial program resulted in the same information being exchanged remotely using the multi-station teleconsultation system that would be exchanged in a direct, face to-face encounter	The clinician's observations are described in the results section. No specific method is mentioned to document the observations. The paper does not clearly mention the aims of the publication. The result describes that the system is effective yet the methods do not describe measuring the effectiveness although the study of two cases proves the feasibility of the intervention.
Raza et al [28]	Retrospective data analysis. The authors extracted data from computerized patient record system, paper chart, physician logbooks of teleconsultation visits, patients written comments after completion of teleconsultations	January 1998 and December 2004 (7 y)	Descriptive statistics were undertaken for the study outcomes. Data analysis was done using Microsoft access, SPSS and ArcGIS Analysis for patient satisfaction data are not described	1. Reasons for referral and access to specialty care: Common reasons: abnormal thoracic radiography (38%), COPD (26%), and work-up of dyspnea (13%); 2. Medical process of care: Due to limited scope of physical examination, consultant relied on the exam findings documented by the nurse or respiratory therapist present with the patient (vital signs documented in 99.7%, physical examination in 84% and respiratory examination in 92% patients); 3.Physician diagnosis: COPD(29%), benign pulmonary nodule (11%), bronchial asthma (6%), and lung cancer (6%). Final diagnosis by physicians after first consultation in 90% cases.	1. Medical decision making: clinically significant change in management for 41% patients and follow-up required in 51% patients. 8% required face to face visit to the hub; 2. Study population and travel distances: Total travel distance and time saved for 684 visits is 473 340km or 294 120 miles and 748 work days considering only patient would have travelled to the hub and no one accompanied the patient; 3. patient satisfaction: Overall positive experience	The data analysed is extracted from the system included a range of sub-specialities however this paper describes data from pulmonary patients only. The analysis for the qualitative data are not described. Data from single teleconsultation spoke centre is described which cannot necessarily be representative of the complete system. There is an assumption that all encounters would have resulted in long distance referral, reducing the bar to consultation may have increased demand a historical comparator might have been useful
Awuame et al [31]	The PCPs performed spirometry in their office after the training which was sent to specialist at the central office, the criteria used to accept a single telespirometric test were the presence of two at least acceptable and reproducible manoeuvres. Flaw diagnosis criteria was considered for interpretation of results. FEV1/FVC fixed ratio, and not FEV1/FVC% predicted, was used to assess for the presence of airway obstruction. Patient characteristics were collected in case report form by the PCPs.	Not mentioned in the paper	Descriptive statistics, consisting of numbers and percentages for ordinal and categorical variables and means with standard deviations or medians with ranges for continuous variables and valid cases, are presented	Not mentioned	78% (7262) of the telespirometric tests were classified as acceptable of these 7262, 41% (3003) exhibited abnormal spirometric pattern. 23% of patients had a clinical diagnosis of COPD but normal telespirometry. Subgroup analysis was done for smoker, non-smokers, symptomatic, already detected COPD and Asthma.	Although the training provided to the PCPs is mentioned in the methods, the training assessment is not provided in the results. The distribution of 22% unacceptable spirometries are not described, if these were from a set of specific PCPs or dispersed amongst all 638 PCPs. The study participants were selected group of participants as selected by the PCPs and not a random representation of the population. The methods describe that the five pulmonologyunits provided trainingis the number of specialists who supported the PCPs in assessing the spirometries is not mentioned.

Table 3. Continued

Report title	Methods for data collection	Study duration	Analysis	Clinical outcomes	Other outcomes	Study limitations and critique
Bonavia et al [32]	Telespirometry was conducted by the process as mentioned in the previous publication of the same study (Avenante et al) [31]. Further a turbine spirometer (Spirotel) was use to perform these spirometries (not mentioned in the Avenante et al). The data for comparison between Spirotel and conventional laboratory spirometry is not presented in these papers. Quality evaluation of the telespirometries was done by two authors based on ATS recommendation and office spirometry.	October 2002 and ended in October 2004	Descriptive analysis was performed (number of observations, means and standard deviations, and categorical data as absolute and percentage frequencies)		22.2 ± 2.5, 2 tests per PCP during study period. 70% of the tests met the criteria for good or partial co-operation, allowing spirometric abnormalities to be detected. Normal telespirometry (38.9); Mild airway obstruction (4.5); Moderate airway obstruction (9.5); Severe airway obstruction (4.5); Very severe airway obstruction (0.7); Abnormal spirometry, but not clear airway obstruction (8.5); Suspected airway obstruction (3.3)	The number of PCPs sending at least one spirometry per month reduced to less than 100 by end of the study. This shows that there were problems in continuity of the telespirometry services especially in access to TCO and PCPs time for conducting telespirometry. Although these explanations are discussed in the discussion, the methods do not mention how these were confirmed. The aim of the study is to determine feasibility yet the methods do not mention measuring the hurdles or facilitators in conducting the telespirometry. Only telespirometry was assessed for acceptability and cooperation.
Bernocchi et al [33]	Assessment of TELEMACO network: By evaluating the organization of the integrated services across the Lombardy territories. Acceptance of TELEMACO Services by the Health Authority: By determining whether a system of reimbursement for the services provided could be implemented by the regional authorities after the project was completed	6 mo	Descriptive statistics	No consultation was used for pulmonology in the component 2 (component 2 is relevant to the objectives of the systematic review) of the system.	Assessment of TELEMACO network: Implementation of project had positive impact on innovations in working methods and procedures. Acceptance of TELEMACO Services by the Health Authority: health authority decided to implement new health networks for better home care	The study has three components, of which only second component which describes "Second opinion for PCPs in cardiology, Dermatology, Diabetology and pulmonology" is included in the description of the study for purpose of this systematic review. Moreover, the methods to assess the network and the acceptance are not described in details in the paper.
Thijsing et al [34]	1. Quality of Care: (using a questionnaire completed by PCPs after the TPCs) The % of Telepulmonology Consultation (TPC) requests, the % of patients physically referred by PCPs to pulmonologists, education effect experienced by PCP, % of TPCs in which the PCP was helped with the pulmonologist's response and mean response time of pulmonologists; 2. Efficiency of Care: % of prevented physical referrals, % of physical referrals who otherwise would not have been referred to a pulmonologist.	April 2009 and November 2012. (3 y and 8 mo)	Descriptive statistics	Twenty-three percent of the patients were diagnosed with COPD by pulmonologist. The pulmonologist answered 'Unsure' to the question 'Diagnosis COPD?' in 16% and with 'No' in 61% of the cases.	Quality of care: 1. percentage of TPCs sent by PCPs for which advice of a pulmonologist was requested: 69%; 2. 92% PCPs admitted to have learned from the pulmonologists; 3. in 96% cases, the PCPs or patients found the pulmonologists' advice helpful; 4. percentage of patients physically referred by the PCP to the pulmonologist, who would not have been referred without telepulmonology: 18% of the TPCs; 5. Pulmonologists answered the TPCs on average after 18.2 working hours. Efficiency of care: 1. the percentage of prevented physical referrals: 27%	Telepulmonology can contribute to more efficiency and a higher quality of care for COPD patients. The clinical follow up of the patients is not done, neither any data mentions if the patient visited the pulmonologists after the suggested referral. The pulmonologists are not asked about the services/ the data are not presented in the paper. The pulmonologists responded after 18 h average; however, the paper does not mention how the patients were informed about the diagnosis/ treatment suggested.

Table 3. Continued

Report title	Methods for data collection	Study duration	Analysis	Clinical outcomes	Other outcomes	Study limitations and critique
Meming et al [35]	1. Feasibility, the proportion of PCPs in the target area who used the AC service, the proportion of patients with asthma or COPD who were assessed by the service, the quality of the spirometry and the number of patients that could be diagnosed, and the variation in diagnostic pattern between the different pulmonologists by using χ^2. 2 Follow-up visits. Patients for whom medication change was advised by the pulmonologist were automatically schedule d for an additional follow- up assessment after 3 mo	2007 to 2012 (5 y)	Nonparametric paired tests were used to compare baseline data with follow-up data. Paired t tests were used for the longitudinal evaluation of FEV1(in litres). Follow-up data of baseline GOLD stages are presented to show the distribution of these patients to other GOLD stages	1. Usable quality for diagnosis spirometry as per pulmonologist 93.6%; 2. diagnosed patients: 79.4%; 3. Baseline diagnosis matching with follow-up: 91.2%; 4. Inhalation technique improved significantly, from 35.1% to 52.5% in three months; 5. Significant improvement in Asthma and COPD status during follow-up. Well controlled asthma patients from 23.9% to 49.5% and well controlled COPD patients from 27.4% to 48.9% in three months	79.3% of the PCPs in the target area referred patients to the service. 60% of adults' asthma and COPD patients were referred at least once.	If PCP followed the referral recommendation of the pulmonologist is not documented
Fadaizadeh et al [36]	(1) Compare the pace of tele-consultation and regular (bedside) consultation: Patient records assessed and the mean time between requesting consultation and visit by the off-site physicians was evaluated and compared; (2) Physicians' satisfaction from tele-Consultation: A questionnaire comprising of three choices was used (fully satisfied, partly satisfied, and not satisfied)	October 13 to December 2015 (26 mo)	Comparison of mean time using Mann-Whitney non-parametric test.	The highest rate of consultation was in neurology (27 cases) and thereafter, in neurosurgery (11 cases). Other consultations were in endocrinology (3 cases), gastroenterology (2 cases), thoracic surgery (2 cases), vascular surgery (2 cases), ophthalmology (1 case), haematology (1 case) and dermatology (1 case)	1. Teleconsultations were answered 2.5 times faster than face to face consultation; 2. Satisfaction survey results showed that the physicians were fully satisfied with tele-consultations in 82.75% of cases. They were partly satisfied in 12.06% and not satisfied in 5.17% of consultations	The paper describes the tele-ICU for thoracic surgery patients however, the consultation provided was mostly for other problems and only two consultations of thoracic surgery are mentioned in the results. Moreover, the number of consulting physicians is not mentioned in the paper
Weikert et al [37]	Authors evaluated basic patient characteristics (age and sex) as well as the geographic distribution of referring hospitals. Furthermore, authors analysed technical aspects like slice thickness, tube current (mAs) and peak kilovoltage, determined whether the slice thickness of transmitted CTs complied with the recommendations defined by the Fleischner Society and in the ATS/ERS/JRS/ALAT guideline. A questionnaire based online survey was conducted to assess satisfaction with and impact of the program and the structured reports that were generated within the context of the teleradiology program.	Jan. 2014 to May 2019 (5 y)	Descriptive statistical analysis	Satisfaction with the centralized IFF expert teleradiology program was 8.4 (out of 10). Their impact on the clinical management of the patients was rated 9.0/10. The utility of the teleradiology program regarding the gaining of own expertise in IFF was assessed as 9.3/10.	All referring physicians (100%) stated that they would recommend the centralized IFF teleradiology program to their colleagues	The HRCT referral although was intended from 12 countries, half of those did not contribute to even 10% of the total number of scans. The survey was taken only by one third of the total participating physicians hence the satisfaction results couldn't be generalized.
Wrenn et al [29]	Authors categorized the question asked during teleconsultation as "diagnosis," "treatment," and/or "monitoring." They further reviewed the medical record to determine the percentage of specialist recommendations PCPs implemented, and the proportion of patients with a specialist visit in the same specialty as the teleconsultation emergency department visit, or hospital admission during the follow-up	August 2012 and January 2013 (6 mo)	Descriptive statistics	No clinical outcomes	1. PCPs asked questions related to diagnosis in 71% of cases, treatment in 46% of cases, and monitoring in 21% of cases; 2. CPs ordered 79% of all recommended laboratory tests, 86% of recommended imaging tests and procedures, 65% of recommended new medications, and 73% of recommended medication changes. In the six months after the teleconsultation, 14% of patients had a specialist visit within the UCSF system in the same specialty as the teleconsultation	The patient visit to specialists were recorded if the patient visited the same hospital, however, there is a possibility that the patients could access another health care facility. The results are analyse d from the data collected from one centre hence the results may not be generalizable.

Table 4. Study aim and outcomes

Report title	Study population description	Aim of study	Type of outcome measure	Facility description
Koizumi et al [30]	Two patients with chronic respiratory failure, attending PCP, and one pulmonary specialist	To create and test a multi-station teleconsultation support system, three remote locations were connected: the homes of two patients with chronic respiratory failure, the hospital of the attending PCP and a pulmonologist in another hospital	The effectiveness of a system connecting multiple terminals for teleconsultation. (Notes: although the methods to measure the effectiveness is not described). The feasibility of use is established	Two patients with chronic respiratory failure, the hospital of the attending PCP, and the hospital of the pulmonary specialist.
Raza et al [28]	Six pulmonary specialist at the Milwaukee site and the patient and ancillary provider (nurse or respiratory technologist - RT) at the Iron Mountain. 314 patients	The goals of the study were (1) to evaluate the use and effect of teleconsultation technology to provide consultative outpatient care for a broad range of pulmonary conditions; and (2) To evaluate the use of a teleconsultation program in terms of (a) access to care (including reduction in both travel for patients and waiting time for appointments), (b) clinical decision making (medical interview and physical exam, medical work-up required, and outcome of teleconsultation), and (c) patient disposition (need for follow-up care and need for in- person evaluation)	1. Reasons for referrals and access to speciality care; 2. Medical process of care 3. Physicians' diagnoses after teleconsultations 4. Medical decision making 5. Patient demographics 6. Patient Satisfaction. 7. Number of visits and Travel distances	Remote location (Spoke): Iron Mountain VAMC in Iron Mountain, MI and Provider (Hub): Milwaukee Veteran Affairs Medical Centre (VAMC) pulmonary teleconsultation clinic
Averame et al [31]	638 PCP and pulmonary specialist for interpreting the telespirometry	To report feasibility and usefulness of telespirometry in general practice from Italian Alliance study. (Aim of the Alliance study was (a) to improve the familiarity of PCPs with spirometry; and (b) to demonstrate the usefulness of a spirometric evaluation)	Diagnostic accuracy of PCPs interpreting spirometry in asthma and COPD according to ACCP, GOLD and ATS/ERS Guidelines	PCP office and pulmonary units
Bonavia et al [32]	large sample (937) of PCPs from all regions of Italy and Fifty-one pulmonary units distributed throughout the country. 17910 subjects	To report the results of an Italian study on the feasibility of telespirometry in general practice	Feasibility of telespirometry in general practice	PCP office and pulmonary units
Bernocchi et al [33]	Patients, 176 PCPs two specialists	Combining management, clinical, and technological tools to improve provision of health care in rural areas, from secondary care community hospital settings to home care	The aims of the project were 3-fold: (1) to implement and use continuity-of-care services (2) to design a network in the territory for sharing continuity-of-care programs for the management of chronic diseases (3) to allow the health authority to collect data to establish sustainable pricing at the regional health level for implementing TM	1. Home-Based Tele management for Patients with Chronic Heart Failure or Chronic Obstructive Pulmonary Disease 2. Second opinion for PCPs at PCPs' Office 3. Second opinion on digital images between PCPs office and specialist hospitals.
Thijssing et al [34]	158 PCPs and 32 pulmonologists	To assess the effect of telepulmonology on quality and efficiency of care	Effect of telepulmonology on quality and efficiency of care	PCPs office and pulmonary specialist's office
Metting et al [35]	11401 patients suspected to have obstructive airway disease (OAD) 360 PCPs from north Netherland, 10 pulmonologists	To improve the management of asthma and COPD patients in primary care using an internet-based service	Feasibility, effectiveness and efficiency in supporting PCPs to diagnose and manage asthma, COPD and overlap syndrome patients.	PCP's office, Laboratory facility for conducting spirometry and pulmonary specialist's office. Communication over internet
Fadaizadeh et al [36]	1. 58 Thoracic surgery patients; 2. consulting physician located in a remote hospital	To assess the advantage of teleICU by accelerating consultations and bringing physicians' satisfaction from teleconsultation outcomes	1. Comparison of the pace of teleconsultation and regular(bedside) consultation of ICU patients admitted during the year before starting tele-ICU; 2. the physicians' satisfaction from teleconsultation	Tertiary pulmonology/ thoracic surgery hospital (location of specialist is not mentioned)
Weikert et al [37]	Databased analysis no study population. Data from 239 hospitals located in 46 cities in 12 countries	To support referring centres to interpret HRCT with respect to UIP in patient with suspected Idiopathic Pulmonary Fibrosis (IPF)	Feasibility of cross-border teleradiology for the provision of state-of-the-art reporting	Referral hospitals (location of specialist is not mentioned)
Wrenn et al [29]	86 Primary care providers (PCP) from eight adult primary care sites at the University of California, San Francisco (UCSF), USA, 195 patients	To analyse how the teleconsultation program affects clinical management of patients in primary care	Percentage of specialist recommendations PCPs implemented, and the proportion of patients with a specialist visit in the same specialty as the teleconsultation, emergency department visit, or hospital admission during the subsequent six months	PCPs office (location of specialist is not mentioned)

with multiple organ failure [36] and Weikert et al. included patients with presence of Usual Interstitial Pneumonia (UIP)-pattern in patients with suspected Idiopathic pulmonary fibrosis (IPF) [37].

Study designs

The 10 papers included in this review are summarised in Table 2 and the aims and outcome measures in the included studies are described in Table 4. There were no randomised controlled trials or controlled before-and-after studies. Four studies, which yielded five papers, were cross-sectional studies which described numbers of patients and health systems where teleconsultations were implemented [28,31,32,34,36]. Two of these five publications were about ongoing systems described retrospectively [28,34]. Three papers described the ongoing systems [29,33,37], two of which used descriptive statistics to report the outcomes quantitatively [29,37] and the remaining one was a narrative technical description of the teleconsultation system [33]. Only one study, which described three case reports, did not include any quantitative analysis [30] and one study described data at baseline and assessed the patients' clinical outcomes longitudinally after the intervention [35].

Country of the studies

All but one of the included studies were conducted in high-income countries. Five papers referred to four studies conducted in Europe [31-35], two in the US [28,29] and one each in Japan [30] and Iran [36]. One study was conducted in a network collaboration of 12 hospitals in Central Eastern Europe and Asia [37] (Table 2).

Quality assessment and limitations of the included studies

The quality assessment of the studies was done using JBI tools [27] (Table 5, Table 6 and Table 7). All papers were rated as moderate or low quality. Papers were assessed based on study types. Three papers were assessed as text or opinion papers (Table 5), half of the selected papers were analytical cross-sectional studies (Table 6), one a study of diagnostic accuracy and one a case study (Table 7) and were assessed using respective parameters. All the selected studies have certain limitations (Table 3). The opinion papers [29,33,37] did not logically defend incongruence with the literature/sources, whereas the confounding factors were either not considered or mentioned in the cross-sectional analytical studies [28,31,32,34-36]. The one case study [30] reported is a low-quality paper.

Table 5. Quality assessment of the selected publications using the JBI tools for critical appraisal (text & opinion papers)*

Study title	1. Is the source of the opinion clearly identified?	2. Does the source of opinion have standing in the field of expertise?	3. Are the interests of the relevant population the central focus of the opinion?	4. Is the stated position the result of an analytical process, and is there logic in the opinion expressed?	5. Is there reference to the extant literature?	6. Is any incongruence with the literature/ sources logically defended?
Bernocchi et al [33]	1	3	1	1	3	3
Weikert et al [37]	1	1	1	1	2	2
Wrenn et al [29]	1	3	1	1	1	3

JBI – Joanna Briggs Institute
*1 – Yes, 2 – No, 3 – Unclear, 4 – not applicable.

Table 6. Quality assessment of the selected publications using the JBI tools for critical appraisal (analytical cross-sectional study)*

Study title	1. Were the criteria for inclusion in the sample clearly defined?	2. Were the study subjects and the setting described in detail?	3. Was the exposure measured in a valid and reliable way?	4. Were objective, standard criteria used for measurement of the condition?	5. Were confounding factors identified?	6. Were strategies to deal with confounding factors stated?	7. Were the outcomes measured in a valid and reliable way?	8. Was appropriate statistical analysis used?
Raza et al [28]	1	1	1	1	2	2	1	1
Averame et al [31]	1	2	1	1	3	3	1	1
Bonavia et al [32]	1	1	2	1	3	3	2	3
Thijssing et al [34]	1	1	1	1	3	2	1	1
Fadaizadeh et al [36]	1	1	1	1	2	2	1	1
Metting et al [35]	1	1	3	1	2	2	3	1

*1 – Yes, 2 – No, 3 – Unclear, 4 – not applicable.

Table 7. Quality assessment of the selected publications using the JBI tools for critical appraisal (case report)*

Study title	1. Were patient's demographic characteristics clearly described?	2. Was the patient's history clearly described and presented as a timeline?	3. Was the current clinical condition of the patient on presentation clearly described?	4. Were diagnostic tests or assessment methods and the results clearly described?	5. Was the intervention(s) or treatment procedure(s) clearly described?	6. Was the post-intervention clinical condition clearly described?	7. Were adverse events (harms) or unanticipated events identified and described?	8. Does the case report provide takeaway lessons?
Koizumi et al [30]	1	2	1	3	2	3	1	1

*1 = Yes, 2 = No, 3 = Unclear, 4 = not applicable.

CONCLUSIONS

We found no controlled trials and relatively few papers mainly of a moderate or low quality which explored specialist to non-specialist teleconsultation in the management of CRDs. This is in contrast to other specialities where comparatively more papers are available describing doctor to nurse or specialist to non-specialist consultation including dermatology [38], psychiatry [39,40] and radiology [41].

Of the included papers a few described systems which did not focus on any one particular disease and lung diseases were just one of the conditions which were managed using these teleconsultation systems. Although some studies indicated that such specialist to non-specialist consultation may have resulted in more local treatment and a lower proportion of referred cases to specialists. The absence of baseline data in some means it is not clear to what extent it may have increased appropriate referrals for patients who previously did not have easy access to diagnosis.

Teleconsultation in the PCPs office with the remotely situated consultant in the hub and spoke model was the most preferred way of conducting specialists to non-specialist consultation and the audio mode was primarily used for consultation. This concludes to be one of the most logistically feasible models for PCPs and specialists and also fulfils the patients' requirements. Very few studies were conducted in the LMICs and most were reported from European counties. It is possible that specialist to non-specialist consultations for CRD diagnosis and management using teleconsultation are taking place but are not being reported in academic literature. The studies we selected were relatively recent and published during the last decade.

While the available literature does not indicate any generalizability, it shows some encouragement that specialist to non-specialist teleconsultation may facilitate diagnosis and management of CRDs to the benefit of patients. However, CRD diagnosis using specialist to non-specialist teleconsultation was more pragmatic and manageable as against the CRD management.

The use of teleconsultation may potentially help patients for CRD diagnosis and management, where face-to-face consultations are not available [42]. Studies have proven to have a positive impact on the quality of life of the patients suffering from CRDs and acceptance by the health care provider [43]. Further, high-quality research to demonstrate the efficacy of the use of specialist to non-specialist consultation for managing CRDs is required to be conducted in controlled settings. A strategy to build evidence to deploy specialist to non-specialist teleconsultation to manage CRDs will aid further research [44,45]. More high-quality controlled studies are required to confirm these suggestions.

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Additional material
Online Supplementary Document

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3.4 Review of other relevant literature

During the first search process, I identified many publications, which, although not meeting the inclusion criteria (as my search question was focused on specialists to non-specialist's teleconsultation), contained useful information with respect to the technical and social barriers that introducing technology may encounter and thus increased my understanding of the topic. Telehealthcare for CRDs has been used and presented by a number of studies focusing on self-care and doctor to patient consultations. I have summarised those articles in the sub-sections below.

3.4.1 Direct patient to specialist consultation

Many studies report direct patient to specialist consultation, which can sometimes be an alternative to specialist to non-specialist consultation. For the reasons stated above, particularly in relation to the availability of specialist doctors, a model of direct patient to specialist doctor was not considered feasible in a poor rural setting such as is not under investigation in this project; however, there is considerable overlap in terms of barriers and facilitators, and so I have summarised the findings, particularly in relation to these below.

The evidence for direct patient to specialist consultations is mixed, largely from high-income countries. In the Indian context, especially in rural regions where specialists and equipment are sparse and monetary resources are few, the available evidence can help contextualise the findings. The literature on this topic is enormous, and hence, here, I have summarised a few exemplar studies which focus on overall telehealthcare in CRDs.

3.4.2 Telehealthcare in Chronic Respiratory Diseases (CRD)

3.4.2.1 Attitudes to technology

A feasibility and safety trial conducted in Switzerland, which studied responses of 48 COPD patients after teleconsultations, found that using telehealthcare technology was appreciated by patients with COPD and using it was feasible. Patient compliance, acceptance and satisfaction were very high with 95% sensitivity and 98% specificity

(Rassouli *et al.*, 2016). Another study supported these findings where a telephone survey was conducted by the Netherlands Institute for Health Services Research (NIVEL). This survey included 400 patients diagnosed with asthma or COPD. Knowledge about eHealth was assessed by asking a pre-structured questionnaire about telehealth services using a mobile application. This application was constructed in collaboration with the Dutch Lung Foundation, especially for patients with CRDs. This survey concluded that a patient's attitude on adopting eHealth is limited but can be changed positively after convincing him/her to use it briefly (Hofstede *et al.*, 2014).

3.4.2.2 Telehealthcare alone is ineffective

Another study conducted in the Netherlands aimed to understand the effect of nurse-initiated telephone follow-up on health status and healthcare utilisation in COPD patients. This study demonstrated that telemedicine alone without any form of education, pulmonary rehabilitation or training, had no benefits for COPD patients. However, this study concluded that telehealthcare has the potential of improving continuity of care, increasing efficiency of outpatient management and preventing deterioration of health status in COPD patients only if used with other interventions (Berkhof *et al.*, 2015). Further, an integrated care system for COPD patients involving the use of telehealthcare suggested that patients and their relatives expected relational continuity in contact with the medical practitioners and access to healthcare delivery either face-to-face or remote (Wodskou *et al.*, 2014).

The systematic reviews summarised below focus on telehealthcare in CRDs and provide a generic view for the use of telehealthcare for CRDs. Increased quality of life (QoL) and decreased hospital admission in COPD patients using doctor to patient telemonitoring were reported in a systematic review conducted in 2012. Although there was some evidence of improved outcomes in terms of hospital admissions, the authors concluded that these were highly complex interventions of which telehealthcare was only one component and that it was not clear to what extent telehealthcare contributed to the outcomes (McLean *et al.*, 2011). The same research group also conducted a systematic review on telehealthcare for asthma in 2012. It concluded that a variety of telehealthcare interventions used for asthma facilitate remote patient monitoring and remote decision making for healthcare practitioners to

manage their patients, but concluded that there was little evidence of clinical effectiveness in mild asthma, but there may be a role in preventing hospital admission in patients with severe asthma (McLean *et al.*, 2010). Some later studies also provided positive feedback on the management of CRDs using telehealthcare to self-monitor their symptoms (Rassouli *et al.*, 2016). However, a meta-analysis conducted in 2015 that focused on the effectiveness of telehealthcare for doctor to patient consultations for asthma indicated no difference in clinical outcomes of patients undergoing treatment with telehealthcare or standard care (Zhao *et al.*, 2015). Another systematic review conducted in 2016 on assessing the QoL of COPD patients using telehealthcare interventions suggested no superiority of telehealthcare over standard care (Ulrik *et al.*, 2016). While a recent RCT of COPD telemonitoring in Denmark demonstrated reduced hospital admissions, this came at the cost of increased ambulatory and primary care.

Research on telehealthcare shows both positive and negative results compared to traditional consultation methods for management of CRDs; however, it may have the potential to enhance healthcare delivery and its effectiveness and efficiency in areas where there is no healthcare available (Fatehi *et al.*, 2017).

3.4.2.3 Implementing telehealthcare

Telehealthcare is often introduced as an alternative to face-to-face consultation for different reasons, often without a clear rationale for how different consultation forms might help. In one study, implementation was often not well 'thought-through' in relation to personnel, training, or logistical factors and in establishing the kind of patients who were the intended beneficiaries (Atherton *et al.*, 2018). While overall, healthcare providers and patients are generally willing to use telehealthcare for the management of CRDs, patients' acceptability is higher as a result of the perceived convenience and time saved.

Telehealthcare may potentially help patients with diagnosis and management of CRDs where face-to-face consultations are not available (Pinnock and McKinstry, 2018). Studies have proven to have a positive impact on the Quality of Life of patients suffering from CRDs to some extent and acceptance by healthcare providers (McLean

et al., 2011). Further, good quality research to demonstrate the efficacy of the use of specialist to non-specialist consultation for managing CRDs is required. Also, a strategy to build evidence to deploy telehealthcare to manage CRDs using specialist to non-specialist consultation will aid further research (McKinstry, Pinnock and Sheikh, 2009).

3.4.3 Barriers and Facilitators in use of telehealthcare for CRD

Some studies that reported telehealthcare use for CRD diagnosis or management discussed the barriers to and facilitators of implementing telehealthcare systems. These findings may inform us about the barriers and facilitators for using specialist to non-specialist consultation for CRD management. The use of technology is one of the important components in such teleconsultations, and understanding preferences for the use of technology could inform future implementations. A pilot study to determine the feasibility and efficacy of using real-time telehealthcare for self-management of COPD using Skype showed that in a preconfigured startup and operation computers, lack of prior experience in using computers did not affect the study conduct (Nield and Hoo, 2012). Some studies conducted in primary care in high-income countries have shown that newer technologies like teleconsultation are adopted by younger generations. However, people who are more technology-friendly and who have time limitations tend to opt for telehealthcare services (Greenhalgh *et al.*, 2018; Donaghy *et al.*, 2019). A study conducted in Switzerland reported high satisfaction rates with using technology and appreciation of technology among patients with COPD (Rassouli *et al.*, 2016). Another set of studies conducted in 2007 showed that the patients and some practitioners were satisfied with the telehealthcare experience regardless of the technology used (Winters and Winters, 2007). This evidence points out that the use of technology cannot be perceived as a barrier for implementing telehealthcare in a specialist to non-specialist consultation for CRD diagnosis and management.

The implementation of telehealthcare for the diagnosis and management of CRDs has multiple barriers but also facilitators. Among the barriers are the technical and logistics issues (Winters and Winters, 2007; Rassouli *et al.*, 2016; Greenhalgh *et al.*, 2018; Donaghy *et al.*, 2019). Technical challenges like connectivity and video quality,

logistical challenges such as appropriate utilisation of healthcare providers' time, availability of medicine and support from technical staff need to be tackled for continuity in its usage. Controlling some barriers such as technology hurdles, professional resistance, patient resistance, management, medicolegal implications, confidentiality and data security; can improve both quality and delivery of healthcare using telehealthcare (Wallace, Wyatt and Taylor, 1998; McLean *et al.*, 2011; Sanders *et al.*, 2012; Hofstede *et al.*, 2014; Rassouli *et al.*, 2016; Mathur *et al.*, 2017; Zarch *et al.*, 2017).

Beyond the technical challenges, functional challenges of telehealthcare include the availability of competent staff and their training, generating awareness among patients about the telehealthcare facilities and its use when options for face to face consultations are not available and their willingness to embrace the technology (Atherton *et al.*, 2018; Greenhalgh *et al.*, 2018). Staff retention could be another barrier which is a major problem in a remote and rural location (Sheahan, 2002). More practical issues included video and image quality, availability and quality of connectivity and setting up video consultations in time and resource-constrained clinics (Atherton *et al.*, 2018; Greenhalgh *et al.*, 2018).

Healthcare providers' time is another crucial component to facilitate the implementation of the specialist to non-specialist teleconsultations. Patients like telehealthcare as they do not need to travel and take their time off from work to visit a doctor (Fatehi *et al.*, 2017; Donaghy *et al.*, 2019) thus, saving the cost of travel and loss of wages to attend the doctor's appointment. Healthcare providers, on the other hand, do not have a similar benefit in terms of time-saving when providing this service to their patients (Sanders *et al.*, 2012).

A study focusing on the reasons behind the reduced use of telehealthcare also highlighted the fear of facing uncertainties when using any technology, probably due to insufficient information provided by the implementers. Further, patients whose first language is not English tend to decline the use of telehealthcare as they fear that they would not understand the functioning of the equipment, the instructions for which are mainly provided in English (Sanders *et al.*, 2012).

Another organisational barrier, illustrated by an Australian project to provide remote child and adolescent mental health services in rural Australia (Sheahan, 2002), is the formation and enhancement of institutional connections and development of a network of skilled consultants to provide remote services and appropriate training. Such investment for setting up a remote consultation system requires significant funding and dedicated and enthusiastic staff to deliver these. Staff retention too is a major issue, particularly in remote and rural areas resulting in a need for continuous training of new staff. The authors concluded that the use of videoconferencing for training and consultation sessions had overcome the challenges of distance, dispersed population, environmental hurdles and logistics.

Thus the effect of staff retention (Atherton *et al.*, 2018; Greenhalgh *et al.*, 2018), their training (Sheahan, 2002), identifying motivating factors for the healthcare providers (Sanders *et al.*, 2012), and funding (Sheahan, 2002) remain important factors and yet need further exploration for effective implementation of specialist to non-specialist teleconsultations for CRD management.

3.4.4 Specialists to non-specialist consultations in diseases other than CRD

Telehealthcare can offer improved communication and patient management between secondary and tertiary care providers, and due to its high efficiency and sensitivity, it is widely used in teleradiology, telepathology, teledermatology and other specialities. The specialists to non-specialist consultation allow a greater number of patients to be attended locally and simultaneously without hospital admissions (Wallace, Wyatt and Taylor, 1998).

Although specialist to non-specialist consultations are commonly observed in the community, I found very few research publications on such consultations. A cross-sectional study conducted in Ontario city and neighbouring rural communities in Canada reported 15237 electronic consultations in five years for all disease conditions, of which in 127 cases of teleconsultation to PPs was supported by nine different allied health and medical specialists. This paper assessed the ability of teleconsultation to improve access of primary care doctors and/or nurse practitioners to specialists and allied health professionals (AHP). The primary care providers and nurses presented a

similar proportion of cases to the specialists and AHPs. The cases presented by doctors to AHP were primarily urban, and 22% originated from rural as against only 12% of cases sent to specialists originated from rural areas. Face to face referrals were avoided in 73% of cases submitted to AHP and 69% of cases of specialists (McKellips *et al.*, 2017). A similar approach resulted in the resolution of 14000 cases using eHealth specialist consultation using the same teleconsultation system in Canada. 65% of physical visits to the specialists were prevented in five years' duration. (Liddy *et al.*, 2018). These studies demonstrate the feasibility of specialist to non-specialist teleconsultations when the service was free of cost to the patients and compensation to the AHPs and specialists was provided by research funding. However, the sustainability of such a service needs to be tested in a real-world setting where patients, governments or insurance companies have to provide payment.

There is an important ongoing public health program utilising teleconsultation between primary care facilities and tertiary care facilities undertaken by the state government of Maharashtra in India, which aims to provide expert consultation to patients in remote areas. These currently functional facilities across the state have treated nearly 200,000 patients using telehealthcare services since 2006 (NHM Maharashtra, 2019), but reports on the effectiveness of these systems are not documented. Although the public health system is reported to be a conducive environment to run such programs, it is a pity that there is no good quality audit or research evidence to establish its effectiveness or cost-effectiveness compared with a traditional approach.

A study testing the feasibility of specialist to non-specialist teleconsultation studied the use of telehealthcare for assessment of head and neck cancer in the Shetland Islands, UK. An Ear, Nose and Throat consultant assessed the patients for head and neck cancer based on the images of tele-endoscopy performed by a doctor at a remote location. This study concluded that the use of tele-endoscopy via videoconferencing reduced the numbers requiring to travel to the mainland, which in turn reduced carbon emissions and outdoor air pollution and saved time for patients. Further, a primary cost analysis also showed that if 35 patients were assessed per year using tele-endoscopy, the cost of travel was more than the set-up of the tele-endoscopy (Dorrian *et al.*, 2009),

clearly demonstrating not only the feasibility and acceptability of the approach but also cost-effectiveness.

A review that compared six successful telepsychiatry models from America suggested that telepsychiatry can overcome geographic inequities. This review also indicated strengthened professional relationships, including increased trust between specialists and primary care doctors due to the successful implementation of such teleconsultations (Hilty *et al.*, 2006). Another review described and compared five different models of telepsychiatry to overcome lack of capacity and geographic inequities. Here, the authors confirmed that the tele-psychiatry referral model had the potential to geographically redistribute specialist mental health services, giving opportunities for the rural, underserved population to utilise the mental health services. It further suggests that telepsychiatry collaborative care, which puts telepsychiatrists and tele-therapists in consultation roles, can leverage scarce specialist resources in mental health. However, the review advised further implementation research to identify the most effective strategy for implementing evidence-based telepsychiatry models for routine care (Fortney *et al.*, 2015). Despite being effective in overcoming geographical inequalities, urban and rural settings, may experience the effectiveness of telehealthcare differently (McKellips *et al.*, 2017). Rural caregivers who face more challenges in terms of transportation, medicinal support, unavailability of clinicians, home health, fewer caregiver support groups, *etc.*, have more to gain than urban caregivers who also can have better access to technology (e.g. faster broadband 4G) and therefore information.

Another study reported the unplanned teleconsultation between specialists and non-specialists for dermatology and burn management in South Africa. This was the only study from an LMIC that I came across for specialist to non-specialists teleconsultation and indicated that more work is needed to integrate such consultations in regular practice (Mars and Scott, 2017).

Chapter 4. Research Methods

The previous chapters provide the background and review of the available literature, which informs the rationale for conducting this study to address the first of the secondary objective of my study.

In this chapter, I describe the methodology and the details of the methods used for addressing the below study objectives. I referred to the COREQ checklist to structure this section (Tong, Sainsbury and Craig, 2007).

2. To determine the requirements, including equipment and skills to support local primary physicians in remote CRD diagnosis and management

3. To explore barriers to and facilitators of successful implementation of specialist to non-specialist teleconsultation at MHC in CRD diagnosis and management from the viewpoints of patients, opinion leaders, primary and respiratory physicians.

4. Following the use of the teleconsultation, service to understand the perception of the patients and health care providers of remotely supported consultations

4.1 Research Design

4.1.1 Philosophical background

All research is dependent on an underlying theoretical perspective, and a qualitative researcher requires a basic understanding of the concepts of ontology and epistemology before embarking on the qualitative research journey (Abend, 2008). Ontology (nature of knowledge) and epistemology (approach to knowledge) are the theoretical basis of the research. Ontology is a general theory to assess the beliefs and understanding of the situation, thus focusing on the nature of knowledge (study of reality). It is a system of belief that reflects an interpretation by an individual about what constitutes facts. In comparison, epistemology is a philosophical enquiry to understand how we know what we know, thus focusing on the approach to knowledge (Charmaz and Bryant, 2010).

Positivist ontology seeks objectivity in arriving at the universal truth. It seeks to prove or disprove a hypothesis by quantifying or measuring the phenomenon. In positivism, reality is independent of an individual's perception and is measured objectively. Interpretivism, on the other hand, holds the view that reality and knowledge are socially constructed by humans, *i.e.* there is no objective reality (Bunniss and Kelly, 2010; Feilzer, 2010). As a researcher, it allows subjective analysis and is sympathetic to the perspective of the research subjects. In interpretivism, an explanation is sought as to why reality is the way it is. However, it does require the researcher to be reflexive about what might influence analysis (Bunniss and Kelly, 2010; Feilzer, 2010).

I initially associated positivist ontology with a quantitative approach and interpretivism with a qualitative approach. However, a clear distinction between these approaches is difficult (Conboy, Fitzgerald and Mathiassen, 2012). Hence to investigate the reality of using telehealthcare for CRD diagnosis and management, I needed to know what the stakeholders perceived the reality to be and their lived experiences. Answering the objectives of my PhD required understanding the reasons behind certain preferences and not just measuring the outcomes; hence I chose an interpretivist approach (Morgan, 2016) to address the second, third and fourth secondary objective. I have summarised my approach in below Figure 4.

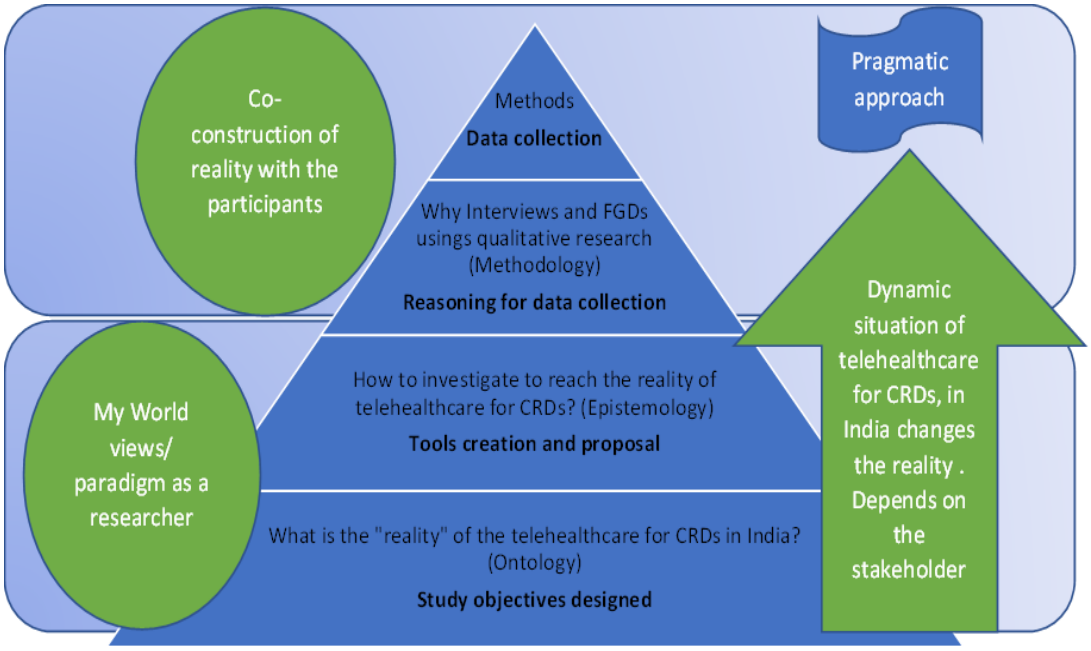

Figure 4: Elements of my world views and their implications for choosing a pragmatic approach

Telehealthcare may be one of the most convenient ways to provide healthcare to the population, yet, despite available infrastructure and resources, it is underutilised (Caffery and Smith, 2010). I wanted to understand why telehealthcare systems and services are not being used to their full potential. Documenting the experiences and opinions of stakeholders who have worked in telehealthcare, especially for the diagnosis and management of CRDs, required a qualitative approach. Further understanding of the health care providers' needs for CRD diagnosis and management required detailed interactions with the stakeholders. These detailed interactions were also extended to understand their perspective on using teleconsultation systems for CRD diagnosis and management. I employed qualitative methods, especially the interview and focused group discussions with the Opinion Leader (OL) and doctor participants and structured administered questionnaire with the patient participants using a mixed-method approach. I acknowledged my reflexivity throughout the process.

4.1.2 Underpinning theory

Theories in qualitative research can be used in research design and analysis. Theories inform research either by using existing theories in research design or in deciding methodology or are developed de novo as a result of empirical research. Theories sometimes act as tools to help arrange the concepts of research and define a phenomenon (Kelly, 2009). G. Abend defined the theory as "a generalised statement of abstractions or ideas that asserts, explains or predicts relationships or connections between or among phenomena, within the limits of critical bounding assumptions that the theory explicitly makes" (Abend, 2008). A theory includes constructs and their definitions and describes the interrelationship between the constructs, explaining a phenomenon (Kivunja, 2018). Theories provide a basis for conducting research to understand, apply or analyse new ways to investigate relationships within the constructs of a framework; and help researchers consider essential and critical components to solve a particular problem. In other words, theories basically provide a framework for researchers which helps to focus on different aspects of data, to understand a complex social process or problem. This study is intended to address the "Why" and "How" around the feasibility of teleconsultation in remote areas and focuses on understanding the perceptions of stakeholders and end-users of the telehealthcare to strengthen an existing underutilised telehealthcare centre for diagnosis and management of CRD in remote rural regions,

I considered Normalisation Process Theory (May, 2006) (May and Finch, 2009) (Murray *et al.*, 2010) (May *et al.*, 2018), Diffusion of Innovation (Rogers, E.M., Singhal, A. and Quinlan, 2014), Medical Research Council (MRC) framework for complex interventions (Craig *et al.*, 2019) and Non-adoption, Abandonment, Scale-up, Spread, Sustainability (NASSS) Framework (Greenhalgh *et al.*, 2017). However, as my research revolved around using an existing system, I considered using NPT as a relevant framework as it focuses on embedding and integrating the interventions in regular practice, which is

related more closely with my proposed work. On the other hand, Diffusion of Innovation looks at how innovations spread throughout societies from introduction to widespread adoption. This might have been a useful theory if I was looking at how telemedicine for CRDs was adopted in various centres but perhaps was less relevant as I wanted to implement a new system in one setting. Further, the MRC framework for complex intervention focuses on how to develop an intervention and my study revolved on strengthening an existing intervention. The NASSS framework although did relate to the objectives of my research it mainly focused on predicting and evaluating the success of technology supported health and care programs. Hence, I found using the NPT as most relevant framework for my research.

4.1.2.1 Normalisation Process Theory (NPT) and constructs

Normalisation Process Theory (NPT) offers a framework to describe, assess and enhance the implementation of an intervention (Murray *et al.*, 2010). The use of specialist to non-specialist teleconsultation for CRD diagnosis and management is one such complex intervention already existing in the primary care setting. I made use of Normalisation Process Theory (NPT) (May, 2006; Murray *et al.*, 2010) to understand and describe the dynamics of implementing this complex intervention.

Construct	**Description**
Coherence	‘Sense-making How is the intervention understood by participants? How do they compare it with other practices?
Cognitive participation	How do participants come to take part in a practice? What keeps them motivated to continue taking part?

Collective action	How do participants make it work? How are their activities organised and structured?
Reflexive monitoring	How do participants evaluate a practice? How does this change over time, and what are its effects?

Each of these four constructs are further made up of four components each.

Coherence means the ability to apply logic in this context, translated to meaning and sense-making by the participants. Coherence is one of the four core constructs of NPT and further includes four components.

- The first component is differentiation which can help us understand if the intervention is easy to describe and if it can be easily differentiated from the current systems.

- Communal specification, the next component answers if the participants have or can build a shared understanding of the proposed intervention's aims, objectives, and expected outcomes.

- To understand whether individual participants have or can make sense of the work-specific tasks and responsibilities the proposed intervention would create for them, Individual specification-another component of coherence, can guide the description.

- The fourth component of coherence is internalisation which describes if the participants understand the potential value, benefits and importance of the intervention.

Cognitive participation, the second core construct of NPT, explains how people involved in the intervention build and sustain practices around the new intervention.

- Initiation describes whether the key individuals are able and willing to get others involved in the new practice.

- Legitimation, a component of cognitive participation, answers whether or not participants believe it is suitable for them to be involved and if they can make a valid contribution to the implementation work.

- Enrolment is the third component of cognitive participation, which assesses participants' capacity and willingness to contribute to the work involved in the new practice collectively.

- The last component of cognitive participation is Activation which will help us assess the capacity and willingness of participants to collectively define the actions and procedures needed to keep the new practice going.

Collective action is the third core construct of NPT. It is the operational work that people do to enact a set of practices, whether these represent a new technology or complex healthcare intervention. This identifies if there is sufficient support from management, if the individuals are confident about their co-workers' contributions and if tasks are correctly allocated according to their skill sets.

- Interactional workability is the first component of collective action that answers if people can enact the intervention and operationalise its components in practice.

- Another component of collective action, Relational integration, determines whether people maintain trust in the intervention and each other.

- The third component of collective action is Skill-set workability which describes if the work required by the intervention is seen to be parcelled out to participants with the right mix of skills and training to do it.

- The last component is Contextual integration which describes if the intervention is supported by management and other stakeholders, policy, money and material resources.

The last construct of NPT, reflexive monitoring, appraises the impact of change or intervention on individuals and the collective impact.

Normalisation theory facilitates understanding of a process by focusing attention on the mechanism through which participants contribute (Murray *et al.*, 2010). I used the constructs within NPT as tools to describe and understand the findings of my study (Figure 5)

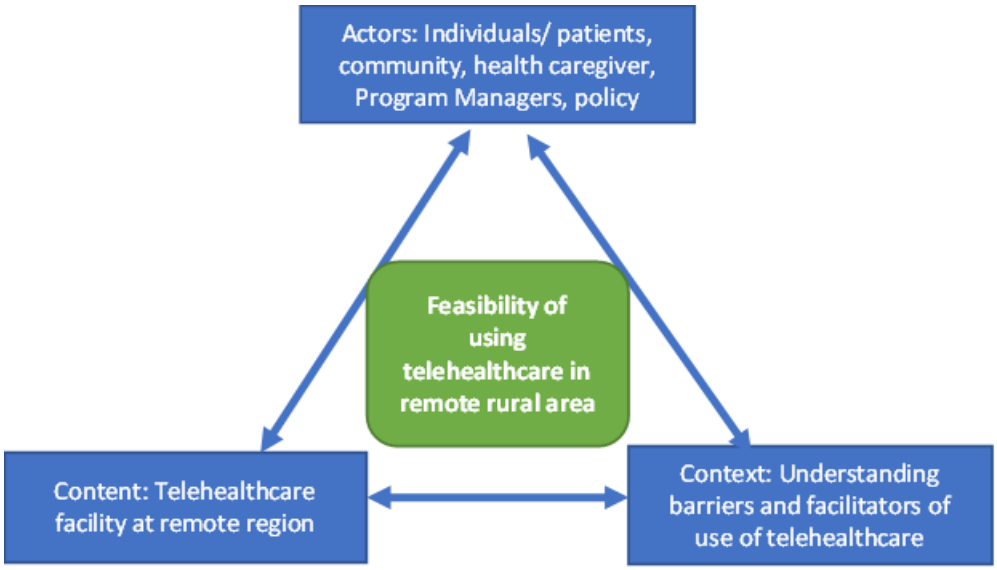

Figure 5: NPT framework for assessing Feasibility of using a teleconsultation facility in management of CRDs in remote rural area

4.1.3 Choice of research design

The mixed-method is an approach that combines both qualitative and quantitative research approaches to answer a research question (Creswell, 2009). I primarily used qualitative research methods to address the study objectives. However, I also incorporated some

quantitative research methods to understand patient perceptions and experiences of the teleconsultation service. Mixed methods further help address both confirmatory and exploratory research questions (Murphy et al., 1998) and hence I used this approach to address the fourth secondary objective "Following the use of the teleconsultation service, to understand the perception of the patients and health care providers of remotely supported consultations."

Qualitative research is commonly used to describe social phenomena, primarily answering the "Why?", "How?" and "What way?" of any research questions (Barbour, 2000). As I sought to understand why specialist to non-specialist teleconsultation for CRD might or might not work, in what way it could be facilitated and how this might be done, a qualitative approach seemed appropriate: qualitative research helps to examine the daily processes, identify the barriers and facilitators of the processes, and suggest changes in day-to-day processes. It was also apparent that the answers to these questions were contingent upon the context in which the teleconsultation was being implemented, for example, the geographic location, the people involved and the moment in time: qualitative research is particularly useful when studying context as it can generate detailed accounts of the environment. As my study revolved around understanding the processes and reasons behind the processes, it required flexibility in conducting research (Carter, Ritchie and Sainsbury, 2009). Qualitative research could grant such flexibility and facilitate meeting the study objectives.

I considered whether quantitative methods would be useful to address my research questions. Quantitative methods are most suitable when systematically measuring certain pre-determined variables or outcomes. However, in my study, I did not intend to measure aspects of the teleconsultation process rather understand it and the context and obtain detailed insights into how it might work. Yet, as in my fourth secondary objective, I intended to understand the patients' perception (and health care providers) following the use of teleconsultation. Based on my previous work in the study area, I assumed that the patient participants were not used to being asked about their views (especially on the use

of technology) and hence would need a simplified structure for expressing their views on teleconsultation. I, therefore, used a partial quantitative approach which included a 5-point Likert scale combined with open-ended questions for understanding the patients' perception.

Thus, although a mix of qualitative and quantitative approaches, my study was dominated by the qualitative research design.

4.1.4 Sampling

Sampling in qualitative studies often involves identifying a 'special' population instead of an 'identical' population in epidemiological studies. Participants are selected because they are uniquely positioned to help the researcher to understand the processes being investigated and their meanings (Carter, Ritchie and Sainsbury, 2009).

'Purposive sampling' is this deliberate choice of individuals as informants due to their qualities (Tongco, 2007). Usually, these participants have rich information about a particular topic, and hence are 'special' and not 'typical' or 'average' (Carter, Ritchie and Sainsbury, 2009). Purposive sampling additionally aims to get the broadest possible array of views recognizing that different types of people may see the problem differently. They may vary in terms of age, gender, social status, rurality, income, profession. Moreover, in qualitative research, the sampling is usually done dynamically as the study progress to explore issues that emerge during the data collection (Carter, Ritchie and Sainsbury, 2009)(Murphy *et al.*, 1998).

However, in some instances, pragmatic considerations are integrated with systematic sampling ways (Murphy *et al.*, 1998). This may include purposeful random sampling, stratified purposeful sampling or snowballing. Purposeful random sampling is used when a large pool of information-rich participants is available, and there is no differentiation in the choice of participants. Stratified purposeful sampling is used when one wants to ensure the representation of preselected parameters (Sandelowski, 2000). Furthermore, in

snowballing, the researcher requests one participant to suggest another who is suitable for addressing certain or all elements of the research questions, thus leveraging the natural social networks (Noy, 2008). Another differentiation of sampling methods is based on the type of participants chosen instead of the way of selection. Extreme or deviant sampling or maximum variation sampling (Patton, 2002) are other ways to identify the participants. Extreme sampling involves selecting unusual participants to understand the unusual circumstances of the research. In contrast, maximum variation sampling achieves heterogeneity within participants to understand a phenomenon through various perspectives from a variety of people in different settings (Patton, 2002).

For my study, I used a wide range of purposive sampling techniques, as mentioned in

Table 2 in Chapter 5, to identify and select the study participants. This provided me with the flexibility to use various ways to identify the participants who could contribute information that could help answer my research questions.

4.2 Methods

4.2.1 Regulatory and ethical considerations

I received the approvals for the proposal, data collection tools and informed consent document from the University of Edinburgh ACCORD sponsorship (Ref no. AC19069 dated 12th June 2019) and KEMHRC Ethics Committee (Ref no. KEMHRC/RVM/EC/ 1015 dated 18th July 2019). I conducted the study in accordance with the principles of the International Conference on Harmonisation Tripartite Guideline for Good Clinical Practice (ICH GCP) and Indian Council for Medical Research guidelines for conducting biomedical research 2017 (Mathur, Thakur and Hazam, 2019). I ensured that all the study participants willingly consented to participate in the research after I informed them about the study purpose, study conduct, the potential risks and benefits, time required for the data collection, confidentiality, and information that no costs are associated with participation in the study. I provided a copy of the information sheet (Appendix 3) to all the participants through email or handed it over to the participants during the consent. I explained the certified translated informed consent form (Appendix 4: English version of the patient consent) to the patients before their recruitment. They were also given reasons for their inclusion in the study. Their rights to refuse or withdraw from the study were also explained during this period. A copy of the signed informed consent form was shared with the participants before initiating the interview or Focus Group Discussions (FGD), and another copy was stored with me for the record. For participants whom I approached via email, I sent a copy of the informed consent form and the invitation to participate to be

aware of the study processes before they agreed and gave an appointment for data collection via email communication.

4.2.2 Identifying study participants

My study participants included four groups.

1. The first group comprised of opinion leaders, including people already in the business of telehealthcare and researchers working in teleconsultation in India

2. The second group included the healthcare providers, including Respiratory Physicians, who would provide teleconsultation to the Primary Physicians and patients

3. Further, Primary Physicians and technicians who provided direct service to the patients presenting at the telehealthcare centre formed the third stakeholder category

4. The last category included patients suffering from respiratory symptoms or diagnosed with chronic respiratory diseases residing in rural areas

I aimed to conduct 10 to 12 in-depth interviews with OLs until data saturation and planned two FGDs, one with the PPs and the other with the specialist RPs. Further, I targeted structured administered questionnaire with 30 patients. The details of the recruited study participants are described in

Table 2 in Chapter 5. In the OL group, I approached nearly 26 probable participants. In the health care providers group, I aimed to involve all the potential healthcare providers, including all six RPs from King Edward Memorial Hospital (KEMH), who would provide teleconsultation to the PP and patients.

Further, PPs who provide direct service at the telehealthcare centre formed another stakeholder category. I approached all the PPs at VRHP and WDTC Pabal who had either already provided or intended to provide their services in the future at the telehealthcare centre. The last category included patients diagnosed with or with symptoms of chronic respiratory diseases residing in rural areas.

I identified potential interview participants in two ways). Firstly, using the organisational network of KEMHRC VRHP, I identified people, mostly the OLs, who worked in telehealthcare in some capacity. This network included advisors, collaborators, or people who could be approached using institutional references or personal introductions by my colleagues at VRHP. This approach increased the possibility of receiving a positive response from the potential participants. Secondly, I created a list of institutes, organisations, and companies working in telehealthcare in 2016-17 and identified the contact person for these organisations. This list included the source of information through which I listed the organisation or person, contact information, the reason for inclusion, and brief information on the organisation's work. I then sent email communications and a screening questionnaire to the identified potential participants one after the other to invite them to participate in my study. And thirdly, I invited all stakeholders who are part of the functioning of the Pabal MHC, including the PPs, RPs and coordinators. I segregated all these participants based on their role as specialists RP, a PP or an OL.

To recruit patient participants, I approached all the patients with respiratory conditions presenting for the regular clinic activities, every Wednesday and Friday, at the Pabal MHC and included all those who consented to participate in the study. Patient data were collected from February 2020 to January 2021 with multiple breaks due to COVID

pandemic restrictions, whereas data from other stakeholders were collected from July 2019 to March 2020. The details of the study participants are presented in

Table 2 in Chapter 5

Informed consent to participate was obtained from all interviewees before the interview. The detailed process of administering the consent is mentioned in section 4.2.1. In some cases, mainly when the participants belonged to government organisations, written or oral permission was also obtained from those supervising them for their involvement in the study. These permissions were requested through a letter on the institutional letterhead to confirm the request's authenticity

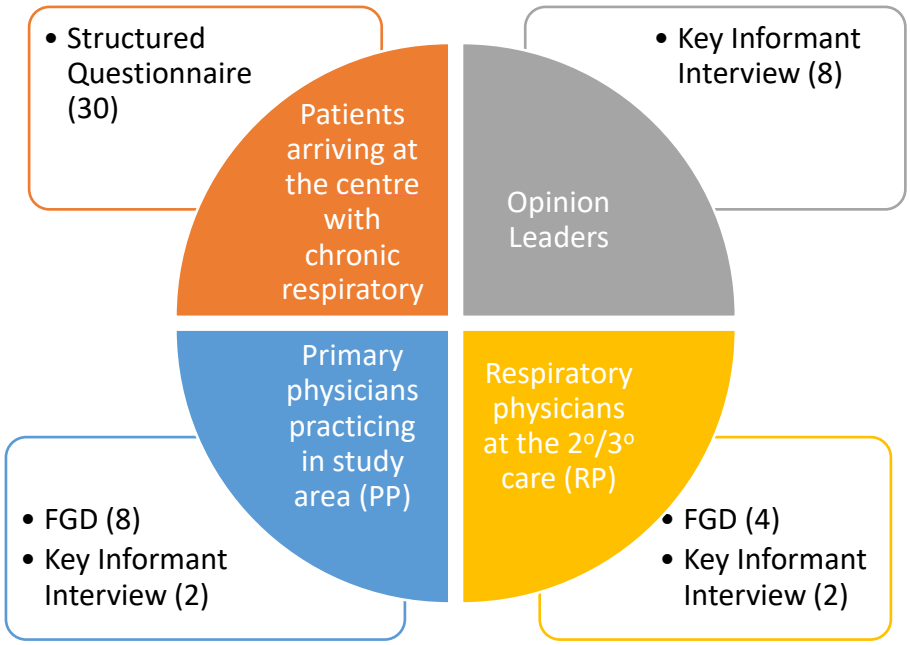

Figure 6: Types of Study Participants and Methodological approach

4.2.3 Choice of methods for qualitative research

I documented the opinions and experiences of OLs using in-depth interviews. In the RP group, I used both in-depth interviews with the senior RPs and FGDs with the resident junior RPs as data collection methods. In the PPs, I used FGDs for data to be collected from pre teleconsultation experience and in-depth interviews for the post teleconsultation experiences of the PPs. I administered the structured administered questionnaire to patients during their visit to the teleconsultation centre. I recorded the

patient responses at two-time points before they started the teleconsultation process and after the teleconsultation. The reasons for the choice of these methods are mentioned in the below sections.

4.2.3.1 Opinion Leaders and Doctors

Given the nature of my study, deploying quantitative methods at this stage to these stakeholders would be less appropriate as I needed in-depth information and reasons for multiple factors. Further, with quantitative methods, like the use of structured questionnaires, I would have obtained limited information only on the variables mentioned in the questionnaire, whereas in qualitative information, I was able to identify new information (Draper, 2004). Quantitative methods would have helped me to achieve the breadth of information from multiple role-players, but I wouldn't have received the data to fulfil my study objectives.

Further, addressing the secondary objective to identify barriers and facilitators of the use of teleconsultation for CRD diagnosis and management, I considered the use of observation, especially naturalistic observation, as one of the methods. Observation is the systematic recording of observable phenomenon or behaviour in a natural setting (Gorman and Clayton, 2004). Although this method has its own benefits, which includes verifying reality as reported and can be used to explore, explain and describe a phenomenon (Baker, Lynda, 2006), it was practically difficult to conduct this activity. The first reason was my position in the institution, as mentioned in section 4.4 (reflexivity) of this chapter in detail. My presence during the teleconsultation process would have led to idealistic behaviour of the staff and PP, which would not have given the true picture of the processes (Gorman and Clayton, 2004). Secondly, the strengthened teleconsultation centre was inaugurated in February 2020, soon after which the COVID-19 pandemic started; hence it was not possible for my physical presence on the premises as I was not a clinician. And lastly, the choice of this method would put me in an ethical dilemma as for being an observer the informed consent process of the activity would defy the ICMR guidelines for medical research of

maintaining the confidentiality of the participants as the MHC being run by a handful of staff members, the participants to this method become obvious.

I used a pragmatic approach to interact with the stakeholders, primarily OLs and RPs. Most of my study participants from these two groups were knowledgeable, experienced, influential and hence busy with limited time availability. Time availability of the stakeholders may be a reason why some would not take part in the study. Further, I found that meeting different people at different time points, locations, purposes, and expertise was more convenient with individual meetings than trying to gather different people for group discussion at one-time point and location. Moreover, all my OLs had different backgrounds and expertise, as I identified the OL from different backgrounds, including public health settings, policymakers, experts from the teleconsultation industry and practice. As personal interaction with the OLs and also the senior RPs would help me receive their opinions in-depth, I conducted in-depth interviews with the OLs to document their views and experiences.

The purpose of interviewing is to allow the respondent to reveal his or her view and perspectives and to allow a wide-ranging discussion in which complex issues can be probed and clarified. The respondents are able to challenge the interviewers' preconceptions about what is important or significant. This was important as I, as an interviewer, was also involved in the strengthening of the teleconsultation system and my prejudice needed to be questioned. Additionally, conducting an in-depth interview was appropriate as one participant's views need not influence the other participants (as in FGD) as every participant was knowledgeable on different aspects of telehealthcare. In-depth interviews also provided me with the flexibility to probe areas of interest and to gain a deeper understanding of the issues discussed based on the interest, expertise and time, and pre-existing answers or anyone else's views did not influence the interaction. I interacted with the OLs during the initial phase of the study. The open-ended questions allowed the interviewees to answer in their own words and offer their personal experiences (Patton, 2002), thus providing me with the flexibility to probe areas of interest and to gain a deeper understanding of their experience.

Understanding the clinician's perspectives in using telehealthcare for CRD diagnosis and management required interactions with clinicians, especially the RPs who either provided or planned to provide teleconsultation to the PPs and the PPs who would receive teleconsultation at the Pabal MHC. I further interacted with the intern RPs and the PPs through FGDs. The intern RPs and PPs were relatively less experienced in telehealthcare, and it was a new subject for discussions for them all; hence the FGD helped to instigate the thought process in newer areas of interest and understand the clinicians' acceptance of teleconsultation. Further, the intern RPs and PPs shared many common characteristics within the group, like age, experience, and exposure to patients, which helped generate new information during the FGDs.

FGDs helped generate more information on doctors' attitudes and perceptions toward the use of telehealthcare for CRD diagnosis and management. FGDs are used to collect information from people with common characteristics. The discussions help to initiate the thought processes of the participants when the participants are not particularly experienced in any of the topics being discussed. Although FGDs run a risk of participants hiding and not speaking in fear to appear foolish. Moreover, some participants may also not speak up to contradict their peers, which might upset them. Women or junior participants may also feel suppressed to express their thoughts in the FGDs. My greatest fear was the FGDs might become a question-answer session between me (moderator) and the participants rather than discussions within the group. Despite these drawbacks, I thought FGD was the best possible method to obtain relevant information from some participants.

Most of the information and data were gathered at the baseline and during the strengthening of the telehealthcare centre at Pabal MHC; however, I also conducted in-depth interviews with two PPs after their experience in actual teleconsultation for CRD diagnosis and management.

4.2.3.2 Patient Participants

Further, I approached all the patients presenting for a regular clinic check-up at Pabal MHC for documenting their views on teleconsultation from February to March 2020 and later from August 2020 to January 2021 after an ease in COVID lockdown restrictions. The Pabal MHC conducted weekly teleconsultation OPDs for CRDs on Wednesday; hence most data were collected on Wednesdays. On their arrival at the centre, the receptionist approached the patients to register for the regular treatment process. The receptionist later informed the patients about the study and enquired if they would be willing to share their experiences for research purposes. If they agreed, I administered the informed consent and showed them Figure 7 and Figure 8 to inform them about the proposed teleconsultation process. I recorded their answers in a structured administered questionnaire before meeting the PP. If they were advised to undertake teleconsultation for CRDs, which they mostly were, I asked them about their perceptions of teleconsultation after their experience using the same structured administered questionnaire.

I used this simple approach, assuming the rural patient's lower awareness about the newer technology. As the patients visited the clinic primarily for treatment, requesting their time for longer interactions would have resulted in more number of refusals and hence, I intended to keep the questionnaire short. I also used a scale-based approach for the questions.

Figure 7: Asynchronous clinician to clinician consultation

Figure 8: Synchronous clinician to clinician consultation

4.2.4 Topic guides and structured questionnaires

I created the topic guides in line with the study objectives, as the objectives were broken down into smaller sub-sections and questions addressing each section were

listed. The components of NPT guided the listing of each question. Further, the outcome of the literature review (Chapter 3) provided insights on what further information needed to be collected and relevant questions were incorporated in the questionnaire. Once created, I conducted pilot interviews with my office colleagues, who provided opinions on modifying the tools. The topic guides also evolved iteratively based on the ongoing analysis of the incoming data.

I created two interview schedules for OL (Appendix 5) and senior RPs (Appendix 6) for data collection at the baseline and a third for PPs for post teleconsultation interviews (Appendix 7). For FGDs, I created two different topic guides for junior RPs (Appendix 8) and the PPs (Appendix 9) as I intended to obtain different information from both groups. For the patient population, I considered interviews initially, but as interviews are time-consuming for patients, I ran the risk of refusals. Hence, I created a structured administered questionnaire (Appendix 10) consisting of seven 5-point Likert scale questions to obtain the maximum information in minimal time. The responses "1" meant lowest and "5" being highest. These questions were around being effective, reliable, convenient, time saving and efficient. The questionnaire also had three open-ended questions to document participants' additional thoughts on the teleconsultation process. I planned to interview participants at two-time points, before and after teleconsultation and questions were focused on reliability, trust and confidence of patients in the teleconsultation process.

4.2.5 Data Collection and Management

The data collected during this study were primarily a mix of quantitative and qualitative, dominated by qualitative data generated from interviews FGDs alongside structured administered questionnaires. The interviews and FGDs were audio-recorded and transcribed in the local language in Microsoft word for translation and data analysis, and the transcribed data were compared and compiled with notes and memos taken during the interview process. The audio files were deleted after transcription and quality check. The data from the structured administered questionnaires were entered in Microsoft excel and were converted into .dta data format

4.2.5.1 Data management

All hard copy data, including the consent forms, notes which were taken during the data collection, and structured administered questionnaire forms, will be kept for five years after March 2021 in a secured cabinet at the VRHP. I labelled the data with appropriate codes in order to deidentify the information from the participants. All identifying information collected about the participant (such as name, age, sex, address, contact information) during the research is kept confidential and secured. The details of the unique identifiers are in secure cabinets and password-protected computers. There is no information in the shared data that could disclose the study participant's identity. Standard and recommended security measures and confidentiality with data sharing agreements remain in place with access control at every stage and audit trails maintained for all access and changes in data. I checked the data quality, comparing some 10% of the transcripts with the audio recordings during the data analysis process and 100% translations compared with the transcripts.

I also recorded detailed data documentation conforming to the international standard for data description. The data description is available online on Health Data Gateway https://web.www.healthdatagateway.org/dataset/ffc34689-1a81-4f56-9c3f-e62b76d8445b. I abided by the principles of General Data Protection Regulation (GDPR) 2018 with regard to the collection, storage, processing and disclosure of personal information and uphold the Act's core principles. Access to collated participant data was and will be restricted to me, my supervisors, representatives of the sponsor(s) and representatives of regulatory authorities. Computers used to collate and store the data would have limited access measures via usernames and passwords.

4.2.6 Data Transcriptions and translations

All interactions with the study participants except three interviews were audio-recorded using the audio recorder (model no. Sony ICD-UX533F). This recorder model did not support the encryption however gave better quality audio when compared to the android-based recorder, which offers encryption; hence I chose to use this audio recorder. I transcribed all the audio recordings of English interviews and

used professional services to transcribe Marathi interviews and translate the mixed language interviews and Focused Group Discussions (FGDs) into English. The professionals providing these services were requested to sign a non-disclosure agreement before I shared any audio data with them. The Marathi interviews were later translated after transcription in the same document so that the original text could be referred to when coding the data. I further quality checked these outsourced transcriptions and translations for all audio files. This exercise served a dual purpose; it helped to familiarise me with my data and provide confidence in data quality. For the participants who refused consent for audio recording the interviews, I transcribed the notes from the interviews soon after the interviews.

4.2.7 Member checking

I shared the transcripts of all the interviews, which were not audio-recorded, and the FGDs with all the FGD participants for confirmation and to validate if their thoughts were accurately portrayed in the transcripts. I also requested the participants to add or modify, if needed, when sharing the transcripts to reconstruct the narrative if they felt that the transcripts did not appropriately represent what they intended to say. I did not receive any requests to modify the transcripts.

4.2.8 Data coding

Once the data were transcribed, translated, and checked for quality and correctness, I coded the translated data line-by-line. I initiated the data analysis with predefined codes based on the FGD and interview guides; however, I realised that the inductive approach would be more relevant as the coding started. Thus, combining inductive and deductive approaches, where I deductively started with predetermined codes but inductively came up with additional codes (*example.:* doctor's ego) as I read through the transcripts.

I used NVivo 11 Pro software to organise the data and performed line by line coding by describing the coded sentences in a few words. Line by line coding allowed me to

keep an open mind towards each sentence and code them without any influence of previously coded data. Some sentences/ transcripts were coded under multiple codes/ subcodes. More codes were created during the initial coding, but the number of newer codes decreased as I proceeded further. Once all the interviews and FGDs were coded, I sorted the nearly 800 codes to merge those with the same meaning and nested the ones with an overlapping meaning, resulting in nearly 350 codes. This code sorting further helped me to understand the data. The merging and nesting continued as I proceeded with data analysis. I did not interpret the codes at this stage. I maintained a journal of reasons for developing and merging the codes wherever relevant and later used these notes when interpreting the results.

I asked two of my colleagues (Manisha and Ankita) to perform the coding exercise on three interviews simultaneously with intention to increase the rigour of my research and for transparency of my coding process. Manisha is a PhD in Anthropology who has nearly 17 years of experience in conducting qualitative research whereas Ankita is a Public health professional with a masters in public health with nearly 10 years of research experience and has a formal training in qualitative research methods. I compared my coding with theirs for these interviews. This exercise helped me to check my interpretation of the data and assess if it could have been done differently in any way. Although, those, my colleagues coded were more superficial and not coded line by line; and, we had consensus in general. We did not have conflicting codes; however, the coding styles were different. For example, Ankita coded certain information as "knowledge"; however, I coded the same as "clinician's knowledge" similarly in one of the interviews, Manisha coded something as "CRD diagnosis" however I coded the same as "CRD misdiagnosis" and at another place as "requirement for CRD diagnosis". Although coding is a subjective process, and our individual inherent assumptions should have influenced the interpretation and hence the coding of the data, yet my colleagues' interpretations were similar to mine. Before my colleagues initiated the coding process, I explained the study and the interviews to them, their thoughts may have been influenced by what I explained. However, this overlap in the codes also assured me that the coding frame was communicable even if the data was interpreted by multiple coders and that it was fairly robust to come to an overlapping

conclusion. This activity additionally fostered my reflexivity by discussing the codes with my colleagues which helped me spell out my reasons to code in certain ways.

4.3 Data analysis and synthesis

I processed the data at multiple stages. I familiarised myself with the data by reading the transcripts multiple times, followed by coding and categorising the data and further formulating a thematic framework and further data interpretation. NPT guided the process of interpreting the data. I have already described the coding process in the above section, where I mentioned that I merged and nested the data iteratively. This merging and nesting process eventually resulted in some categories. These categories, when interpreted in relation to the study objectives and in accordance with the NPT, themes emerged from the categories. The details of these processes are mentioned below.

I performed the data analysis at two levels, within cases/ participants and between cases/ participants. The within-case analysis helped me understand what the participant has spoken about the most, what the participant knows more about, and what they choose to speak about. This also explained what the participant thought was more important or were knowledgeable about and hence comfortable speaking about more. The between-case analysis helped me understand the possible relationship between the codes and create the categories from the codes.

I simultaneously inspected the organised coding framework throughout the analysis, which aided me to gain clarity in my thought process and rearranging the coding framework. I also discovered new things beyond the surface level of the data and some new relationships within the data leading to abstract concepts and categories such as behavioural issues of the doctors. The coding framework underwent a transformation during the process, and the created categories were merged under recurring themes as the relationships between these categories emerged. I further created a conceptual framework that represented the data structure. I chose the open and exploratory method that helped me derive new concepts from my data and not depend on preconceived theories to determine my research outcome. I wanted to conduct

exploratory research where I wanted to generate new concepts and ideas. However, I also tried to explain the data using the NPT constructs.

4.4 Reflexivity

Charmaaz defined reflexivity as "*the researcher's scrutiny of his or her researcher experience, decisions, and the interpretations in ways that bring the researcher into the process and allow the researcher to assess how and to what extent the researcher's interests, positions and assumptions influenced inquiry"* (Charmaz, 2006).

My role as a researcher in the study was affected by various aspects of my professional and personal background. I am a female with fairly good English and Hindi (National Language) and excellent Marathi (local language) skills. I am able to speak in vernacular Marathi if needed when interacting with the rural population. I have a master's degree in biotechnology and have worked in community-based research since 2010. I have spent my childhood in rural parts of India, and many of my family members are associated with farming in rural areas. I also have very close extended family members who are private doctors practising in semi-urban towns near my native place. I have lived in Pune city for the last 12 years since completing my education, and I work in a hospital-based research centre. Thus, I have experience living in both rural and urban areas and have a close association with doctors. This provided me with some understanding of the intricacies of the clinical practice in the rural area and helped me understand the doctors' perceptions revealed during the data collection and analysis. Living and working in a rural area helped me to understand the on-the-ground realities of the scarcity of health care services and the challenges that rural health care providers face when working in remote areas. As I was involved in strengthening the Pabal MHC, I was bound to have a partiality for the functioning of the telehealthcare centre. Moreover, some of my study participants were aware of my role in the strengthening of the Pabal MHC; they may therefore have tended to speak positively about the service and the centre. To reduce this bias, I incorporated more questions about the challenges of implementation and sometimes took a negative stance towards the teleconsultation centre and its services during the interview to deviate the

participants from only positive responses. The participants from government organisations were wary about revealing some details during the interview process; however, I assured them of their anonymity multiple times and explained the overall research process. They had to believe in me before they could share the information with me, and hence, I had to develop friendly relationships for them to speak openly during the interview. In one incident where I conducted an interview with a participant in the morning at his home office, his wife served us tea with snacks and invited me to stay for lunch after the interview. One doctor from KEMH assumed that I was the coordinator at the Pabal MHC, and I had to clarify it in the interview. My old collaboration with a government organisation helped to get a quick appointment of a very busy policymaker from the national capital of India. However, in one instance, a proposed participant's poor relationship with KEMH led me not to receive an appointment of the staff member from their hospital.

As regards the patient population, despite me being conversant in communicating in the local language, I was not part of the community. My overall appearance was that of an urban woman; hence I was simultaneously an insider who could speak their language but an outsider who, the patients assumed, did not relate to their problems. Additionally, my position in the organisation (KEMHRC) was that of someone in power, and hence the local staff at the MHC referred to me as 'madam', which was picked up by the patient population. This also made the patient population assume that I might be someone who could help in providing them with free or low-cost health care services. Their responses might have been highly influenced by all these factors.

Nonetheless, my experience helped me interpret the data, and hence I did not ignore my assumptions when analysing the data; however, I supported my assumptions with evidence where available. I was self-aware of this situation, and it had helped me to note down my own biases when I analysed and interpreted the data.

Chapter 5. Results: Interviews and Focus Groups

This chapter describes findings from the qualitative data collected from the Opinion Leaders (OL), Primary Physicians (PP), specialist Respiratory Physicians (RPs) and patients, followed by interpretation of the results.

I conducted 12 in-depth interviews with eight OLs, two RPs and two PPs; two FGDs, one with eight PPs and the other with four specialist RPs; and 30 structured administered questionnaires with patients (the results of which are presented in Section 6.9 of the next chapter). The methods used for the data collection are described in Chapter 4. The characteristics of the study participants in each category are described in Table 3. I approached 36 participants (9 females and 27 males), of whom 32 initially expressed interest in being involved in the research; however, only 24 (5 females and 19 males) eventually participated in interviews and FGDs.

The OL group included people allied to the telehealthcare business, including technical experts, researchers, a community representative from Pabal village and doctors already working in telehealthcare in India. Additionally, public health system leaders and policymakers were also included in this category. Four of the eight OLs were employed by government organisations; two were associated with commercial telehealthcare companies, one was a specialist doctor, and one was a community representative; both had the experience of working in the telehealthcare sector.

Four of the six RPs were Doctor of Medicine (MD) pulmonary medicine interns practising at the KEMH. They participated in the FGD of RPs. One of the six was a senior RP also practising at the KEMH, and another was an RP with extensive clinical and research experience in respiratory medicine from another organisation.

The PPs were private practitioners in the rural area around the Pabal village. Five of the eight who participated in the FGD were trained as Bachelor of Ayurveda Medical and Surgery (BAMS), one was Bachelor of Homeopathic Medicine and Surgery (BHMS), and two were Bachelor of Medicine, Bachelor of Surgery (MBBS) all of them are trained for 5 years to obtain the degree. These PPs had experience working in rural areas as primary

care providers. Their experience ranged from 4 to 20 years of clinical practice (Median 6.5). The two PPs who provided services at the Pabal MHC and were later interviewed post-intervention were trained as BAMS. I tried to maintain the gender balance in the participants to sustain the gender dynamics in the responses when I listed the probable study participants; however, of the 24 participants, only five were females, all of whom were PPs. I did not identify any female RPs as they are very few in India, and four female OLs whom I approached either did not receive permission from their superiors for participation in the study or did not find time to participate despite their willingness to participate.

Table 2: Details of Study Participants

Sr No.	Study ID	Role	Gender	Age	Reason for inclusion	Recruitment method	Method used for data collection
1	OL 1	Opinion Leader	Male	65	Administrator for the Pabal MHC and one of the important stakeholders in the implementation of telehealthcare as a community leader	Personal and professional connection	Key Informant Interview
2	OL 2	Opinion Leader	Male	47	Pioneer in telehealthcare in India. Founder member of the HP-MHC, one of which is also installed at Pabal. Respiratory physician by training. Highly influential for national-level programs and national policies in respiratory health and other integrative research	Personal and professional connection	Key Informant Interview

3	OL 3	Opinion Leader	Male	65	Has worked in IT for most of his life and is now an honorary consultant to the telehealthcare startup who has interacted with many major hospitals in the state for the implementation of telehealthcare	Through Face to Face interaction	Key Informant Interview
4	OL 4	Opinion Leader	Male	40	Works at a government-run institute that is a pioneer in telehealthcare in India. Looks after the telehealthcare department of the institute and has a large experience in setting up of telehealthcare systems in remote areas across the country	Identified institution contact through the internet and was informed by the director of this institute to communicate with him as in charge of the	Key Informant Interview

						telehealthcare department	
5	OL 5	Opinion Leader	Male	42	Intensivist who uses informal telehealthcare in regular practice. Has formal education in digital health informatics from Australia. Based in KEMH in Pune	Through Face-to-Face interaction	Key Informant Interview
6	OL 6	Opinion Leader	Male	38	Manager at the government-run telehealthcare nodal centre at specialist node	I spoke to the state head of the public health systems telemedicine department about the study and	Key Informant Interview

						was directed to him	
7	OL 7	Opinion Leader	Male	43	Manager at the government-run telehealthcare nodal centre at the provider end	I spoke to the state head of the public health systems telemedicine department about the study and was directed to him	Key Informant Interview
8	OL 8	Opinion Leader	Male	50	Technology background with work in digital health. Principal at aPublic Health college and has worked with many commercial companies as an	Professional connection	Key Informant Interview

					advisor for telehealth. An active member of Telemedicine society of India		
9	PP 1	Primary Physician	Female	33	Ayurveda postgraduate with eight years of clinical practice in a rural area in the vicinity of the study area	Through Face to Face interaction	FGD
10	PP 2	Primary Physician	Female	41	Ayurveda practitioner with around eight years of clinical practice in a rural area in the vicinity of study area	Personal and professional connection	FGD
11	PP 3	Primary Physician	Female	57	Postgraduate in modern medicine.with 20 years clinical experience and more social science research who understands the study area and is working as clinical researcher in the study area	Through Face to Face interaction	FGD
12	PP 4	Primary Physician	Male	34	Homoeopathy graduate with ten years of practice in rural area in the vicinity of study area	Through Face to Face interaction	FGD

13	PP 5	Primary Physician	Male	38	Ayurveda graduate with ten years of practice in rural area in the vicinity of study area	Through Face to Face interaction and professional connection	FGD
14	PP 6	Primary Physician	Female	28	Ayurveda graduate with four years of practice in semi-urban area	Through Face to Face interaction	FGD
15	PP 7	Primary Physician	Male	33	Ayurveda Physician, with PG degree, four years of clinical practice in semi-urban area	Through Face to Face interaction	FGD
16	PP 8	Primary Physician	Male	29	Ayurveda graduate with five years of practice in rural area in the vicinity of study area	Through Face to Face interaction	FGD
17	PP2 (post teleconsultation)	Primary Physician	Female	41	Primary physician who runs the general OPD at the KEM Pabal MHC and communicates with the specialists for teleconsultations. Ayurveda practitioner	Professional connection and also part of the FGD	Key Informant Interview-Post-teleconsultation

18	PP 9	Primary Physician	Male	55	Primary physician who runs the general OPD at the KEM Pabal for face to face traditional consultations. Ayurveda practitioner. Has observed teleconsultation and has negative views about teleconsultation	Professional connection	Key Informant Interview Post-teleconsultation
19	RP 1	Respira-tory Physician	Male	55	Respiratory physician working in KEMH Pune and will also be delivering the teleconsultations to the respiratory patients	Through Face to Face interaction	Key Informant Interview
20	RP 2	Respira-tory Physician	Male	55	Respiratory physician with immense work on COPD prevention and care and leading researcher in respiratory health in India.	Through Face to Face interaction and professional connection	Key Informant Interview
21	RP 3	Respira-tory Physician	Male	32	MD Chest practising for last five years	Approached his boss through Professional	FGD

						connection, and departmental permissions were taken before face to face interactions	
22	RP 4	Respira-tory Physicia n	Male	33	MD Chest practising for last five years	Approached his boss through Professional connection and departmental permissions were taken before face to face interactions	FGD

23	RP 5	Respira-tory Physicia n	Male	33	MD Chest practising for last five years	Approached his boss through Professional connection and departmental permissions were taken before face to face interactions	FGD
24	RP 6	Respira-tory Physicia n	Male	34	MD Chest practising for last five years	Approached his boss through Professional connection and departmental permissions	FGD

						were taken before face to face interactions	

5.1.1 Challenges in identifying and selecting study participants

Qualitative research is a relatively new and different approach for Indian doctors and researchers. When I mentioned data collection, people assumed I meant patient data from their telehealthcare centre. I had to explain my proposed data collection process and assuage their doubts. Approaching unknown people from commercial companies and government-run centres was challenging as they feared competition from KEMHRC for running a teleconsultation centre. With one exception, the representatives of the commercial companies contacted were either uninterested in the research or probably assumed KEMH to be one of the competitors hence did not respond to my written requests, despite multiple follow-up emails. I sent at least three follow-up emails to all non-responding stakeholders.

Further, to reach the appropriate people in the government sector, I had to obtain multiple permissions. I identified a point of contact for a specialist node and a rural node in one district and contacted them through landline telephone numbers. This personnel were willing to provide me with information but needed permission in writing from their superiors to provide information on record. Receiving permissions to officially interact with the government staff required a lengthy bureaucratic process. In one instance, I spent more than seven hours in a district hospital awaiting my turn to meet the hospital's dean for written approvals, who, although he verbally agreed to the data collection, never responded with the promised permission letter despite several in-person follow-ups.

In the following sections, I describe my study results and interpret them in respect of the secondary objectives listed below-

2. To determine the requirements, including equipment and skills to support local primary physicians in remote CRD diagnosis and management

3. To explore barriers to and facilitators of successful implementation of specialist to non-specialist teleconsultation at MHC in CRD diagnosis and management from the viewpoints of patients, opinion leaders, primary and respiratory physicians.

Note: In order to maintain the confidentiality of the study participants' identity, I have tried to be gender-neutral and have used 'they'/ 'them'/ 'their' as pronouns instead of any gender identifying pronouns.

5.2 Requirements, including equipment and skills to support primary physicians in remote CRD diagnosis and management

The participating doctors and OLs discussed the processes involved and the requirements for setting up a telehealthcare centre and further implementing the services. The discussions included the requirements for and factors influencing the diagnosis and management of CRDs using teleconsultation. All participants emphasised the importance of connectivity, software, hardware, and reliable power for the functioning of the setup in addition to human resources. The framework in Figure 9 summarises the requirements for CRD telediagnosis and teleconsultations.

5.2.1 Location and space requirements

The importance of location for setting up a teleconsultation centre and additional space requirements at the tertiary care centre, as well as the teleconsultation centre, were discussed by participants who had previously had the experience of providing teleconsultation services. An OL who had set up a telehealthcare centre in one of India's remotest locations emphasised that the needs of the community must influence the choice of location. However, they mentioned that the feasibility of access to connectivity and availability of maintenance services by the technology companies must also drive the selection of the location. This was mentioned in light of their previous experience where the teleconsultation service remained unused when equipment broke down, and the transport of the equipment to and from the service centre located in the national capital took several days.

Additionally, the participants discussed the need for a dedicated space for both the setup of a centre and for a teleconsultation clinic at the tertiary care hospital. An RP described a need for separate space for each teleconsultation at the specialist clinic, such that doctors conducting simultaneous remote and in-person consultations do not disturb each other. This RP had worked in a bustling tertiary care centre where simultaneous face to face

consultations occurred in a small clinic setup. They also further mentioned a need for a separate dedicated computer or laptop for accessing patient records for teleconsultation such that they could also access the patient records in emergency conditions and need not wait for a common computer to be available. Another participant who works in a government telemedicine department also mentioned the need for a dedicated space as their department additionally provides video conferencing services. They have found that the dual use of the space discourages the actual use of the system for teleconsultation as it is frequently used for videoconferencing by the health systems staff at these centres with the state office for meetings.

"…and if we are going to decide a time slot then we can decide the place also, means if there is some screen and somebody wants to go and check the records or ….. if any emergency x-ray needs to be interpreted ….it will not be that feasible on the phone then we do the consultation by going to that specific place in that time slot…" RP 1

The selection of location and space for teleconsultation clinic appears to depend on multiple factors, including the availability of electricity or provision for receiving internet connectivity but most importantly, the needs of the community, the availability of space in the chosen location and the support from the villagers for establishing a telehealthcare centre there. Nonetheless, I assume that the communities that might actually benefit most from telehealthcare might actually be those where it is more difficult to establish service because of power, internet and maintenance issues.

5.2.2 Requirements for CRD telediagnosis

I derived this information from the FGDs with the PP and RP and interviews with the RPs. In addition, my interactions with the clinician participants, who either worked at the MHC or planned to provide their services, provided further information about their expectations and needs for CRD diagnosis. During my data collection, the doctors were initially hesitant to use teleconsultation for CRD diagnosis; however, as the discussions continued, almost everyone suggested ways to conduct CRD diagnosis using teleconsultations. Many

participants mentioned that CRD diagnosis is usually challenging, and the RPs felt that CRD is underdiagnosed or misdiagnosed in the routine face to face consultations in primary care. Hence, they considered that CRD diagnosis using teleconsultation would be demanding even when a PP is expected to diagnose the CRDs with support from a specialist RP.

"So the major concern from my point of view, is, despite the huge and the growing burden of chronic respiratory diseases, a significant number of patients remain undiagnosed. So there's a underdiagnosis, there is wrong diagnosis, and there is over diagnosis. All three happen, especially in chronic conditions. It's a very common thing asthmatics are labelled as COPD, people who have asthma are not not labelled as asthma for many many years. People don't have who don't have anything are labelled as asthma." RP 2

The PPs also initially expressed the view that CRD diagnosis is more difficult using teleconsultation as the information exchange is inferior to face-to-face interaction with the patients.

"And you cannot see all the things through machine. You have to use your brain for it. And till the time patient is not in front of you one cannot reach to particular diagnosis." PP 4

Nonetheless, when the requirements for such activity were discussed, both RPs and PPs described that the most critical factors are documentation of patient history and good clinical examination. Every doctor has their own method to assess the patients' history and obtain clinical information, and they describe their methods. Some said they relied on the physical examination, while others mentioned the value of diagnostic reports in diagnosing a patient. (Diagnostics reports are usually provided by certified diagnostic laboratories for blood tests or X-rays and are handed over to the patients or the recommending doctor, other diagnostic tests like the ECG or spirometry are performed by the doctors themselves).

In addition to the diagnostic tools and reports, documenting patient history is crucial for CRD diagnosis. While all the doctors emphasised the importance of the patient history in CRD diagnosis and on deciding on further management, they were sceptical about the reliability of the doctors accurately and completely documenting the history, noting that this would vary from doctor to doctor.

. *"….we do not get idea about patient's health condition is serious until we ask their history. And we do not know how much real* [disease] *information these people* [patient] *give to us, so we have to be alert. There is some gravity (depth) which is not here* [in teleconsultation]…*For diagnosis ausculation is a major factor. We have to differentiate whether it is a creps* [crackles] *or rhonchi* [wheezes]*? But..from history we get to know other things like which factors are aggravating the disease. Question- answer session clears most of the doubts. Family history also affects, if there is someone with bronchial asthma in the family it is positive indication. Your Question- answer session has to be very strong,.."* PP 8

Given the concerns about the reliability of asking about and recording history and clinical assessment due to different methods used by every doctor, many PPs suggested that standardising the clinical assessment process would be beneficial for specialist to non-specialist teleconsultation. Some PPs mentioned that the patient diagnosis may vary with change in assessing the patient history and clinical information as it is based on the doctor's perception. The RPs also did not trust the PPs to appropriately diagnose CRDs. Owing to which all doctors recommended a standard checklist be created for documenting the history when conducting teleconsultations. They suggested that this checklist could be created or adapted in consultation with both PPs and RPs such that the checklist covers all crucial parameters. For example, the questionnaire/ checklist could have objective parameters such as diagnostic test scores and have sections for the input of medical symptoms and detailed history. However, in the interviews, we did not discuss the details of what should be included in any checklist as it would have diverted the discussions from the original topic. The RPs further indicated that the PPs needed to be trained to administer

the questionnaire and conduct an appropriate medical examination in terms of CRD diagnosis. The RPs took for granted that the PPs are not competent to make an appropriate diagnosis: they feared misdiagnosis of CRDs.

These statements by the RPs, seemed to suggest an important lack of trust in and respect for the knowledge and capabilities of PPs as the RPs were concerned about the competencies of the PPs in CRD diagnosis and management. The RPs further suggested that training in the diagnostic process could be given to PPs at the RPs clinic. This implies an unequal power dynamic in the RP and PP interactions and hierarchy in the relationship between the PPs and RPs. Although it was not explicitly discussed throughout the data collection process, such power plays arose intermittently during my discussions with the doctors. This power play seemed to arise because of the perceived difference in the knowledge of the RPs and PPs. The RPs are specifically trained in the respiratory diseases and have more experience in treating the respiratory diseases whereas, the PPs who are usually the generalists, are not specifically trained to diagnose and manage the respiratory diseases and although they may have comparatively treated fewer patients with respiratory diseases. Further the possibly perceived superiority of the doctors trained in modern medicine over the ones trained in AYUSH may also have contributed to this power dynamics.

"…. So a good history, but to take a good history you need to have information about, what questions to ask, now.. for that you need to have knowledge. So if you don't have the knowledge, you're not going to ask those questions." RP 2

Auscultation of the chest for clinical examination is another essential requirement for CRD diagnosis, which all the participating doctors described. Many participants added that appropriate auscultation by a trained doctor could lead to the diagnosis of both suspected and unsuspected CRD cases. Moreover, as it is undertaken with all the patients attending the clinic, it can lead to early CRD diagnosis for some unsuspected patients. An RP further added that if the telehealthcare systems have the facility for digital

auscultations, it is easier for the PP and RPs to examine the patients. Every doctor voiced that performing auscultation needs precision and interpretation of lung sounds needs expertise, but that in the case of digital auscultation, any trained PP could perform the auscultation and share the digital records with the RP specialists for interpreting the sounds. Thus, use of digital auscultation may help in enhancing the diagnostic rate as the proximity of the patient to the RPs is not required for the diagnosis and the digital records of the auscultation could be transferred to the RPs for diagnosis. Storing and sharing respiratory sounds was impossible in the conventional stethoscope which is now possible with the digital auscultation and has enabled the doctors to discuss the patients' respiratory sounds, which also has a potential to increase the accuracy of respiratory assessment (Kim et al., 2022).

An OL emphasised that accurate interpretation of digital breath sounds needs clarity in the transmitted sounds, which requires a particular device to be linked to the teleconsultation system. The use of digital auscultation requires good, dedicated audio devices, as it is an important process in the CRD diagnosis, and any surrounding noises during the auscultation process might lead to a false interpretation of the sounds. The doctors might face logistical challenges when listening to the auscultations as they need to be in a silent place with a good audio device which is not always possible. Many commercial companies have designed sensitive digital stethoscopes; however, such stethoscopes must be easy to use, and for user acceptability, they should imitate the manual stethoscope.

"ohh yeah, yeah…so if that is being transmitted again digital then we can hear the sounds which the…umm…that particular person [PP] *is hearing, but he* [PP] *should be able to hear the way our traditional stethoscopes sound…*[the digital stethoscope must imitate the traditional ones]*"* RP 1

"… that's okay good but what is that the stethoscope was taking all the surrounding sounds [noice] *also, like if you are talking, it is taking up the talking ……. the stethoscope should be sensitive, but look* [ensure] *that it doesn't take up all that extra noises"* OL 8

In addition to the patient history and clinical examination, the participants spoke about multiple tools required for CRD diagnosis and management, including a pulse oximeter, portable X-ray machine, spirometer, all for diagnosis and deciding the appropriate treatment. Moreover, they said that some items like an oxygen cylinder and a nebuliser for emergencies are also needed. In addition, some suggested that an ECG is required to rule out cardiac conditions in suspected patients. However, given the scenario in Indian villages, the PPs would normally have only minimal equipment such as a regular stethoscope, BP apparatus, and pulse oximeter. Items such as an X-ray machine, spirometer or ECG machine, which require a slightly higher level of investment and technical expertise to perform, would be difficult to fund in all primary care setups in the rural area.

"The ones that are basically needed for our OPD, like Peak flow, spirometer for spirometry…umm…one X-ray [machine] *will be required, ECG will be required, nothing beyond this will be required…"* RP 1

An RP explained the diagnostic process for CRDs in three stages. The first stage of the process is taking the patient history. Once all the suspected patients undergo a detailed clinical examination and history, two-thirds of the suspecting cases would require spirometry evaluation to confirm the diagnosis in the second stage. Later, in the third stage, a fraction of those would require chest examination using X-rays for the final CRD diagnosis. The RP stated that a spirometer is crucial for CRD diagnosis and that a doctor cannot confirm the CRD without spirometry results.

Some RPs also mentioned that in Indian healthcare systems, spirometers are not widely used, and even a third of the RPs do not possess a spirometer. Further, conducting spirometry is a skilled process and interpreting the results requires further expertise. Thus,

the RPs confirmed that the availability of a spirometer alone would not solve underdiagnosis; however, implementation would require trained technicians and doctors to conduct and interpret spirometry. In contrast, another RP and a few PPs emphasised the need for an X-ray machine, given its usability and ease of use. In addition, the X-ray images can be easily shared, and it is easy to interpret the results. Nevertheless, a word of caution was always mentioned. The quality of X-ray images must be clear or can lead to misdiagnosis. This discussion indicates the importance of both spirometer and X-ray in the CRD diagnostic processes and the value of the spirometer in differentiating CRDs from each other. However, although spirometers may be available for use in specialist practice in India, it may take time for all PPs to have access to them and use them properly.

"the quality of photos of the X-ray that are sent should be good… because we never see the reports, we see the film, so… the film is important" RP 6

A PP from the rural area described the limited availability of simple diagnostic tools like the X-ray and ECG in rural areas. They thought that the use of an ECG to distinguish between cardiac and respiratory conditions is required at the primary clinic where the patients visit the clinicians. According to this PP, the ECG machine can help to differentiate between CRD and cardiac conditions during episodes of breathlessness. RPs also discussed the need for blood tests such as full blood counts during the diagnostic process. According to the RPs, these blood tests can add value to the diagnostic process and help rule out other reasons for breathlessness, for example, anaemia. For blood tests to be conducted at a rural setup, facilities would be needed for blood collection and either testing or transporting the samples from the rural lab at the teleconsultation centre. Otherwise, the benefits of teleconsultation would be reduced for patients requiring blood diagnostics, given that they would need to travel to get the tests done.

5.2.3 Technology requirements

The participants further mentioned the technology requirements for the use of telehealthcare for CRD diagnosis and management. The doctors stated the need for

devices to transfer ECG and X-ray images and the facility to access the patient history. A few participants described the evolution of technology used for teleconsultation and expressed the view that current technology options available on the market provide all the desirable options for conducting teleconsultation. A doctor compared the technology evolution with an example of the evolution of travel options and mentioned that every option has its advantages and challenges.

"…to go travel you need a vehicle at any point of time, it could be a cycle, a scooter, a car or you could use new gadgets to fly from one place to other. Every technology has some negatives and positives, scooter makes a noise, unsafe fear of accident if not used a helmet while driving, if you drive a car there is lots of traffic because of which longer distance cannot be covered and will take time." OL 5

The importance of ease of communication and access to clinical records was raised. A PP who had experienced specialist to non-specialist teleconsultation (as a non-specialist) suggested that when planning the model for teleconsultation, one should consider a registration system linked to all patient records. They also mentioned that multiple PPs could access the records from the registration system at different locations/ clinics. This statement refers to the fact that Pabal MHC houses multiple clinics on-premises, and only one clinic has access to the telehealthcare system and its records. This PP further said that the link to be sent to a specialist must be free of Login and be sent to different specialists on their phones without "Login". They believed this Login free facility would allow them to approach any available specialist depending on the patients' needs. They indicated that an essential component of teleconsultation is the Electronic Health Records which must be easily accessible to the doctors every time the same patient visits. This PP also suggested that providing options to contact the specialists using different communication modes would help contact them more efficiently and that the specialists must be provided with options to access the patient record and perform teleconsultation using phone or computer, or laptops. However, the participants did not ponder about the data security when suggesting such solutions.

"And if it is on the phone…means it is okay because sir [specialist] *has to have an access to a laptop but will it be easier if access to that link is given to him on phone…sir* [specialist] *will have to see it in order to click the hotlink.. Range* [internet network] *problem should not be there... "* PP 2 (post teleconsultation)

The detailed technical requirements for CRD telediagnosis are summarised in 5.3.6. Additionally, almost all the study participants mentioned that the technology needs to be constantly upgraded, irrespective of the model used. This, in my opinion, would give more flexibility to the specialists and would help in better coordination of time and logistics for teleconsultations.

In summary, the doctors would essentially require facilities for good communication with the specialists in addition to some essential requirements like spirometer, digital auscultation and pulse-oximeter, but diagnostic tests done using the X-Ray, ECG and blood tests if required could be done in nearby centres, the results of which could be shared with the specialists.

5.2.4 Connectivity requirements

Although some participants experienced problems with connectivity in the early days of telehealthcare in India, many mentioned that connectivity is no longer a problem. One of the participants working in a government setup mentioned that they started in 2009 with 512 kB bandwidth and later in 2015 received funds for a dedicated 100 Mbps line. Another OL who has set up a telehealthcare system in the remotest hilly region of India mentioned that the internet provider has to be chosen wisely, taking into account their post-deployment services in case of breakdown.

During the discussion, all the participants mentioned the need for connectivity to better transfer clinical data like auscultations and images. However, some participants added that

the newer technology in the systems providing telehealthcare will also enable the transfer of patient information at lower bandwidth. One OL also mentioned a commercial company that claims to provide telehealthcare solutions which can function even in flickering second-generation internet connectivity.

"High speed, with the advent of the 4G or 5G, it [teleconsultation] *became absolutely smooth. Proper network* [network with good connectivity] *was not popular, it took a lot of time but now it is like water, available everywhere* [widely available]*."* OL 5

Despite the availability of good network connectivity in recent years, the Pabal MHC has experienced disrupted connectivity due to the abrupt discontinuation of electricity supply to the internet router or maintenance by the internet provider. Such interruptions to internet connectivity might hamper the teleconsultation process, and backup plans need to be in place at the rural centres.

5.2.5 Personnel requirements

This section addresses the study participants' views on the need for a general facilitator for a telehealthcare centre's functioning regardless of the disease conditions assessed. The participants considered the telehealthcare centre's functioning to require essential human resources, including a trained doctor to coordinate and communicate with the specialist for conducting teleconsultation. However, a few OLs mentioned that the required human resources depended on the patient load, which would determine the time commitment required of the doctors and this might change with time as the centre evolves.

5.2.5.1 Team members

The respondents believed that a telehealthcare centre must have a multi-dimensional team comprising a coordinator, a PP, a counsellor and a technician. The PPs' role is to diagnose, assess and follow-up the patients' condition. An RP further said that patient counselling is required as CRD management is a continuous process, and counselling, in terms of detailed advice, will help the continuity of the treatment process. Thus, the counsellor/

educator'srole would be to support the treatment process by checking in with the patients to make sure they knew what they were doing in respect of CRD management and not the counselling for mental health. However, the RP who suggested this did not have a counsellor in their clinic. Although, some RPs during the FGD suggested that a trained counsellor could explain the disease to a patient and the importance of continued medication and exercise for better treatment and thus need to be part of the team. Nonetheless, if such a counsellor is not available at the remote centre, it can always be an option to conduct patient-counsellor teleconsultation when referred by the RP.

"It will be better if there is a counsellor or if the doctor does not have time, there are so many patients because it is necessary to explain the patient about what is the disease and if the patient understands that, then he understands the seriousness and comes for follow up" RP 3

The RPs also proposed a technician for all technical aspects, including maintaining the telehealthcare system and overcoming technical challenges like a system breakdown or connectivity issues.

5.2.5.2 Doctors as essential members of the team

The participants agreed that both the PPs and RPs are essential members of the team, and their roles would be to conduct the teleconsultations. The PPs agreed that the RPs are subject experts and have more detailed knowledge compared to the PPs. And that the RPs hold different perspectives towards diagnosis and management. PPs look at the patients' health more generally, and the specialists focus on specific conditions

An RP during the FGD mentioned that the PPs are the critical bridge between the patients and the RPs, and they need to be skilled in communication and have sound clinical knowledge. The RPs expect that the PPs be trained to conduct spirometry and perform clinical evaluation under their supervision such that the PPs can follow the instructions for the patient treatment given by the RPs. This implies the RPs expect the PPs to behave

as a conduit between the specialist and the patient and act according to their directions rather than exercise their own clinical autonomy, although the patient's responsibility lies with the PP, suggesting a hierarchical perception of the nature of the PP and specialists' relationships. Nonetheless, as explained earlier the differences in the training and experiences of both the RPs and PPs could be one of the possible reasons why such hierarchy is practiced.

All doctors agreed that good training and a clinical assessment checklist would help the PPs. They perceived the checklist would guide them not to miss any critical clinical concerns and that the patients' time with the RP could be devoted to specialist aspects of disease diagnosis, management and treatment choice. However, all the doctors were concerned about personal feelings, professional ego and sensitivities but recognised that the ego might interfere in the teleconsultation interactions, and one must find solutions to reduce this interference. This particularly came from the specialists who feared that PPs might perceive themselves as less knowledgeable if they express the need for help from a specialist to treat the patients, again indicating the specialists' assumptions about the PPs being less knowledgeable. They may also fear that their image in the patients' eyes would be damaged if they were seen to be requiring specialist help.

"Yes you [PP] *need* [help] *but that we have to break that this big ego among the doctors. Why should I* [PP] *take…umm… consultation* [from RP]? *Don't take* [sarcasm]. *Because you know that you are stuck, first thing is we should remove our ego* [not let the ego interfere in asking for help from the RPs]*."* OL 5

"I [What PP might say] *need somebody else's opinion, may be his opinion will give me to handle this patient correctly, so I… the patient is not going to know that you are taking a second opinion"* OL 8

5.2.5.3 Coordinator of the Telehealthcare centre

All the study participants agreed that a coordinator is essential for a telehealthcare centre's overall management and functioning. However, some thought that a PP could play a dual role as a PP and coordinator. Most of the discussions on the coordinator describe the roles and responsibilities of such a coordinator.

",…… this what I call is a champion because [s]/*he is supposed to drive from the each of the stakeholders, you have to connect to the patient, you have to connect to the technologist, you have to connect to the hospital, you have to… umm… the… management and to the doctor… they are the ones who are gonna take it forward"* OL 3

An OL and a few RPs stated that the coordinator must coordinate with multiple stakeholders, including the doctors, patients, technicians, funders and run the centre. In addition, they need to be motivated enough to be the driving force behind the centre's activities. The same OL suggested identifying a person who will take responsibility and lead the centre by understanding the centre's specific needs.

Further, all the study participants extensively discussed the desirable qualities of a coordinator, one of which is the coordinator being a local. Many study participants expressed that a local person is more likely to provide continuity in the centre. They also confirm that identifying a local has two benefits: enhancing local capacity building and leveraging their understanding of the community for its efficient functioning. Many Ols further advocated a local coordinator as their contacts will also help the patient recruitment. Some participants further expressed that a local with a minimum qualification will stay longer, given the coordinator's higher responsibility, as the locals are more likely to stay, and the minimum education will not make them eligible for any different positions outside the locality. Additionally, a couple of Ols mentioned that training a local person will support the ecosystem by working with the local community.

"…local person who will not leave that village and go they come and who are not highly educated, so now they get benefit out of learning something out of this they are getting education, they are learning something. Okay, so you don't need a highly qualified person for that. If you train them, they are not going to go out anywhere because they don't know any other work. You have trained them only for this work, so they will stay with you" OL 8

A PP working in the area and an OL mentioned that another perceived advantage of employing a local coordinator is their understanding of vernacular language. The OL emphasised that the coordinator must speak in the local dialect. Additionally, the local coordinator's communication and technology usage skills are built to provide them with a source of income. Moreover, it would be beneficial for the coordinator to offer slightly higher than usual payment per village norms.

In contrast, regarding the coordinator's remuneration, one OL stated that the coordinator must be dedicated and motivated and need not be on the payroll but a volunteer who genuinely is interested in running the centre. This OL also assumed that I was the coordinator at the Pabal MHC. This assumption may have led him to speak positively towards the centre and provided practical insights for improvement.

"..And that dedicated worker means they should not be on the payroll, somebody who is interested, like you.." OL 5

However, other Ols countered that the staff must be remunerated appropriately for their time and asking for voluntary time would not be viable and sustainable.

"…You would have to pay them when we cannot be a charity. Because you can't expect a knowledgeable person who has desires of making money to offer charity." OL 2

Another OL proposed a different model than the deployment of dedicated staff. They mention that the available team at an organisation can take up additional responsibilities

with some additional honorarium. However, they expressed that the staff must be informed about their scheduled tasks and duties and equally distributed work. However, someone must take the lead and distribute the work, which a part-time coordinator could do. They also mentioned that giving responsibility to one local can also be damaging. First, if the person leaves the organisation on bad terms, they can influence patient recruitment in the longer run. Secondly, if the person is not good with the community personally, the villagers will avoid visiting the centre during their employment.

An OL who has implemented multiple telehealthcare centres said that, in their experience, a coordinator is an important person whose qualities and motivation decide the success and failure of the telehealthcare systems. Another OL suggested that if the person is not motivated enough, one must train the person to understand the importance of the system and imbue responsibility in them for implementing the telehealthcare system.

"…he should be like an entrepreneur give him the responsibility this centre is yours; you are having the responsibility of running this, challenge him how can you improve the patient" OL5

An OL who is an intensivist at a large tertiary care hospital expressed the view that in his experience that the coordinator and the ability to motivate others, including administrative and accounts staff. Additionally, this OL also mentioned that the coordinator's prominent role is coordinating with the specialists and RPs for conducting timely teleconsultation.

"*And for that …, there should be one dedicated coordinator who can run around and catch that consultation…consultant…"* OL 7

The coordinator's role seems crucial to successfully implementing a telehealthcare centre and its continued smooth overall functioning. This implies that a responsible and motivated coordinator can raise the profile of the teleconsultation activities; however, identifying such a coordinator from the local community might be challenging.

5.2.6 Medication requirement

Another requirement that multiple participants discussed was the availability of medication at the teleconsultation centre. A PP recommended keeping a stock of generic medication as the local medical store might not stock the prescribed medication. One OL mentioned that one village where the telehealthcare centre is located does not have a pharmacy store, and one in a nearby village does not keep stock of all medications. In case of the medications prescribed for the CRDs, the patients have to travel to purchase medications like inhalers and steroids. Such medications should therefore be available at the telehealthcare centre. Another OL who has worked in remote regions of the Rajasthan state in India suggested that the organisations providing teleconsultation services need to facilitate access to medications at reasonable costs to make the centre successful.

A PP also expressed that the availability of medications at the centre would make it easier for them to prescribe medicines as they would be aware that the patients would be able to access the prescribed medicines. This was spoken by a rural PP who also understands that not all medicines are available in the nearby pharmacies. However, they were doubtful, requiring patients to pay for their e medication. This PP further expressed that if the medications are expensive, the patients might discontinue using them after they feel better; however, they mentioned that if a clinician provides them at the telehealthcare centre, the patients would possibly continue using them.

"But what about prescription medicine? How does it reach and at what price and who pays?" OL 3

Another PP mentioned that if medicines are not available at the centre, the patients will probably have to travel to purchase medicines and thus, similarly to having to travel for blood tests, the benefits of teleconsultation would be reduced. The patients would prefer diagnosis and treatment at one point, most probably free of cost. According to this PP, teleconsultation becomes cost-effective only if it avoids travel and saves time and money.

Such requirements give rise to another major regulatory and logistic hurdle to be overcome. Making medicines available might require regulatory approval, and further maintaining the stock and dispensing of medicines might also require additional human resources. However, these results indicate that the availability of medicines at a teleconsultation centre may be a crucial requirement, and its unavailability will result in patient travel or non-compliance with prescribed medicines.

5.2.7 Monetary resources

The study participants had similar views to each other regarding the monetary requirement for setup. An OL voiced that building high-end technology requires investment, but it is not a significant barrier. Another OL added that the permission to set up and to raise the initial funding is not difficult and cited that setup costs are a one-off and therefore easier to obtain. Another OL supported this reasoning by stating that organisations with money can spend or raise money through funders or donations to build teleconsultation centres. This OL further added that once the telehealthcare centre is established, the actual monetary challenge lies in implementing the centre as it requires recurring costs. Nonetheless, this also signifies that one must identify an investor or funder for the initial investments, or the investments must be initiated by a government agency as part of schemes or programs focusing on health access in rural areas.

"[speaking about the set-up experience of the government telehealthcare facilities] *Initially to start off with, ISRO* [Indian Space Research Organisation] *funded the project which was transfer to (State name) government. All equipment are provided by ISRO. Now this system is also given by ISRO. It has come from Bengaluru. Batteries, UPS* [Uninterruptible Power Supply] *and all setup has come from Bengaluru initially."* OL 7

An OL who is a community leader believed that the existing Pabal MHC setup had sufficient funds for establishment; however, continued salary support for a dedicated coordinator is essential for improving the telehealthcare centre. They also mentioned that if the telehealthcare centre is situated at a location where other institutional activities have

human resources available, these could partially support the telehealthcare centre. This doesn't suggest that the available human resources could prioritise the activities of the telehealthcare centre and also doesn't clarify if they would be paid additionally for their work for the telehealthcare centre.

Although gathering resources for setting up a telehealthcare centre would be challenging, obtaining one-time resources would be easier when compared to obtaining monetary resources to sustain the centre. A participant listed the items that would require money, including the salaries of the human resources, electricity and internet charges, and maintenance. Another participant who runs a telehealthcare centre added that the advertisement and organising of patient check-up camps and making medicines available at the centre would also require additional resources.

Many participants commonly mentioned staff and doctor compensation as one of the essential expenditures. An OL voiced that the doctors at both ends need to be compensated in some form. They further mentioned that if the payment is monetary, the financer must be very clear in the remuneration terms. All the participants also agreed that doctors at both ends need to be compensated, and a few suspected it might increase the treatment cost. One OL suggested a different financial model for each organisation depending on the source of payment to the doctors; either the patient bears the expenses of payments to both the doctors or the service provider needs to identify another source for payment or subsidies to ease the burden on the patient. In the case where the service provider expects the patient to pay for two doctors, it is doubtful that rural patients would have the financial capability or willingness to pay for two doctors.

Another OL gave the example of the KEMHRC Pabal unit, which runs on a not-for-profit basis, and the doctors participate in different research activities and volunteer their time for the Pabal MHC in return for good career prospects and incentives for good performance. However, they further mentioned that this model works for KEMHRC but will not apply to other places, especially for-profit organisations. An OL emphasised that

a charitable way to work is not sustainable in the long term, although this can put things in place initially. This indicates the need for long term and sustainable arrangements for the payment of doctors and staff members.

"No matter what you do it will cost some time and money, someone has to pay" OL 2

An OL who is well-versed with the telehealthcare systems in public health departments remarked that the specialists are paid INR 300 (~GBP 3) per consultation for all the consultations in the public health system. This, according to the OL, creates interest for the specialists to provide teleconsultations. Another OL working in the public health systems supported this statement by giving the example of teleconsultations for prisoners for which the doctors are not paid any honorarium. This OL mentioned that the doctors are reluctant to provide any prisoner teleconsultations.

Some participants raised concerns about the potential payment of fees by the patients, particularly in remote locations where it is perhaps most needed, as these patients tend to be poorer than those in more accessible areas. A participant mentioned that to make a private telehealthcare model sustainable in India, and an organisation is expected to earn the basic expenditure either from patient fees or through various other sources such as donations. When asked during the structured questionnaire, the patients from Pabal village, where the telehealthcare setup is located, expected to receive the treatment either free or for minimal costs like INR 50 (~GBP 0.5). Such a discrepancy between patients' and doctors' expectations requires us to explore more options for creating sustainable payment models in telehealthcare systems setups in villages with the population who have minimal paying capacities.

Further, during discussions around the sustainability of the system, one of the OL suggested that a high volume and lesser profit approach might be more appropriate considering the paying capacity of the population residing in remote villages. This could also provide access to healthcare in remote areas but at a reasonable cost to the patients. This does not suggest a lower quality of consultation but maximises the use of the doctor's

time by having more patients at the centre and not having more free time in between consultations. In this case, it may be prudent to widely advertise the services of teleconsultation centres so that more and more patients from the vicinity access the services and the doctors' time is fully utilised to provide quality services to more patients.

"*Now instead of you seeing one patient for 100 rupees* [~1 GBP], *see 10 patients for 10 rupees. So, work with them, you will have larger volumes like they are the base of the pyramid, okay, they are the ones who need tele medicine services, they are the ones who cannot pay, they are the ones who are not going to the hospitals so work with them, that's what keep the cost low but you will work numbers"* OL 8

Another OL mentioned a different approach to calculating the monetary profits through telehealthcare centres by larger tertiary care hospitals. They mentioned that the telehealthcare centres in the vicinity of the city would provide wider reach to the hospital services and thus also result in good publicity for the hospital and expand the catchment population with a newer patient population. Such thinking would provide an easier and logical way to calculate profits as the patients who otherwise would have opted for other hospitals for any surgeries or procedures would thus visit the tertiary care hospital, which has initiated a telehealthcare centre in a village.

"means the patients who will not come to you [otherwise] *will come to you and the patients who will come to you will get the procedure done from you, where will you count this revenue…"* OL 5

5.2.8 Time requirement

Study participants who were experienced in setting up telehealthcare systems mentioned that setting up is a long iterative process that may take from months to years. An OL shared an example of their own experience mentioning that they were appointed as staff at a government telehealthcare set up in 2005, which initiated its functioning in 2009, and it took two more years until 2011 for it to become fully functional. Another OL mentioned

that the start of the last decade was the early stages of telehealthcare in India. They faced challenges at every stage; however, they anticipated that the process would shorten eventually as the newer centres would benefit from the previous experiences. Two more Ols concurred that an extended time of a few years was required for setting up a telehealthcare centre, as overcoming hurdles requires time. Nonetheless, it seems that once the infrastructure and team are in place, the remaining steps are iterative, and the centre will keep improving and upgrading as it goes along.

"Yes, initially, we had lots of connectivity issues, and hence, it took three years of our time actually to implement the telehealth system." OL 7

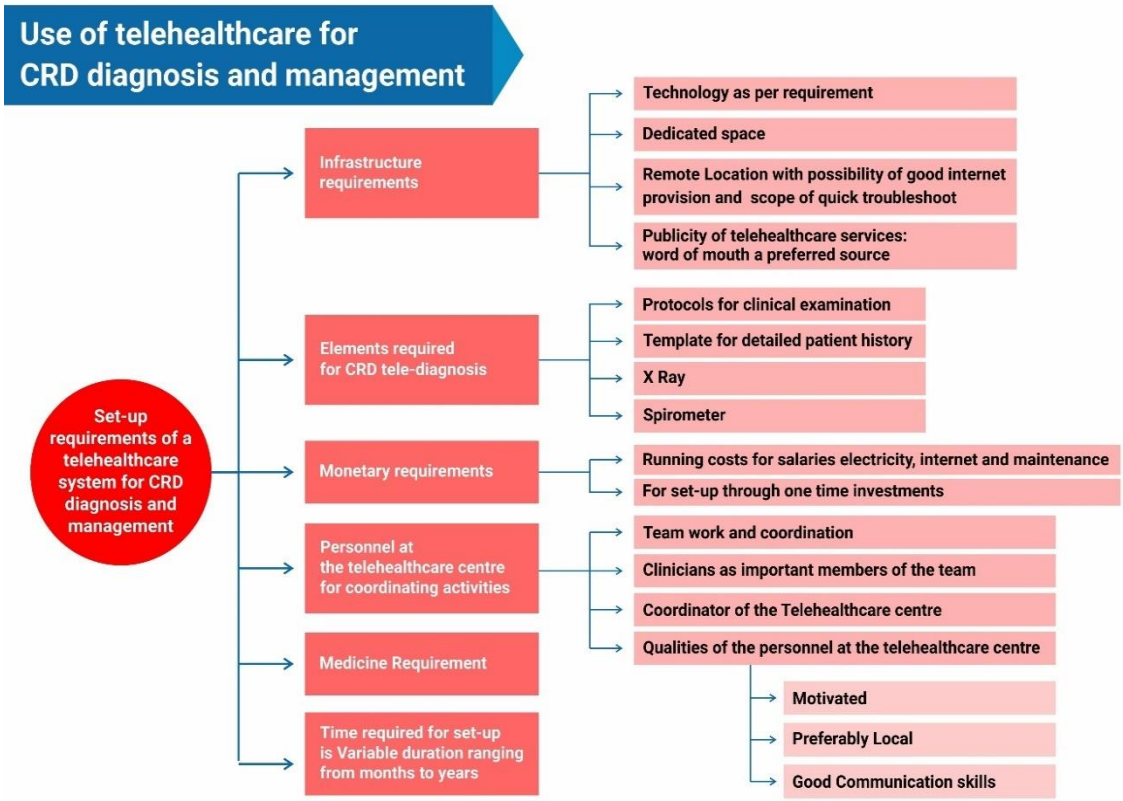

Figure 9: Framework for requirements of setting up and implementing a telehealthcare centre for CRD diagnosis and management

5.3 Barriers to and facilitators of successful implementation of specialist to non-specialist teleconsultation at MHC in CRD diagnosis and management

This section describes study participants' attitudes to teleconsultation for CRD diagnosis and management, which may either act as barriers or facilitators or both to the implementation of the services. I have summarised these findings in a framework in Figure 10

5.3.1 Motivation for providing telehealthcare services in remote areas

I have derived these findings primarily from the interview data from the Ols. One OL mentioned that involvement of the institutional leadership' in the setup of the telehealthcare system leads to increased interest and motivation in the team. This is not surprising, but it confirms the desirability of leadership involvement in the overall process of establishment and implementation of a telehealthcare centre. Another OL added that every stakeholder involved in setting up and further implementing the teleconsultation centre would need motivation and might expect rewards to keep them motivated. The rewards could be financial or related to work satisfaction. This OL believed that every stakeholder would have different expectations; the investors or owner organisations will expect financial returns or profits, which will motivate them to invest more; the physicians and champions will expect stability and job satisfaction along with remuneration, and the patients will expect good treatment at a lower cost. So, this OL expressed that one has to keep the stakeholders motivated by keeping them satisfied with remuneration and profit shares. It appears that the implementers need to balance the needs and expectations of each and every stakeholder and to keep everyone happy and motivated.

"…every stakeholder will ask this… what is in it for me. Doctor will ask, what am I going to get now the person who is investing, let's say an NGO or a company or a hospital, owners they will ask what am I going to get?" OL 8

Another OL who has experience working in a private organisation expressed a different view saying that the champion or a coordinator themselves must be motivated to run the centre. This one motivated champion could encourage other stakeholders and coordinate with them. This requires another level of leadership who must find their own stake to motivate themselves in the system and have the motivational skill to motivate others in the system. They further mentioned that this champion should manage the work, starting from connecting to the patient to managing the doctor and persuading the stakeholders to join the initiative by aligning their vision and mission with the organisation. According to this OL, a motivated champion must see the larger picture of the initiative and understand the organisation's vision and further suggested that this can be considered a key to successfully running a telehealthcare centre globally. The quote of the OL mentioned below is self-explanatory.

"You see, any place only those who have the passion for the work and understands the benefit of it would be able to see the large picture, if not immediate, in the long run, that institution's telemedicine centres or the programs would take off very well" OL 3

Another OL, who has worked with multiple telehealthcare centres across the Maharashtra state, when comparing successful and unsuccessful telehealthcare systems, thought that the person-in-charge would determine the success or failure of the turnover of patients.

"Infrastructure is there; everything is there [all essential requirements are available]. *Only thing which is needed is an affinity* [motivation and feeling of ownership towards the telehealthcare centre] ...*which is not there* [no motivation]. *Yes. Affinity* [motivation] *is very important. If it is there then* [motivated] ....*they will refer patients who are in a real need of it…"* OL 7

However, such a champion might be more likely to emerge from the existing team and should be identified by the leadership.

All other OLs agreed that motivated, passionate and responsible staff is key to a thriving telehealthcare centre. Some of them mentioned that the responsibility for the centres should lie with the people managing them; they should take responsibility and accept the challenges of running the centre smoothly. One OL suggests that the centre's staff must be treated as entrepreneurs. Overall this indicates that if a person is trusted with responsibilities and is given the flexibility to work and design their own strategies to undertake their responsibilities, it might help build the success of a telehealthcare centre.

A PP who has experience managing a telehealthcare centre was more concerned about the patients' motivation to attend the follow-up clinics. This PP mentioned that regular patient follow-up was needed to improve the telehealthcare centre outcomes, which could be achieved by village level motivation. This statement was made in the context of a low rate of patient attendance at follow-up even when recommended; thus, irrespective of the model of consultation both online and offline, the patient population needs to be motivated and informed about the benefits of follow-ups which might help to increase the follow-up rates.

An experienced specialist physician with education and interest in telehealthcare questioned that if the patients are willing to come physically to the clinics, what is the motivation to do a teleconsultation. They mentioned that *"clinical practice is about saving lives; a life saved cannot be counted in money earned; it is a pious activity"*. They expressed the view that providing teleconsultation support will not give them the direct satisfaction of treating the patients because it is like advising a colleague, which may or may not translate to a change in patient outcome or behaviour. Hence, this OL suggested that they would not find any motivation to conduct the teleconsultation process for a longer time and suggested that instead, more junior RPs could regularly provide teleconsultation. Despite their resistance to providing teleconsultation, they feel that the person using the technology would feel motivated if using telehealthcare facilities reduced their existing workload. This raises the question of how satisfying or not teleconsultation might be for the doctors involved and how best to incentivise their involvement.

Nonetheless, this was also an opinion of a single OL which might be driven by their own preferences and experiences which would avert them from using technology for consulting a physician. For example, they might not be comfortable with technology use but may be reluctant to admit it. Further, spending time on supporting another doctor without receiving the credit of treating patients could be another possible reason for this OL to resist providing teleconsultation. This is probably because the treating doctor is legally responsible to provide treatment and the patients would credit the treating doctor with the good treatment despite the support from the specialists, this may not provide the expected job satisfaction to the specialist. However, it was not clear why they assumed that the junior RPs would be willing to provide this service.

"Definitely, it [telehealthcare facility] *is a…umm…gift..it cannot be used by just imposing on the staff. First of all those staff or the users have to feel that this is a gift for them, not a compulsion…"* OL 5

Consequently, human resources and their motives seem to be an important barrier or facilitator to implementing a telehealthcare system, directly impacting the success and failure of the telehealthcare centre.

5.3.2 Challenges in CRD Diagnosis at the primary care clinic

Every doctor has their own way of disease diagnosis, and the consistency of approach to diagnosis needs attention, especially for specialist to non-specialists teleconsultation. This variability, according to participants, can pose challenges in the CRD telediagnosis process thus can affect the outcome of CRD diagnosis.

"The general practitioner and consultant have different aspect of looking at the patient… they both are on the same page [even if they agree]. *The GP* [PP] *is treating by thinking other level and consultant or expert they are….by the considering the part diagnosis at another level* [both PPs and RPs have different understanding and ways to diagnose the patients] *and so, there may be a discrepancy* [in] *way of treating by the general physician*

[compared to the RP].....*And there are different styles of diagnosis of every physician... Some carefully examine patients and go to the diagnosis only by considering* [and some rely only on] *clinical symptoms."* PP FGD

Another OL, however, mentioned that despite the variable approaches to CRD telediagnosis, it is still a better option than not having facilities for CRD diagnosis. This OL further mentioned that given the unavailability of specialists in rural areas in India, CRD diagnosis using teleconsultation in rural areas might not be accurate. Despite such obvious challenges, telediagnosis of CRD may identify emergencies and screen patients who might need further treatment.

Although access to patients' EMR is an obvious feature of teleconsultation, doctors expressed the need for EMR, especially the feature which makes the records available simultaneously at multiple locations, indicating its importance in the teleconsultation process. After the PPs had conducted some teleconsultation with RP for CRD diagnosis, a PP expressed that it would also help the PPs and RPs communicate even if they are on rotating duties, and the records could be accessed by different doctors at different locations even simultaneously. They said this in the context of the currently existing telehealthcare setup at the MHC. Although the EMR could be accessed via cloud at multiple locations using a login and password, the system does not have the option of retrieving patient history quickly during the follow-up visit, however this was one of the point in the report which suggested system upgradation.

"The history that comes while taking a backup.. History… how many times a single patient has come.. it should open in one page…Haan [connecting word in local language with no meaning here]*…means something like he* [patient] *had previously come for this, now he has come for this, this medicine was given previously… Means…that cannot not understand from this system…*[the system records episodes and not patients] *"* PP 2(post teleconsultation)

Further, the RPs repeatedly mentioned that CRD diagnosis in any other clinic setup could be complicated due to the non-availability of diagnostic equipment at the primary care clinics in rural India. Especially, X-rays and spirometry are not readily available in these clinics. In such a case, the participants suggested that the information for the patients on where they can access such tests must be available. Alternatively, this equipment must be available at primary clinics as mentioned in section 5.2.2

"Then what we do is, we give a [referral] *chit and ask to go to Vadu,*[if] *ECG is available at Vadu but X ray is not we ask them to get it done from some other place."* PP 9 (post-teleconsultation)

In the absence of diagnostic tests like spirometry, a PP who regularly attends patients with CRDs in their clinics mentioned that they rely on patient history to reach a diagnosis. The PPs stated that CRD diagnosis is complex and needs detailed clinical information about the patient for labelling a patient as a CRD patient and hence suggested that repeated patient follow-ups for documenting patient history is required for a confirmed diagnosis. This also indicates that the PPs in their general practice rely on repeat examination and history rather than diagnostic tests like spirometry to diagnose CRD and hence are reluctant to refer patients for any diagnostic tests, probably due to the non-urgent nature of the disease or due to fear of loss of revenue due to loss of patient.

"*Basic thing for diagnosis of COPD is knowing patient history, age factor and clinical findings. These three things are majorly useful in diagnosis. Basically first episode you cannot label as COPD. It requires prolonged history, from how many days the person is ill and other things. This cumulatively helps to diagnose COPD"* PP 5

None of the PP participants initially thought that further investigations for CRDs or referral to a specialist are routinely required. However, they mentioned that if they were to be provided with access to such tests, they might come forward to take support from the specialists to interpret the tests. The PPs recognise that specialists have different ways to diagnose the patients. In contrast, RPs feel the need for X-rays and spirometry reports

in addition to the history and patient notes to conclude a diagnosis and further manage the disease. Therefore, they find it helpful that a PP might ensure all required diagnostic tests are done, check the reports and summarise before the RPs see the patient.

"…changing the management just by looking at the X ray or [spirometry] *reports only* [is not possible], *even here* [at the KEMH OPD] *also after seeing the patient, we cannot recall* [patient history], *we have to see all our notes* [hence EMR will be helpful]*"* RP 4

Despite the uncertainty in the availability of diagnostic aids, the RPs expressed that if the PPs are competent or trained to administer the questionnaire for patient history, they can direct the patients to further diagnostics. If the diagnostic facilities are available at the primary care clinic, they can further consult an RP using teleconsultation to interpret the findings, and thus CRDs telediagnosis is feasible. The RPs further mention that, unfortunately, some PPs prescribed bronchodilators and steroids empirically to the patients without further investigating because of the absence of access to diagnostics tests, such as spirometry, postponing the actual CRD diagnosis and thus appropriate treatment. Confirming acute episodes as exacerbations of an underlying chronic respiratory condition requires spirometry for prescribing further treatment as what this can lead to disease aggravation in the absence of continued treatment. Failure to use this may lead to inappropriate treatment, for example unnecessary steroid therapy and can lead to adverse effects (e.g., increased risk of pneumonia, osteoporosis) as well as the financial consequences of a treatment that doesn't work. Likewise, failure to diagnose, for example COPD and use appropriate treatments such as long-acting beta-stimulants may result in poor control of the condition. A possible reason for not referring the patients for further assessment is the fear of losing the patient to another doctor, especially to a specialist, once the diagnosis is confirmed in turn affecting the revenue of the PP. Prescription of bronchodilators and steroids empirically may also provide temporary relief for the particular episode to the patient leading to multiple visits of the patient to the treating doctor thus assuring continued revenue from the single patient. Another possible reason may be the unavailability of the spirometer and lack of awareness of the PPs in (Vanjare

et al., 2016). This practice, however, could be avoided by training the PPs and emphasising the need for continued follow-up with the patients even if they feel relatively well. Continued training of the human resources is one of the important facilitators for smooth functioning of the telehealthcare centre. Training the PPs might be effective because it could provide them with confidence to provide appropriate treatment to the patients for the CRD management. However, training depends on multiple factors like the acceptability of training, attitude towards training, time availability to get trained as described in Section 5.3.4. However, translation of training to successful delivery of appropriate treatment is uncertain and further depends on the factors mentioned above yet training the PPs is one way to ensure that the patients receive appropriate treatment.

"Patient becomes well if we give bronchodilator, some supportive corticosteroids, Patient gets relief easily and is in good condition for some days. After some time/days when environment changes or external factors changes then it [asthma symptoms] *gets elevated, from that we get to know that it comes in Asthma category."* PP 3

The PPs also understand that the RP/ specialists will expect a range of diagnostics tests to have been undertaken prior to teleconsultation. Another major challenge that has come up during discussions with RPs and PPs is diagnostic uncertainty due to the overlap of CRD symptoms with those of myocardial diseases. PPs described patients diagnosed with cardiac conditions which turned out to have CRDs. In such emergency cases, the PPs mentioned that they would not be comfortable with the teleconsultation process and preferred to provide the first line of treatment and further refer the patient.

"But we should be able to differentiate between cardiac and respiratory patient. Sometimes there are rhales [rales] *in COPD patients and also there are rhales* [rales] *in left ventricular failure. You should be able to differentiate that. Primary physicians should be able to understand that, and he should inform* [refer] *that further* [to specialist]*."* PP 7

These challenges, mainly of variations in doctors' skills and capacities which creates person to person variation in concluding the diagnosis and the unavailability of diagnostic

equipment in primary care clinics, would need to be overcome to facilitate the use of the telediagnostic process in CRD

5.3.3 Legalities and regulations

This section describes participants' views around the Indian regulations and legalities of teleconsultations after discussions with the RPs and OLs. Legal and medicolegal concerns were identified as barriers to the implementation of telehealthcare in general.

One RP feared that inaccurate diagnosis and inappropriate treatment following teleconsultation could have medicolegal consequences. They suggested that teleconsultation lacks precision in giving a clear idea about the patients' symptoms as the doctor's diagnosis may be based on the information provided by the patient alone and not supported by the doctor's observations. They assumed that the process of doctor-patient communication might not be as efficient during teleconsultation as face to face, the OL gave an example of mistaking a myocardial infarction for heartburn, and such cases can cause legal troubles to the doctors.

"On phone he mentioned…it's only… I have an acidity and I just tell him to take antacids… again in the night he had pain and heartburn, so again I told him to go to a physician, he didn't listen, a very next morning when he went to the hospital and got an ECG done he was having myocardial infarction, so now who is responsible, I had told him to take antacid, that if he had died of myocardial infarction and he had sued me in Court of Law I would have been punished." RP 2

Although my study focuses on specialist to non-specialist teleconsultation, one RP stated that India's Supreme court does not entertain consultation through a messaging system like WhatsApp. It is deemed illegal as the treatment is provided without a proper diagnosis when using WhatsApp. Likewise, another RP believed that if the patient to doctor contact occurs during teleconsultation, they might face legal issues in case of any problems, but fewer legal issues might arise if a specialist doctor is consulting another doctor. They

further mentioned that in doctor-to-doctor teleconsultation, a PP or treating doctor is legally responsible; hence they would be more comfortable to provide teleconsultation to another doctor but not directly to the patients.

Uncertainty about the legal basis of remote consultation was perceived to be a potential barrier to the system. Most OLs were sceptical regarding the legalities of teleconsultation. They alluded to the laws of the Indian constitution not having clear directives about teleconsultation. When asked about overcoming the challenges of teleconsultation, some suggested the need for clarity in the regulations for teleconsultations.

"*Presently the whole thing around teleconsultation is nebulous, I think the primary thing that needs to happen really rapidly, for it to really evolve, is the recognition that it needs a legal envelope, put in as rapidly as possible, because you are dealing with lives."* OL4

In contrast, one OL feels that the absence of regulations is enabling as there is more liberty to try out different methods.

"..terrific when there's no regulations, Go ahead and do what you think is right, we will deal with the future when it comes" OL 8

Notably, most of my study participants believed that a legal guideline or framework is needed. The doctors said that they would feel safer when conducting teleconsultations if the legalities were clear. An OL who works in a public health centre mentioned that their state-level system had, in the absence of national-level regulations, provided guidance regarding the legal responsibilities for treatment given using teleconsultation. They further stated that doctors were initially reluctant to provide teleconsultation due to unclear legal responsibility. However, since the state had clarified that the legal responsibilities of teleconsultations lie with the referral centres, the specialists are no longer sceptical about providing teleconsultations.

(These data were collected before the Government of India published the guidelines for telehealthcare in May 2020; however, many concerns are still not addressed in these guidelines. The details are discussed in section 2.2)

5.3.4 Training

All the participants mentioned the need for training for all the stakeholders involved in the teleconsultation process, which is typical for initiating any new activity. Such training was considered one of the essential facilitators in the setup and implementation of telehealthcare for the RP consulting the PP to diagnose and manage CRDs. However, the acceptability of training to these stakeholders/ role-players is questionable based on some of their responses in the FGD. The perceived training needs for each stakeholder are discussed in detail below.

5.1.1.1 Training Acceptability:

The consensus among the RPs is that the PPs and the technicians need training under RPs guidance. However, a couple of PPs, feel that rather than training for the diagnosis, they must know the RP/ consultant better to know what the RPs would expect from the PP during the consultation.

"*And I being a student of Dr. U, think of what he will ask? For example I ask him that patient is having fever since last 4 days, should I start antibiotics? I know what questions he will ask after this. He will ask is patient playing, is the patient eating etc.... If I know this I will ask should I start antibiotics? Then he will answer if the play full activity is on going then do not start the antibiotics. And this wavelength has matched and their question has removed. If I ask the same question to Dr. J then, who insists much on lab reports. He will ask have you checked blood, done WBC count etc.. If you have done WBC count then if the count is 15000, admit the patient. This level of thinking changes."* PP 4

Neither the RPs nor the PPs explicitly agreed to get trained probably due to the hesitancy to accept lesser knowledge. Some OLs also expressed the view that although an important component, the doctors would not prioritise getting trained to perform the teleconsultations, probably due to scarcity of time. One OL also mentioned that self-confidence or overconfidence in understanding the processes involved in teleconsultation is another probable reason RPs deny the need for training.

"… if the doctors believe they are gods, it makes it even more complicated. Do doctors want to be trained? I would be…. I would love… to wish that they are interested. Some would be… but I think they are too busy to want to devote that amount of time on training." OL 3

One OL mentioned that technology had become increasingly user friendly; hence, the training required to use something as simple as a videocall system would not be extensive. Additionally, the RPs probably would not prioritise getting trained over their busy schedule of treating patients, although it seems to be a recognised need

"We will know how to operate that. A demo is sufficient" RP 4

The PPs, on the other hand, seem open to the idea of getting trained by the RPs. Although they did not explicitly mention it as a requirement for themselves, they indicated that other PPs may need to be trained. I am not sure about the reasons behind this, but it was probably because they prioritise their workload which might get affected during the training duration which will also, in turn, lead to loss of remuneration during the training time. However, on receiving an opportunity for training the PPs would not hesitate to get trained by the RPs. The way to get trained was through agreement for the PPs to work alongside the RPs/ consultants in their clinics which they felt would help the PPs to understand the RPs needs when consulting them through teleconsultation. This again hints at a prevailing hierarchical view of medical practice with one group subservient to the other rather than engaging in a collaborative endeavour which has been previously reported by (Pearson, 1999). It also suggests that although there is consensus about the need for training, there

is no consensus about what that training should include by both RPs and PPs, thus, suggesting that there might not be a clear shared understanding of the key competencies needed by doctors to deliver this service successfully.

5.3.4.1 Primary Physicians' Training

Although all participants mentioned that training all stakeholders is essential in implementing the telehealthcare centre, a few insisted that the PPs at the telehealthcare centre need to be trained as a priority. The doctors indicated that the PPs being the primary patient contacts, their personal communication with the patients and skills in patient management are essential for implementing telehealthcare and not just for the diagnosis and management of CRD. In RPs' opinion, the PPs' training for CRD diagnosis and management has multiple facets, including auscultation, spirometry, and clinical evaluation methods.

"….the physician who is there has, that [s]/*he should be little trained in respiratory disease* [s]/*he should be a expert in examining the respiratory system."* RP 3

They recommended that PP training should not only include CRD management but also training on communication. One RP, in particular, insisted that communicating with the patients is an essential part of the CRD management process. In contrast, another RP focused more on training for respiratory examination as they reiterated that auscultation being part of respiratory examination plays a significant part in understanding the CRD status. Additionally, the PPs discussed the need for a common protocol for conducting auscultation and other processes for CRD management. The PPs expressed that common protocols would simplify the training and management processes, especially in a setup with rotational duties. The RPs further insisted that PPs must be trained to conduct all processes as per the RPs who tele-consults with the PP. They further indicated that such training would also imbue increased trust between PPs and RPs. Nonetheless, RPs expressed that it is essential that the PP be trained under the RPs by observing the RPs clinics for a few weeks.

"He can come as an observer because he has the basic knowledge, because he is a doctor, he has the degree, he is a graduate therefore he has the basic clinical knowledge. We cannot hold her/his hand and teach, listen like this, not like that. But there is anything specific, we will definitely tell if there is any specific finding but not like we will take a lecture or training for him" RP 5

"Last time…, suppose if I have trained him… means he has been trained under me then I can trust him… RP 4

The RPs further discussed that if they doubt the PPs' capabilities, the teleconsultation would be ineffective as RPs would then refer the patient for face to face consultation. Another OL hence suggested a training session on interpersonal communication for both PPs and RPs.

"…It [teleconsultation]does not take place only based on communication, consultant asks something different and [local] *doctor tells something different. Consultants do not have that much time. We have to tell them in 1 or 2 minutes what is here, and he tells* [prescribes] *medicines. If I do not tell him what is expected, then....and other things like this is this much etc....."* PP 6

The RPs' suggestions indirectly keep hinting at a hierarchical nature of the relationship between PPs and RP, where the RPs assumed that PPs are unaware of the diagnosis and management of CRDs. This could be due to the knowledge and experience of the RPs in managing the CRDs. Additionally, the RPs or specialists are considered superior in social structure when compared to the PP probably because the admission and successful completion of the post graduate degree to become RP requires higher intellectual abilities which is achieved by a very few doctors. However, maintaining careful management to maintain a balance of the self-respect of both PPs and RPs would be crucial for training organisers. This suggests that the RPs also need to come together to agree on what they collectively need from the PPs to facilitate the telediagnosis process. RPs talk about

training individual PPs in their way, but their way may not be the way of their RP colleagues. The RP data has a strong sense of maintaining their clinical autonomy

5.3.4.2 Respiratory Physician's training

While all RPs during the in-depth interviews and the FGDs focused on the need for training for PPs under their guidance, they did not express the need to train themselves either in the teleconsultation systems or in the practices that AYUSH practitioners use in the CRD diagnosis and management process.

[about the teleconsultation process] *"..it will not be needed that much…or just giving you a demo or something will work.."* RP 5

The RPs also assume that the informal remote medical consultation that they occasionally undertake using a mobile on a regular basis would not be different from the formal teleconsultation system. This further instilled confidence in the RP that they can manage the telehealthcare process without training?

"…we will understand one by one when we get in to it" RP 6

5.3.4.3 All stakeholders' training on communication

The study participants, including the doctors, expressed that communication training for all staff members at the telehealthcare facility was important. Good communication between staff members and patients was seen as essential to the success of telehealthcare systems, as evident in the functioning of any other system. There was a recognition that patient footfall depends on the perception of the quality of the treatment provided and, importantly, on the healthcare providers' approach at the telehealthcare centre.

"I think there's absolutely no doubt about it that communication skills particularly when you are not physically in the same space needs to be trained." OL 3

An OL emphasised that training on communication is required for all the stakeholders and not just the doctors. In contrast, the acceptability of training by some staff is in question as many doctors expressed that the use of technology is simple and training on communication using technology is not needed.

"We all need to be trained, not just doctors, everybody. So I think training is mandatory and I don't know who's going to do it." OL 3

Another OL mentioned that communication at the telehealthcare centres occurs at two levels. First is communication between the doctors or specialists to non-specialists, and second is between the PP and the patient. Communication skills are vital to conducting remote consultations, especially when the person is not physically present. This OL further stressed that due to physical distance in the communicating entities, body language plays a minimum role and what matters is how one speaks, and hence communication protocols need to be established for smooth functioning of telehealthcare centres. Communication between the doctors was seen as crucial for the proper care and treatment of CRD patients. The RP must trust the PP and good communication from both ends is a necessary process to preserve this. The RPs added that communication problems would pose a challenge in the overall implementation of the telehealthcare system.

Further, training on communication is required for the PPs to understand the patient's needs and socially acceptable norms, specifically to treat the CRDs as CRD patients require counselling to encourage them to adhere to treatment. For example, the PP must be able to consider the patients' religious beliefs or be informed of the local festivals when advising treatment to the patients. The religious food preferences like suggesting the use of non-vegetarian food, festival specific rituals like the use of crackers during Diwali or community-specific activities like involvement in crop harvesting. Such training on communication will help the PPs to consider all such background information of the community to amalgamate it with the treatment methods and provide relevant suggestions by acknowledging this information.

Another OL indicated that the telehealthcare centres would be usually located at remote locations and would have patients attending from the surrounding vicinity. Moreover, this OL suggested that the general communication that could make the attending patients comfortable is also important in chronic diseases where patient follow-up is key to successful treatments. This also aligns with the requirement that the coordinator be local as being from the same community will help them understand the local context, and the same could apply to the PP as well. An RP also mentioned that although this is common and obvious to any clinical practice, teleconsultation cannot function without communication skills.

"So the primary care physician...What I'm saying is the primary physician must undergo Counselling Sessions. Rather… How to do counselling, not counselling, but how to do counselling. And if that does not happen, the whole program will fail. You will make a COPD diagnosis or Asthma. You have given the right treatment, the patients are not taking it and that's what happens in a routine life, routine day-to-day life anyways. So that communication with the patient is.....how do you enhance that?" OL 2

Additionally, an OL also insisted that the communication training must include motivational training to encourage the personnel to take ownership of the system and feel that they are responsible for the functioning of the process. This will make the system more likely to be sustainable and successful in the long run.

5.3.5 Logistics

Logistics for the functioning of a telehealthcare centre came up multiple times in discussions with all the study participants. For example, an OL who has experience in managing a telehealthcare centre suggested that overall smooth functioning depends on logistics, including internet connectivity, time management and coordination between teams. Nonetheless, another OL mentioned that logistics would differ according to the ecosystem, and the ecosystem depends on the differences in people, culture, and surroundings.

According to a PP in an interview conducted after they had experience in teleconsultation, well-designed telehealthcare systems and software could facilitate the logistics. They further suggested that the software must be developed considering the logistics needs of the users and must be modifiable for certain items. For example, the PPs must be able to choose any specialists and not only the registered ones on the system. They also mentioned that the software must be easy to access and that the patient history must be readily available for all the treating doctors. However, another OL who works for a government organisation that provides teleconsultation services on a commercial basis spoke of their experience that they provide either software or both software and hardware as per the users and budget requirements. This PP who trialled teleconsultation in Pabal suggested that the software must have the facility for simultaneous access to the videoconference system and the clinical records at the PPs end. The current system they used allowed access to the patient records from a single computer, and the PPs were placed in an adjacent OPD.

"Registration…umm… the place where registration is done.. This is the only access point for…umm…videoconferencing and for checking on call in the system..OPD…but there should be a second access [from another room] *for that…means…in other OPD.such that patients privacy is maintained.... and if some protocol is given there like only those who need specialist thing* [consultation] *have to be called and specialist need to click on the hotlink from there from specialist* [specialist's OPD].. *And after they click, you immediately need to give a single click on the system... "Help me"* [tab on the system]... *Then that zoom will be open for you….we…It is not like it is very difficult..The only thing is there should be second access so that they can do it from other OPD"* PP 2 (post teleconsultation)

The PPs suggested solutions to some important concerns when discussing the logistics. Most of these suggestions were related to time management and coordination between doctors.

"There should be a fixed roster plan as per speciality. So Monday Orthopaedic Tuesday general medicine Wednesday dermatology like this. The implementers should inform the villages about the specific roster plan, thus the patients will get to know about the services and they will use these.." OL 6

Further, many study participants voiced their suggestion for having a regular timetable for managing the services. The PPs suggested that as for the traditional face to face clinics, the patients must be given appointments for a specialist teleconsultation. The RPs also agreed to this suggestion and further mentioned that this will help them identify appropriate locations with gadgets and cameras and save time for everyone.

"If the appointments are given after our OPD hours then it would be beneficial for us, without a doubt." RP 6

This arrangement could help the PPs in coordinating with the specialists and the patients. Participants discussed another option of weekly or monthly teleconsultation for different specialities. This was also ratified by an RP as they suggested that the patients with CRD require continuity in follow-up, and a regular schedule can be helpful for both patients and doctors as treatment adherence is important in CRD patients. An OL who is a manager at the government-run teleconsultation centre shared his experience of maintaining a roster that helped them in the continuity of the service.

"We have a clinic every day from 1130 to 130. And four to 6pm. They have a register, and they attend the teleconsultations based on their rotation." OL 6

An OL shared his experience of fewer patients visiting the telehealthcare centre in remote areas due to lower population density. Hence, they mentioned that the telehealthcare clinics function for a limited time or days per week or discontinue after a certain period. Another two OLs and an RP also had similar opinions and mentioned that continuity in providing services is essential in rural areas such that the rural patients have some reliable options for seeking healthcare. One OL suggested that the availability of telehealthcare

services must be offered for 24 hours thus suggesting wide range of opinions regarding availability of services

These discussions indicate that management of the doctors' time is important in terms of the smooth functioning of the teleconsultation process. The teleconsultation centre may not be functioning initially at its full capacity given the low population density in rural areas, and hence prearranged schedules for the teleconsultation activity may help doctors and patients better manage their time.

5.3.6 Views on models of telehealth

The participants discussed various models of providing telehealthcare, and I have summarised and categorised the discussion in this section. One respondent categorised telehealthcare as primary, secondary and tertiary telehealthcare as per the healthcare delivery system. They defined primary teleconsultation as a doctor to patient teleconsultation and secondary teleconsultation as a specialist to non-specialist teleconsultation. This OL further cited an example of a remote robotic surgery to explain tertiary teleconsultation but did not particularly define it. However, a few more respondents described various teleconsultation types by the people involved in the teleconsultation process. My study objectives focused on the secondary type of teleconsultation between specialist and non-specialist, yet I have briefly documented the types of models so as to weigh their benefits over each other.

- Doctor to Patient teleconsultation

One OL, who is also a specialist doctor experienced in teleconsultation, recounted their experience of providing teleconsultation to patients in India and across continents. They said that the primary teleconsultation between doctors and patients worked in remote rural areas across the globe where doctors are not available. Another OL further shared that patients also use doctor to patient teleconsultation to obtain a second opinion for their health issues, and they gave examples of the commercial websites which provide such

doctor to patient teleconsultation. They also reported that these websites provide facilities for uploading patient reports and charge fees on a per-call basis. According to the OL, such facilities will serve many people and save patients' and doctors' time. Nonetheless, such processes might be appropriate only when access to even a PP is impossible, for example, in extremely remote areas or in COVID like scenarios where limited physical contact is safe. However, in CRDs, such consultation was not advised by any of the study participants considering the complexity of the CRD diagnostic and management process.

- Specialists to non-specialists including clinician, a nurse or paramedical staff

A few respondents, including the PPs and OLs, mentioned that teleconsultation is a better way to take a second opinion for a PP from different doctors or specialists, primarily to ensure the diagnosis when in doubt. One OL mentioned that this doctor to doctor teleconsultation model could be modified to make it more cost-effective by involving non-medical clinicians in specialist to non-specialist teleconsultation. The non-specialist could be a PP, a trained nurse, or a paramedical staff. They further mention that the doctors can work online for multiple centres simultaneously. This OL also identified this model as the Hub-and-Spoke model, where the specialist is located at the hub.

"Either you can ask directly in front of the patient, or you can ask separately to the physician like we have the other mediums in telemedicine, just send the report and take an opinion, all those things can be possible." OL 7

Such teleconsultations could be synchronous or asynchronous and may be suitable for CRD diagnosis and management as a clinically qualified person interacts with the patients in this model. Further, as mentioned in section 5.3.3, this model is legally more acceptable, and the doctors interviewed are inclined towards using this model. Thus, the choice of the model could act as a facilitator for the success of a teleconsultation centre.

5.3.7 Publicity and advertisement

A few participants described the need for publicity about the telehealthcare centres because sustainable execution of the telehealthcare clinics would demand more patients. One of the participants, who is also a community representative from Pabal, described publicity techniques, including distributing pamphlets and announcements using loudspeakers, as the best way to inform the population about the availability of telehealthcare services initially. Later, patient check-up camps, are adequate for the community to know more about the available services. Patient checkup camps are events where the centre makes more doctors, facilities, and medicines available on a particular day, with either no or minimal cost and this event is publicised widely. This OL informed that more patients tend to visit on the camp days. Such activities also require monetary resources, as already mentioned in Section 5.2.7. Moreover, hence advertisements and arranging camps would need planning and identifying monetary resources.

Another OL, in contrast, suggested that advertisements are not needed in rural areas as publicizing the clinics by word of mouth is faster and more effective. They further mentioned that the first few patients share their experience of the treatment with others and become the unofficial brand ambassadors of the facility, which will help inform others from the community about the available services. This also concurs with the patient's expectation of a good treatment, as mentioned in Section 6.9. Once the patients realise that the treatment is good and is working, they continue to visit the centre regularly and also publicise the services.

", if patients come to know about these facilities, the OPD numbers will increase. Patient awareness is required to increase the use of this system. If patients know about this, it is the best possible solution for OPD basis." OL 7

A PP practising in the area where the MHC is located suggested that if a local physician suggests teleconsultation, it will help build trust in the patients. They further mentioned that it would be similar to a traditional referral to specialists but available in the vicinity.

5.3.7.1 Telehealthcare clinics as advertisements for the tertiary care hospitals or specialists

Some participants revealed that conducting teleconsultation as specialists could help them build a network and advertise themselves. They mentioned that the telehealthcare centres could also provide new patients for the tertiary care units. The patients who otherwise would have gone to some other doctors or hospitals might approach the hospitals providing teleconsultation for surgeries or any other physical interventions after teleconsultations. Thus, providing specialists consultations using telehealthcare technology indirectly acts as an advertisement for the tertiary care hospitals. This discussion is also described in detail in Section 5.2.7

"…Okay, if you see 10 patients through telemedicine, one patient may come getting refer to your hospital, so indirectly how much money you would have spent for your marketing? Nothing, right?...Now with this telemedicine with that you doing the marketing as well as you are getting a patient to your institution." OL 5

5.3.7.2 Negative publicity

One doctor OL suspected that the conventional traditional healers or other healthcare practitioners in the vicinity may fear competition from teleconsultation clinics and may negatively advertise it. One OL also warned that any erroneous treatment at the centre could lead to negative publicity; hence suggested deploying good doctors at the telehealthcare centre. This also suggests that the PP at the teleconsultation centre must be knowledgeable and be able to provide rational treatment to the patients.

All the above discussions imply that advertisement and publicity are important in increasing the centre's visibility and thus increasing the number of patients visiting the centre. However, any single publicity strategy might be ineffective, and hence multiple activities should be employed to advertise the centre.

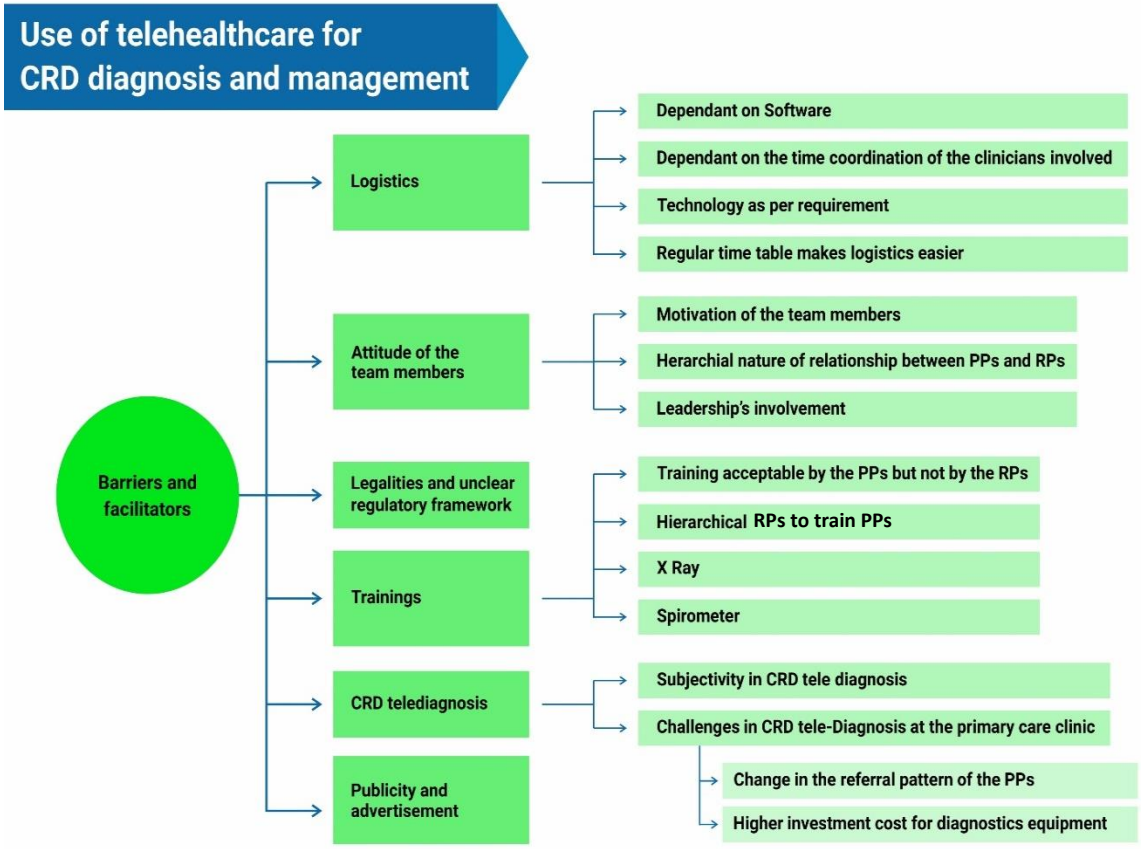

Figure 10: Barriers and facilitators in use of telehealthcare for CRD diagnosis and management

5.4 Stakeholders' perception of remotely supported CRD diagnosis and consultations

This section describes the stakeholders', *i.e.* the study participants' perspective towards the CRD telediagnosis and teleconsultation. This information is extracted from the FGD, and in-depth interviews with the study participants (OL, RP and PP) are summarised in framework Figure 11. These perceptions are important to understand as they play a prominent role in deciding the course of action of the stakeholders. If the stakeholders' perceptions are unfavourable towards the teleconsultation system, they would not consider

using it; however, if the perceptions are favourable, the stakeholders are more likely to try various ways to use the system and bring it into routine practice in the longer term.

5.4.1 Perceived Direct Benefits

All the study participants perceived telehealthcare systems as beneficial either directly or indirectly to the community and other users, and I have described it below.

5.4.1.1 Benefits to the local community

The study participants, including the OLs, RPs and PPs, predominantly described telehealthcare as having the potential to benefit the community and being implemented at multiple places and by various medical practitioners. The overall perceived benefits include it being a convenient option for healthcare delivery in terms of access for both patients and doctors and saving patient travel and time.

In addition, the local community representatives where the current MHC hosting the telehealthcare centre is located felt it was beneficial for them at various levels. The local community representative, on behalf of the patient population (as mentioned in Section 6.9), agreed to this and broadly expressed that the availability of a telehealthcare system in the village, especially for managing their CRDs, is beneficial. One OL further mentioned that the rural population usually approaches the local practitioner initially and visits specialists only when the disease worsens. Hence having access to various specialists by virtue of telehealthcare is a welcome step as the patients would not have to wait to see a specialist for their health condition. This OL further suggested that the local community could participate in the service delivery and get employment at the MHC.

The participants' view is that the community members would need to be made aware of the benefits of the teleconsultation system in the early life of the centre. However, once the community becomes aware of the benefits of a telehealthcare centre in the village, the community members would probably publicise it more through word of mouth. This

might increase once they receive good treatment at the centre and experience the benefits themselves. This kind of publicity might also help to receive support from the community, including the political support in the village.

5.4.1.2 Early identification of disease or diagnosis of the disease

Many doctors suggested another benefit of using teleconsultation systems might be identifying life-threatening unsuspected diseases that could have been missed in the absence of the telehealthcare systems. As digital auscultation could be electronically transmitted during the teleconsultation process, it potentially becomes easier for a specialist to identify any issues.

"…like just like a gastritis kind of symptoms. When we auscultated, we found some problem…immediately told them to do a ECG through tele… this is through one of our rural tele medicine centres. And we… in ECG we were able to make out that it is an MI, so we immediately...we did not waste time and referred the patient to tertiary centre…." OL 5

Similarly, some PPs mentioned that CRDs could be identified using telehealthcare as conducting detailed digital auscultation is one of the teleconsultation process's primary activities, which might help identify a CRD in an unsuspecting patient as well.

"…So like that we are able to find out, even respiratory also… A lot of…umm…these asthma cases we have been able to identify and treat them because we do auscultation, right?" PP 7

This unintended benefit is also possible if the auscultation process is carried out thoroughly in a regular face to face clinic; however, digital auscultation has its own benefits, such as recording or clarity of sound, and it could be explored further.

5.4.1.3 Impact on specialists' workload

An RP mentioned the potential reduction in workload due to fewer patients attending the RPs outpatient clinic as another benefit for the RPs themselves and the system as a whole to help manage the patient load. The RPs explained that essential testing and preliminary diagnosis could be performed at the primary clinic using telehealthcare services. Patients could also be followed up regularly using teleconsultation with minimal advice from the RPs, thus maintaining continuity in the follow-up turn and reducing the burden of the RPs. Interestingly, no RPs were concerned that the reduced OPD burden could reduce their income from their pay-for-service OPD. The RPs may expect to see patients who otherwise would not have visited the RPs clinic at all and hence do not expect their overall income to be affected.

"means whether those patients are taking medicine or not, whether their peak flow reading is there or not, we call the patient every month for follow up to see whether they are better or they have stopped taking drugs or whether peak flow readings are changing or what, then we have to increase or decrease doses, this could be easily done with telemedicine there, for that every month follow up….and not necessary for the patient to travel every time…" RP 4

Thus, the study participants suggested that telehealthcare is thus beneficial for both patients and the RPs. No participants discussed any drawbacks of the system despite various probes during the data collection process.

5.4.2 Perceived Indirect Benefits

An OL mentioned that the gain from the telehealthcare system could not always be weighed in financial or direct gains. It could be indirect, in the form of goodwill or increased patient outreach, or another benefit like job opportunities for locals. One of the OLs who has closely observed the KEMHRC Pabal MHC mentioned that the MHC is

linked with many other research activities, bringing in various learning opportunities for locals.

"Don't count everything with money. There is something which you also need to take which will benefit…your indirect benefit is more than rather than direct money benefit" OL 4

An OL mentioned an unexpected benefit was that the setup and implementation of telehealthcare require interaction and coordination between multiple stakeholders, which was an enriching experience for their team. Another OL also mentioned that all benefits are not financially quantifiable but enhance the gains from the telehealthcare facility. Motivation, morale-boosting, feel-good and community support are additional indirect benefits of implementing a telehealthcare OPD in a rural setup. It provides work satisfaction to those working at the centre.

"Okay there are indirect benefits which we have to quantify that, generally we do not quantify those indirect benefits…. there are things like…umm…morale-boosting and…umm…I mean purpose of…umm…doing this…" OL 8

OLs working in public health facilities mentioned that telehealthcare facilities need robust infrastructure for information technology, hardware, internet facilities and human resources. They mentioned that the hospitals utilise these facilities, infrastructure and human resources for additional purposes. For example, the high-speed internet, available for the telehealthcare clinics, is used for multiple other hospital activities. They further added that the telehealthcare IT technicians also troubleshoot other technological problems of hospital staff. In fact, in some instances, in large hospitals, hospital staff also misunderstand the Telehealth department as the IT department, given the large number of technical facilities available at the centre. Although this indirect benefit also meant that the actual teleconsultation services may be interrupted by other activities like the requests video conferencing however, the OLs working in this department have learned to deny such requests and prioritise the original purpose of the system for teleconsultation.

"There is lots of people who come to our room for other technical support like internet issues etc. They think we are IT department and any issues concerning the IT, connectivity everything is directed to us." OL 6

An OL from a specialist node in the public health system reported that the telehealthcare systems in government hospitals are used for other unexpected purposes like prisoner health check-ups.

"The doctors and the system was very much in trouble and burdened. If a prisoner was ill, they had to take the patient from prison to hospital. Then the patient used to stay, spend some time with his relatives. But then there was security to the patient. And this, now saves a lot of resources and time" OL 6

Many OLs mentioned another indirect use of the telehealthcare systems, and the high-speed internet has made access to education easier in rural areas. Due to the establishment of the technology infrastructure, this system is used for education at some locations.

5.4.2.1 Benefits of Data documentation during use of telehealthcare

An OL, who is also a policymaker, recognised the importance of data documentation and said that telehealthcare mandatorily needs electronic data capture, which is optional in the traditional face to face consultation and is generally not practiced in smaller private health care facilities. They further added that this is a considerable benefit of telehealthcare in LMICs like India, where the availability of electronic health data is scarce.

"…and of course it is far more effective in generating lots of proper data, you called and things like that, equipped face – to – face consultation take one look and nothing is documented. In this method, everything is documented." OL 2

A few OLs who have been working in health technology spoke about the benefits of the telehealthcare system in making data available for future use for Artificial Intelligence (AI). An OL mentioned that telehealthcare provides data documentation and storage

benefit, which differs from that in traditional consultation. This OL also mentioned that the documented auscultation, spirometry and X-ray data could be leveraged to train the AI models for CRD diagnosis, and more data collected at the telehealthcare centre will make the AI models stronger and more accurate.

The RPs mentioned that the data documentation could help both the PP and RP to access the patient records during and after the teleconsultation. In contrast, another senior RP mentioned that despite the electronic data capture and usage, the doctors still would use hard copies to record patient information as these would be convenient for ease of access when providing treatment. Another OL mentioned that the data documentation also reduces the subjectivity in patient treatment and ensures doctors' legal safety. The RPs further suggested that documenting the consultation/ suggestion given by the RP and further the treatment prescribed by the PP could provide a good patient record which both the treating doctors could access.

"…if *ten things are advised and the doctor filters and takes four out of them, then at least we should also be able to see that record online, suppose if a specific time is given to that patient and he has a specific number, so if that number is entered there then what was done last time or what did I…whatever things about the report… so we were able to follow the old, at least management part and report part so it will be helpful to us also. So at least detailed history, recent report or treatment needs to be visible"* RP 4

An OL who has some administration experience mentioned that EMR are the primary requirement for the implementation of telehealthcare systems, and it could also be linked to the billing of the patients. Another OL working at the policy level further added that telehealthcare on a larger scale would make the health data available for multiple purposes in India, including the audits of the provided treatments.

"Now if you are on an online monitoring system… You have an EMR [electronic medical record]*, you have a…. you have a…. record of parameters as a changing situation* [live reports of vitals], *you have a record of what has been prescribed* [prescription records].

You are able to make a determination whether what is the cause of death and is there is a responsibility… who is responsible [records could make it easier to ascertain cause of death and who would have been responsible in case of negligence]*."* OL 2

5.4.3 Acceptability

The functioning of telehealthcare systems needs multiple stakeholders at various levels, and the acceptability of the system and the motivation of all these stakeholders is crucial for the establishment and continued implementation of telehealthcare.

5.4.3.1 Acceptability by the doctors

The physicians, both primary and respiratory, are open to the idea of teleconsultation. All but one of the 10 PPs interviewed expressed positive views about teleconsultation. An OL suggested that the acceptability of teleconsultation to PPs relies on an acknowledgement of two things. One is that they need help, and two is that they should advise the patients that they need help. They further said that the PPs usually consult a specialist and take opinions, but formally taking an opinion, and documenting it, is rarely done. There was a consensus among the physicians and OLs that the doctors will gradually accept the idea of seeking consultation or even providing consultation using the telehealthcare systems if it becomes an integral part of their job description and does not have any legal implications suggesting that with teleconsultation, this practice would become more formal. The consulting doctor will also be acknowledged for their advice.

The RPs feel that conducting a teleconsultation is feasible if another doctor is available at the patient end. Once the PP at the patient end is trained, the RP is comfortable conducting teleconsultations with the doctors. Nonetheless, the RPs also agree that the PP must decide the need for teleconsultation for a particular patient.

"…Ideally yes, ideally yes. Actually, instead of the patient coming all the way from Pabal, 50 kilometers from..umm…a place far away it will be better if…umm…the rural

practitioner be a MBBS or BAMS degree, administration and who has been trained in that particular area." OL 2

The RPs, however, expressed some caution that the PPs need to be trained and trusted by the RPs. They also expressed the need for diagnostics facilities at the teleconsultation centre to underpin the diagnosis and further mentioned that the physical absence of the RP at the teleconsultation centre is compensated for by additional examination/ investigations, which can partially substitute for their physical absence. Additionally, the clinicians, both PPs and RPs, will expect remuneration for their time and knowledge, and if they are paid fairly, this should make providing remote consultations more acceptable to the doctors. Another RP mentioned that the patient must be informed about the teleconsultation processes in synchronous consultation with the doctors as this information will help the patient cooperate during the video consultations.

"Now patient comes, we need to train them, umm…how do you look at it because see what happens is we have a camera right? But we will be seeing the image below, so now you need to know what to see, you have see there and here both, so if you are seeing the video if…especially doctor if he is only seeing the video here down, for the patient it looks he is seeing somewhere else he is not seeing me, right, so that kind of a training you need to give even though you are…the doctor is seeing the patient the patient cannot know that so he has to quite often see on the camera directly so…." OL 8

. One OL said that doctors would vary greatly in their enthusiasm for providing this service. There will be some who are interested and find it exciting and provide it readily, but others will not be interested. They further mention that not all are experts in the technology, not all clinicians will find the systems exciting, and not everyone will participate in the teleconsultation activities. In contrast, some clinicians conduct teleconsultations proactively, even if it is not part of their job profile.

Overall, it appears that doctors have in principle accepted the teleconsultation system and the process but will need motivation and reassurance in terms of monetary resources and/or job satisfaction and legal safe guards to adopt the system.

5.4.3.2 Patients' Acceptability

Stakeholders who have closely worked with the patient population feel that the rural community generally accepts the idea of the system. The section below describes the doctors' and OLs' perceptions of the patients' acceptance of the system.

An OL who has conceptualised and implemented several telehealthcare centres in India and plays a role in policy-making processes at the national level expressed the view with respect to telehealthcare systems' reception by the patients.

"…by and large we found that village people were quite happy" OL 2

An intensivist who has worked in telehealthcare mentioned that it had become relatively easier to explain the technology setup to the patients and the community because of recent advances in technology and patients' increased familiarity with technology for video calls and other multimedia messaging services. A PP highlighted that teleconsultation might require patients to adjust their expectations of care. For example, rural practitioners in India highly rely on injectables to treat pain, fever, and alike illnesses. Injectables are also sometimes used in the treatment of exacerbations of CRDs, and patients may expect a similar approach from the RPs during teleconsultation. Hence, the PP mentioned that in some instances, it would be difficult for the patients to adapt to the concept when they are used to having quick relief with the injectables, but the RP recommends the standard [oral] approach. However, the OLs and some PPs believed that the patient population would gradually accept this change. As the local non-specialist doctor or the PP is the primary contact of the patients, the OLs reiterate that the PPs will need to convince the patients about the benefits of the standard practice. This also means that the PPs need to be

convinced and trained in the standard treatment protocols for the CRD management such that they can explain the treatment process better to the patients.

"So, if you convince them [the PPs] *and they know the…umm…how it is going to be beneficial, and they are all accepting it. People are also accepting…initially they may have little resistance because they are used to that injection, because rural people unless you give an injection, they are not…satisfied"* OL 5

An RP further raised a concern about how patients might perceive PPs consulting remotely with a specialist about their care. They suggested this might undermine the standing of the doctor within the rural community as it might give the impression that the PP is unaware of the correct treatment and hence needs support from another doctor. One adverse consequence of this might be that the patient discontinues treatment from the centre for regular healthcare services. Therefore, he PPs would have an additional role in explaining to the patients the processes and benefits of such intervention.

"[They may think] *my doctors doesn't know anything hence is asking help from other doctor. But I think by and large patients would benefit and accept this form of treatment."* RP 2

An OL implied that once the centre has established a good rapport with the community, the acceptability of the population/ community increases gradually by word of mouth. Therefore, media plays a vital role in promoting the benefits of telehealthcare systems to the community. They further mentioned that gaining acceptability to patients is a gradual process and requires time for normalisation in the systems.

"…So, from a patient's standpoint, building trust on this mechanism will take time. They don't even understand what's going on…." OL 6

In general, the doctors assumed that teleconsultation would be suitable for patients and that they would readily accept teleconsultations.

*"…if they know the benefits out of it, especially they don't have to travel 50 kilometers from, they are getting…umm…they are assured that their reports are being seen by a specialist, So, I don't think they will have any problem. If there are any issues, very well they can come and physically meet us. I don't think there will be any problem with acceptance or with clinical management. "*RP 1

More information on patient's view on the teleconsultation process are mentioned in Section 6.9

5.4.4 Telehealthcare in emergency

The participants have contrasting views for the use of telehealthcare in emergencies. Some participants strongly believe that teleconsultation could be put to best use during emergencies, whereas some disagree and say it is not helpful during emergencies.

A PP during FGD discussed that teleconsultation is a good option for the emergency management of a patient. According to them, it can save a patient's life coming with acute issues. Another PP trained in Ayurveda agreed with the mention of asthmatic attacks in Ayurvedic terminology.

"Now I feel that telecommunication will be much helpful in acute respiratory diseases than chronic diseases. And what we say as Wegawastha, [acute respiratory] *in Ayurveda, it will be more useful during asthmatic attack."* PP 3

An RP in another FGD expressed a neutral view mentioning that diagnosis is subjective to the physician, and the PPs need to determine if the patient needs teleconsultation or needs to be referred for further treatment during emergencies. They further mention that the PP has to assess if they need any specialist opinion for further treatment of the patients and justify by saying that routine cases will not require teleconsultation. However, a few complex cases can be forwarded for specialist opinion using teleconsultation. An OL clarifies this by saying that the PP has to compare the risks of referring a patient to another

centre by calculating the time to reach the higher healthcare centre vs the possibility of treating the emergency using teleconsultation.

" Or if the patient is going to die on the way, can I do something… umm…from here, okay tell the assistant or somebody… start from this, do this and then refer. Then that is the…umm…best way of using it, don't tell, no I am here I will guide you and then do no, tele medicine should be like triage.." OL 8

The PPs during FGD also spoke on the same lines mentioning that during emergencies, they need to settle the patients first and can consult a specialist using teleconsultation for further line of treatment.

"Telecommunication can be used for settling a patient, you have to refer to the expert at that [for next line of treatment] *time using the telehealthcare."* PP 5

However, a few PPs frowned upon the idea of using teleconsultation during emergencies. One PP mentioned that *"in serious emergencies such as MI* [Myocardial infarction] *patient or asthma patient instead of fiddling with teleconsultation, there is a need to start the first line treatment immediately"*. PP 2

They further expressed that PPs are competent to provide the first line of treatment and thus suggest that consultation during emergencies of chronic illness are not good and effective. Nonetheless, another PP indicated that the decision to teleconsult during emergencies could be at their discretion. In case of emergencies, there could be specific emergency referral pathways through which these patients can be referred. In some emergency cases, the RPs might suggest on the spot medical interventions or may recommend the transfer of the patient to the higher centre.

The use of teleconsultation during emergencies seems to rely on various factors, and hence the use of telehealthcare in emergencies could be at the treating physicians' discretion.

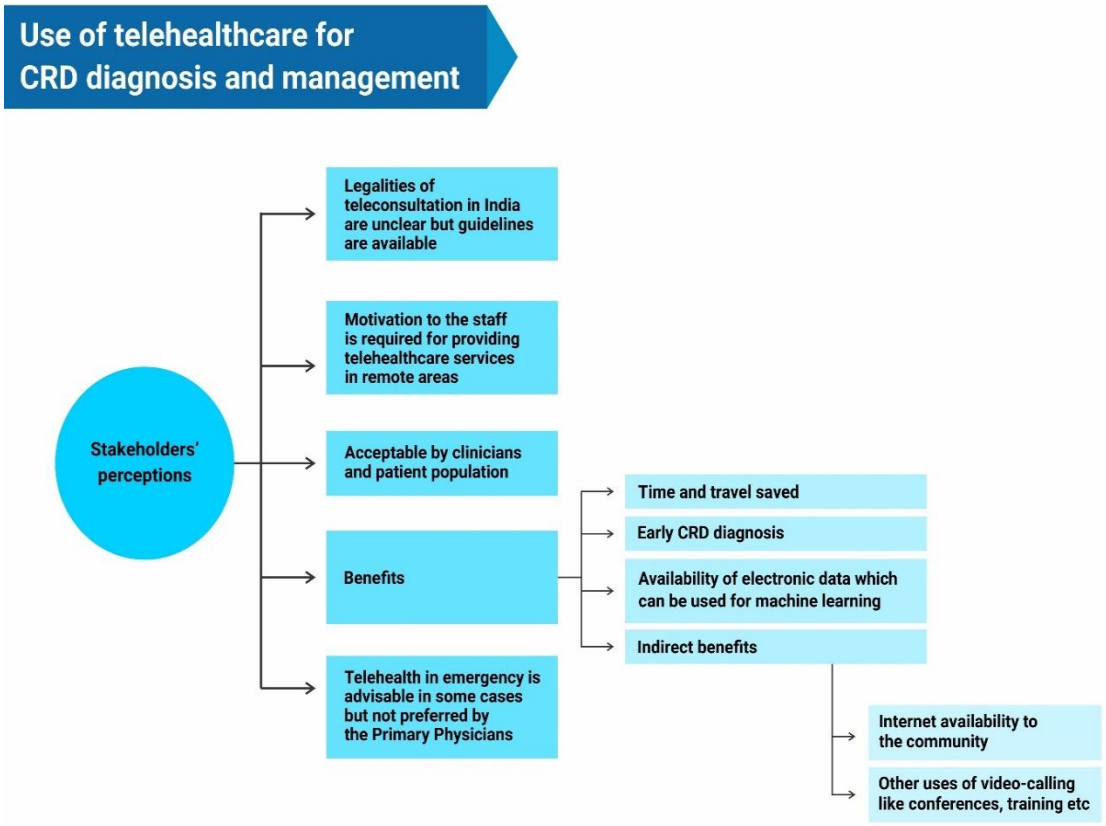

Figure 11: Stakeholders' perceptions around the use of telehealthcare for CRD diagnosis and management.

Chapter 6. Strengthening the telehealthcare centre and patients' and providers' perceptions towards teleconsultation

The strengthening of the Pabal MHC was an iterative process. The approach was pragmatic but informed in part by the research findings of the first four secondary objectives. I have described the previously existing setup in section 2.3. In this chapter, I describe how the existing teleconsultation facility was strengthened to enable CRD diagnosis and management. I go on to report the perceptions of the patients and health care providers who experienced remotely supported consultations.

The strengthening of the teleconsultation centre, Pabal MHC, was a collective process. I was one of the members who proactively initiated the strengthening process. The administrators at the SSH Vadu, WTDC Pabal and VRHP, were actively involved in streamlining the processes, and hence I have mentioned “we” at places where others were involved in the process. The strengthening described below was carried out in parallel with the qualitative data collection before the patient participants were recruited. I describe the chronology of the events and activities conducted in the below Figure 12

Activity	Oct-Dec 2018	Jan-Mar 2019	Apr-Jun 2019	Jul-Sep 2019	Oct-Dec 2019	Jan-Mar 2020
Qualitative data collection and analysis						
KEMHRC Ad Hoc committee approval for modifications						
Hardware Survey and repairs						
Identifying financial resources for strenthening						
Renovation of the infrastructure						
Identifying the PPs						
Communication with the RP and obtaining permissions from KEMH						
PPs training at the RPs clinic						
Communication with commercial companies for upgarde						
MoU with A3RMT and installation						
Initiation of the renovated teleconsultation centre						
Publicity and advertisement						

Figure 12: Chronology of the MHC strengthening activities

6.1 Administrative approvals

I initiated a deliberate attempt to modify the functioning of this existing complex intervention. Collective action in the KEMH, which runs the Pabal MHC, was required. I initiated interactions with multiple stakeholders from KEMH, KEMHRC and WDTC Pabal as the functioning at the Pabal MHC is overseen by multiple departments (Figure 1). I further identified the financial and human resources needed based on the discussions during the qualitative data collection and analysis and explored the administrative process for obtaining permissions to implement changes.

I initially proposed the introduction of an Ayurvedic OPD at Pabal MHC in addition to the regular face to face OPD. Initiating Ayurveda OPD was intended to bring patient footfalls to the OPD, and Ayurveda practitioners could use the teleconsultation systems for specialist opinions. I presented this proposal to the KEMHRC- Ad Hoc committee in

December 2018, who approved it with some seed funding to purchase medicines and minimal equipment required to run an Ayurveda OPD. Further, I interacted with Ayurveda Physicians working on various research projects at the Vadu Rural Health Program to lead the Ayurveda OPD. A few motivated Ayurveda Physicians volunteered their time, and the Ayurveda OPD was inaugurated in November 2020 after 23 months post-approval. I simultaneously garnered permission to involve the pulmonology department at the KEMH in providing teleconsultations and training when needed by the Ayurveda Physicians. This process involved the medical administrator of KEMH and the head of the Pulmonology department. Further, I also began registering the Pabal MHC as a clinic under the District Health Office, which is ongoing (as of January 2022).

6.2 Upgrading telehealthcare system

To strengthen the facility, I needed an inventory of the available equipment, their usage and the current status of the equipment at Pabal MHC. Hence, in December 2018, I deployed a hardware technician to survey the computers, equipment, and connectivity to ensure the proper functioning of the teleconsultation facility. The hardware technician reported the breakdown of several items and requested a replacement for various cameras, cables & wires, stands *etc.* Further, building renovation was also required; hence, I initiated appropriate maintenance of MHC for infrastructure and instrument repairs with due permissions and administrative processes. I also requested funds for maintenance and repairs from CSIR, which was sanctioned in July 2019.

Further, the teleconsultation unit deployed by the HP had certain challenges during implementation. The challenges ranged from difficulty in accessing data, a non-functional digital stethoscope, non-availability of telephonic consultation with the specialists and overall apathy towards the use of the system. We communicated with HP about upgrading the teleconsultation unit; however, HP did not respond even after repeated reminders. I further contacted a few start-ups that provided teleconsultation units with various options. We at VRHP approached them for collaborative research using their equipment. Two

start-ups showed interest in taking the partnership forward. However, the communications moved forward faster with a local Indian company A3RMT (http://www.a3rmt.com/), and they were willing to donate their equipment. In return, they expected a research partnership with VRHP to identify and apply to various research opportunities to raise funds to prove the effectiveness of the system. Additionally, KEMHRC being a well-known institution, gave A3RMT larger visibility in the public health research fraternity in India.

A3RMT provided an advantage in having their office in Mumbai closer to Pune against Bengaluru, which is in another state. This proximity was considered necessary in case of future breakdowns as both the companies needed in-person maintenance if a breakdown occurred. Secondly, A3RMT uses universal ports and attachments which are compatible with any device available on the market and Neurosynaptic uses specially designed ports that can connect to only devices developed by their company.

A3RMT, incubated in the Indian Institute of Technology Bombay, is a for-profit company. Its system provides flexibility in using different models of teleconsultation and can be scaled up for various specialities, including pulmonology. The model provides varied functionalities and the measurement of vitals, including digital auscultation and inbuilt ECG. It also supported the use of existing spirometers. A3RMT system has some advantages over the previously used systems. Unlike the previous system, teleconsultation could be done at the convenience of the specialist as it uses Short Messaging System (SMS) system to send a link to the patient reports. (The previous system had facilities for only synchronous teleconsultations.) The specialists can now access reports at any time and provide consultations to the primary physician. The system also has the facility for synchronous video consultations, and the SMS link helps in asynchronous consultations Figure 13.

Further, A3RMT does not require any application or software on the specialists' end, and the patient records can be obtained on the web with a simple login. The previous system

required an application installed at the specialists' end. In the current system, the data is stored on the cloud and cannot be accessed without login credentials, thus ensuring data privacy which was also available in the previous system; however, the newer one was more convenient to use in terms of user interface and teleconsultation facilities. We arranged installation at Pabal MHC in February 2020.

The new A3RMT system has some ongoing resolvable challenges. The returning patient is registered as a new patient, and the technician has to fetch the previous patient records using the name and date of the previous visit. Once the case is closed, one cannot send SMS through history, and the SMS need to be sent only when the case is open. Sometimes, the physician at the centre need to send the SMS to the specialists after attending all cases of the day, and in that case, only an email facility is available. Further, Pabal MHC is catered by a PP trained in Ayurveda medicine. They consult various specialists across various departments from KEMH in Pune for support. The current system provides a login-based contact with the doctors provided to the pulmonologists/ respiratory department. However, this system could be leveraged for other specialities, too, and not every specialist in KEMH can be given a login as there are hundreds of specialists and not everyone is interested or required; hence, a facility for the specialists to comment or give notes on the case without login but a specialist specific link would be more helpful. This facility would ensure the confidentiality of participants by making an audit trail available to identify the people or devices which accessed the link while providing convenience and time-saving option for the specialists by not needing to login using a username and password. Further, the data from the teleconsultation clinic is recorded in the A3RMT server; however, our users could not find any options to download the data. All these challenges are being addressed gradually.

The qualitative interviews and FGDs with the RPs and PPs conducted from July 2019 to February 2020 also highlighted the requirement for a digital X-ray machine in addition to the existing pulse oximeter and spirometer for CRD diagnosis and management as mentioned in section 5.2.2. Installation and use of an X-ray machine require regulatory

approvals and certified X-ray technicians for use. The Shirdi Sai Baba hospital (SSH), also known as KEM Vadu, a secondary care hospital, had all these permissions but at that time used a non-digital X-ray machine. After discussion with the SSH management, they suggested installing the digital X-ray machine at SSH instead of Pabal MHC. As Pabal MHC is 23 km from SSH against being 55 km away from KEMH, it would be possible to refer the patients to SSH when X-rays are needed. Additionally, SSH received the upgraded X-ray machine, which possibly had more utility at SSH than at Pabal MHC. The administration at KEMH Pune agreed to install a digital X-ray machine at SSH and trained a local certified X-ray technician to operate the machine in January 2020.

Another requirement that the doctors mentioned during the qualitative data collection were the availability of a diagnostic laboratory or facility for sample collection. The SSH already has an accredited laboratory; hence I consulted the SSH administrator to facilitate the sample collection and transport from Pabal MHC to SSH Vadu.

6.3 Deploying Human Resources and their training

The functioning of the telehealthcare centre requires a range of human resources. The qualitative data suggest that a telehealthcare centre requires a coordinator, a PP and a hardware technician at the centre. However, when facilitating the process for strengthening the Pabal MHC for CRD diagnosis and management, I realised that the process would also require spirometry and X-ray technicians; although the need for a technician was not evidently mentioned in any of the qualitative data but Xray and spirometer were discussed as a primary requirement for CRD diagnosis.

The PP named KT, an Ayurveda Physician I identified for managing the teleconsultation clinic, was a resident of a nearby village and had access to public transport to reach the Pabal MHC. She was part of the VRHP research team and was instructed to attend the teleconsultation clinic two days a week, every Wednesday and Friday. These two-day arrangements were made in consultation with her project supervisor, and her workload

was adjusted accordingly. The details of her remuneration are discussed in section 6.6. Training needs for all PPs, in general, were raised during the interviews with the RPs and FGDs with the RPs and PPs and are described in section 5.3.4.1. She was trained in using the teleconsultation unit by the engineers from the A3RMT.

Further, for CRD diagnosis and management training, I obtained permission from the KEM Hospital pulmonology department for three weeks of in-person training. During July-August 2019, she visited the regular OPDs at the KEM Hospital pulmonology department as an observer. This training additionally helped her to be comfortable in communicating with the pulmonologists.

The VRHP, fortunately, owns spirometers and also has trained technicians who can conduct spirometry. Special requests were made to these technicians for support to conduct spirometry at the MHC when requested by the RP. For a more sustainable approach, the PP was also gradually trained in conducting spirometry. The X-ray technician at SSH Vadu was a local and was already certified and trained.

6.4 Workflow

The Pabal MHC has run a regular face-to-face clinic since 2015, and after the teleconsultation system was upgraded in 2020, an additional clinic was initiated on a bi-weekly basis. We decided on Wednesdays and Fridays for the teleconsultation clinic. These days were selected as the Pabal village has a weekly market every Friday, and we can expect more people to visit the clinic. Wednesdays were planned as other days were not feasible as Mondays was a weekly meeting day for the WTDC staff, Tuesdays the clinic was booked for Ante Natal check-ups for pregnant women and Thursdays the electricity availability is uncertain at Pabal village, leaving us with Wednesdays and Friday.

The technician at the Pabal MHC registered all visiting patients using the teleconsultation system. The technician further entered patients' demographic information along with the

pulse, Weight and Blood Pressure in the system. The local ayurvedic doctor checked all patients and prescribed medicine. Those who required the teleconsultation with the specialists, especially the pulmonologists, were invited there on Wednesdays or Fridays. The workflow is described in detail in Figure 13 below. In cases where patients required further diagnostics, they were either referred to the nearest diagnostics centre or were given appointments for conducting tests like spirometry or ECG for Wednesdays or Fridays when the PP and technician trained in conducting these tests were available at the centre. If blood tests were required, samples were collected early morning on the next working day, and the Vadu SSH staff member, who is a local Pabal resident, transported the blood sample to Vadu SSH Laboratory for testing. For any special blood investigation or diagnostic evaluation such as a Computed Tomography (CT)-scan or Magnetic Resonance Imaging (MRI), which were available neither at Pabal MHC nor SSH Vadu, the patients were referred to KEM hospital Pune or the nearest diagnostic centre.

In this paragraph, I have described an example case to explain the patient flow. Patient 1 arrived at the Pabal MHC with symptoms of cough and breathlessness. The PP at the MHC conducted a detailed clinical examination, recorded patient history and conducted spirometry as the PP suspected lung obstruction. All these data were uploaded to the cloud server of the A3RMT system. However, after looking at the spirometry results, the PP couldn’t come to a conclusion on the patient's diagnosis. The PP then clicked the facility on the teleconsultation system, where a link is sent by SMS to a pulmonologist at KEMH. They also informed the patient to revisit the clinic the next day. The Pulmonologist checked the link in the evening the same day and documented his diagnosis in the notes section in the system. These notes and the diagnosis were then uploaded to the cloud server. The PP then accessed this information later the next working day and informed the returning patient of the diagnosis and further treatment. Although most of the time, consultations were asynchronous, in rare instances, when either the patient or the specialist wanted to interact with each other, they were synchronous. However, arranging such

synchronous consultations was tricky and required multiple attempts to arrange appointments suitable for all three parties

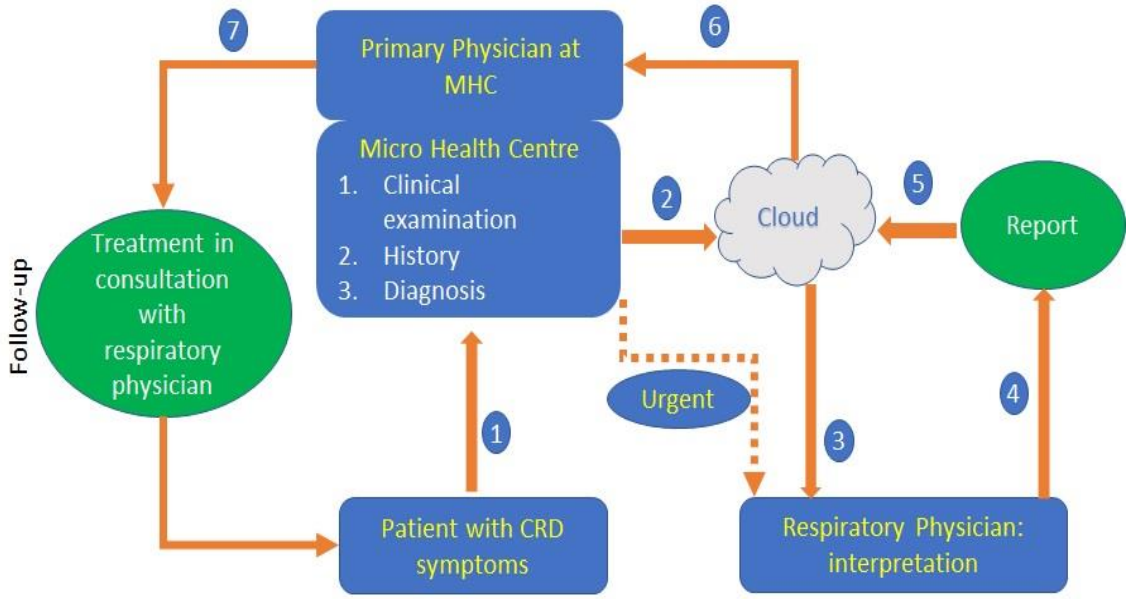

Figure 13: Workflow at the Pabal MHC

6.5 Stakeholder engagement and advertisement

Publicising the centre was one of the strengthening actions informed by the qualitative data. I conducted one-to-one meetings with community representatives to encourage cooperation in running a teleconsultation clinic in Pabal since November 2019. The advertisement for the centre was undertaken initially with pamphlets by the WDTC staff. The WDTC staff also used a loudspeaker installed on a vehicle to read out the pamphlets in Pabal and nearby villages. Later the patients started visiting the clinic due to word-of-mouth publicity.

Further health check-up camps with the targeted population for respiratory distress were arranged every Wednesday and Friday of the week when all the technicians and doctors were available. Health check-up camps are institution driven activities where a group of people with similar conditions undergo tests and treatment at the OPD level at the same time. The advantage of organising a health check-up camp is that the specialist doctors and the requirements for the check-ups are available on a particular day of the camp. The WDTC staff also coordinated this activity. The RPs at the KEMH Pune were available online for a limited time for synchronous teleconsultation if needed. I ensured that the doctors were available for the respiratory patients at both ends.

6.6 Financial arrangements

Arranging funds for the maintenance and functioning of the teleconsultation centre was a significant challenge throughout the process. As mentioned earlier in section 2.3, the Pabal MHC was installed by CSIR. The ownership of the containers and clinics remains with the CSIR, although the operational responsibility is KEM Pune's. I identified different activities and approached various stakeholders, including the CSIR and KEMHRC leadership.

For maintenance activities like re-painting the containers repairs of the instruments and computers, I approached CSIR with support from the KEMH and KEMHRC administration. The new funds for the A3RMT system are being raised through donations. For the functioning of the MHC and payments to the human resources, including the PPs, I utilised existing institutional resources at the VRHP. The X-ray technician at SSH Vadu was on the hospital payroll. The spirometry technician spent voluntary time during the respiratory camps at the MHC. The RPs and PPs were paid for other research-related activities and were informed of this additional responsibility before accepting the research profile.

6.7 Limitations

Although the system was strengthened, the approach had multiple limitations. The organisational structure is complex, and multiple players have a stake in the functioning of Pabal MHC. It is governed by three entities, including VRHP, SSH and WDTC Pabal, all reporting to their parent organisation. This complex structure makes it challenging to identify responsible persons and doctors to resolve any queries or smooth functioning of the centre.

The selection of the teleconsultation system was based on convenience. We did not solely consider a detailed assessment of available systems in the market. Although multiple telehealthcare solutions were available, a detailed comparative analysis is required to assess the pros and cons of each system. This system from A3RMT was chosen only because the company could identify a donor for donating the instruments to WDTC Pabal for service delivery in the rural community.

The human resources involved were not primarily responsible for the activities related to the functioning of Pabal MHC. Hence the Pabal MHC related activities were not on their priority list. Further, none of the human resources involved, except a technician, were paid for their services, and most of the work was voluntary. The RPs, too were not paid any consultation charges and hence were not obligated to be available for the consultations. The motivating factors for all concerned were in part altruistic, *i.e.* to be able to improve rural health, alongside the possibility of long-term paid engagement if the teleconsultation services ran smoothly. However, this meant that sustainability was a risk.

The financial resources acquired depended on goodwill and communication with various stakeholders. The human resources were paid salaries for some other activities, which was their primary responsibility. The teleconsultation unit/ system was a donation, the spirometer was loaned from another research study, and the X-ray unit was a second-hand unit that was no longer required at KEMH and hence was shifted to SSH. Additionally,

the electricity and internet charges were paid by the KEMHRC as regular organizational expenditures. The maintenance cost for the centre for repairs was a result of goodwill and communication between IGIB and VRHP leadership. Organising health check-up camps during my data collection required minimal charges for snacks and refreshments, which I spent from my PhD budget. The funds for running the telehealthcare centre were acquired from various sources, and the patients were charged a minimal INR 50 (~ GBP 0.5) as fees. This approach is not scalable, and thus a detailed plan is required for acquiring funds for implementing the telehealthcare services in the rural area where paying capacities of the communities are low. Moreover, I did not consider the commercial aspect of the system; thus would require more resources to make it self-sustained.

6.8 Current status of the system

From February 2020 until November 2021, a total of 1056 patients were registered at the centre, of which 131 underwent teleconsultation for various ailments. Of all the teleconsultations between the specialists and PPs, 36 were conducted for respiratory symptoms. Below are some images of the centre as it currently.

Before

After

6.9 CRD Patient's perceptions of teleconsultation

I planned to administer a structured questionnaire to patients when they visited the teleconsultation centre. The post teleconsultation part of the questionnaire was planned to be administered only if the patients had agreed to obtain treatment through teleconsultation. The teleconsultation service was explained to patients using pictorial representations Figure 7 and Figure 8 from section 4.2.3.2, and they were asked to rate how reliable, effective, efficient and convenient they perceived the service to be for receiving treatment on a scale of 1-5 (1 being the lowest and five being the highest) before and after the teleconsultation

All the patients, who came to the clinic during the seven months, spread across 11 months due to COVID lockdown restrictions, with respiratory symptoms, were invited to participate in the study, and all of them agreed to participate. None of the patients refused such treatment when offered by the PP. The patient characteristics are described in below Table 3.

Most of the patients rated the reliability, effectiveness, efficiency and convenience of teleconsultations as '4' before they experienced the teleconsultation service and '5' post-teleconsultations. The pre-teleconsultation rating was based on the description of the services using the pictorial representations by the PPs, although the patients did not experience the service. This also helped to understand their perception of such service and if they would trust such service if made available, which they could compare with the post teleconsultation experiences. In all the responses post-teleconsultation, the scoring given by the patients either remained the same or was higher in most cases compared to pre teleconsultation responses None of the patients' scored less than three. Figure 14, Figure 15, Figure 16, Figure 17 and Figure 18 describe these results graphically.

Table 3: Patient characteristics

Sr. No	**Participant Characteristics**	**% (n=30)**
1	Average Age	55 yrs
2	**Gender**	
	Females	60% (18)
	Males	40% (12)
3	**Education**	
	Primary	27% (08)
	Secondary	20% (06)
	No formal education	53 % (16)
4	**Occupation**	
	Homemaker	37% (11)
	Farmer/ farm labour	57% (17)
	Other (Office work)	07% (02)
5	**Owned Smartphone**	
	Yes	20% (06)
	No	80% (24)
6	**Use of technology on daily basis**	
	Yes	20% (06)
	No	80% (24)
7	**Used video-calling service previously**	
	Yes	13% (04)
	No	87% (26)

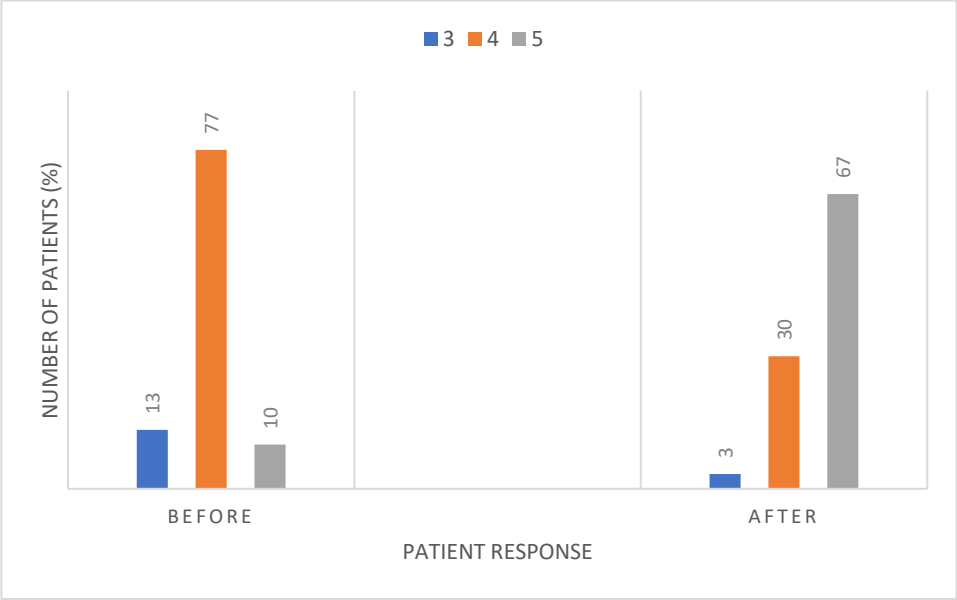

Figure 14: Patients' perception of reliability of teleconsultation services for CRD diagnosis and management before and after experiencing teleconsultation

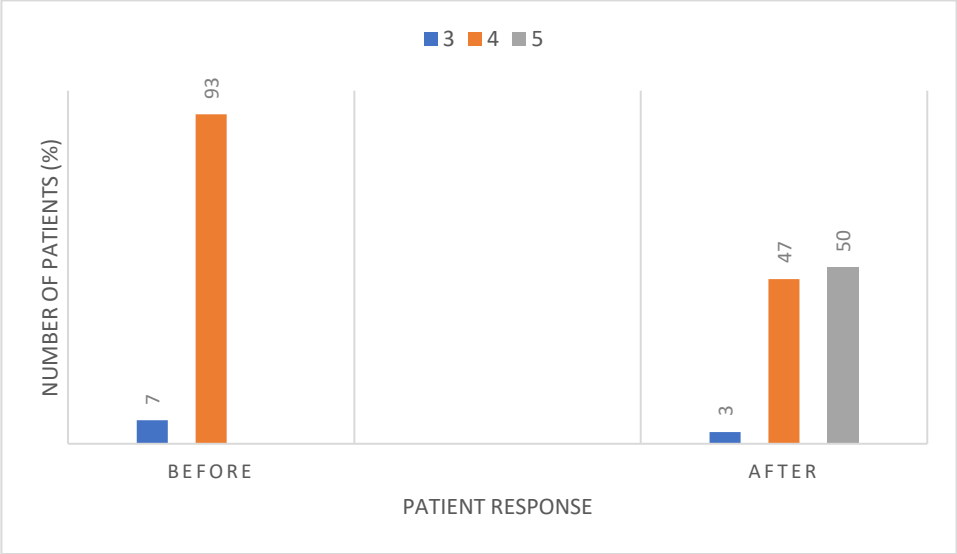

Figure 15: Patients' perception on the effectiveness of teleconsultation services for CRD diagnosis and management before and after experiencing teleconsultation

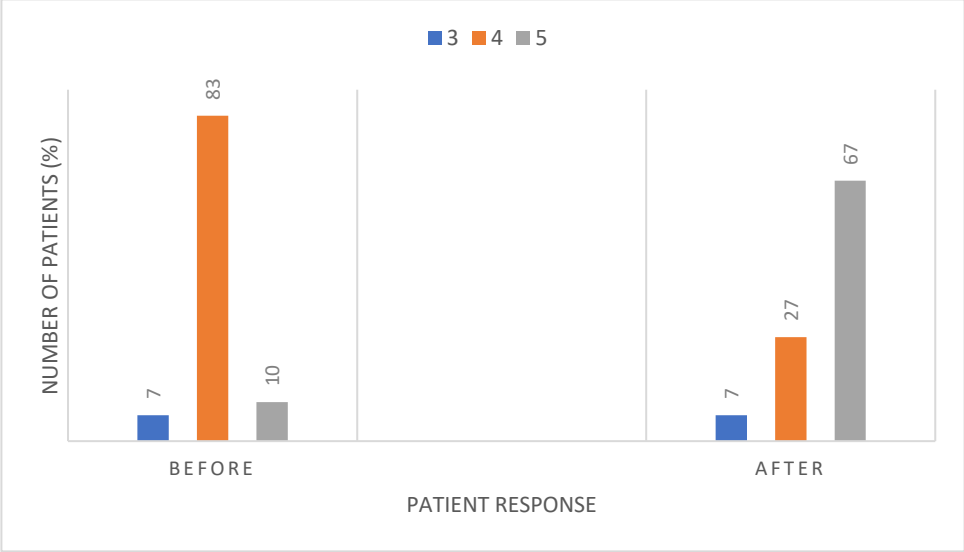

Figure 16: Patients' confidence levels in teleconsultation services to receive CRD treatment

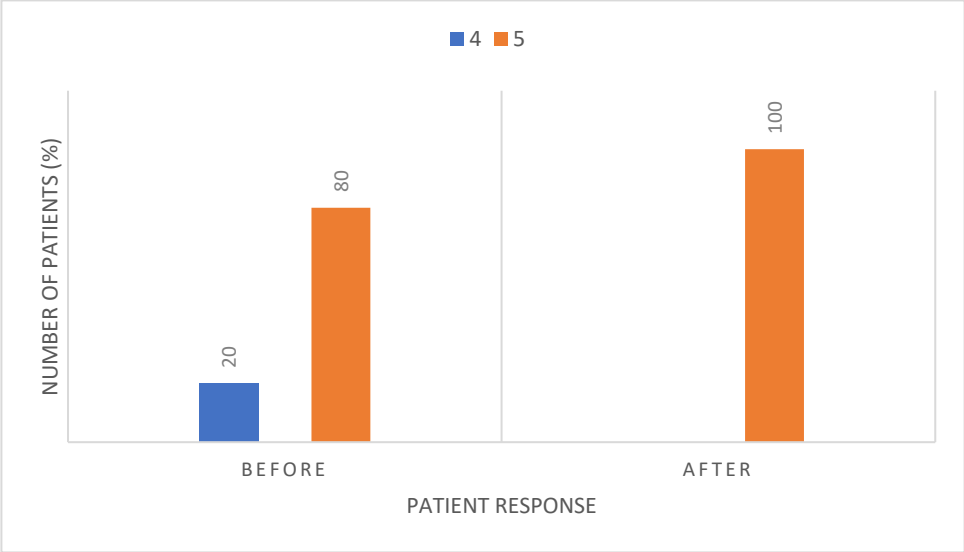

Figure 17: Patients' convenience levels pre and post teleconsultation

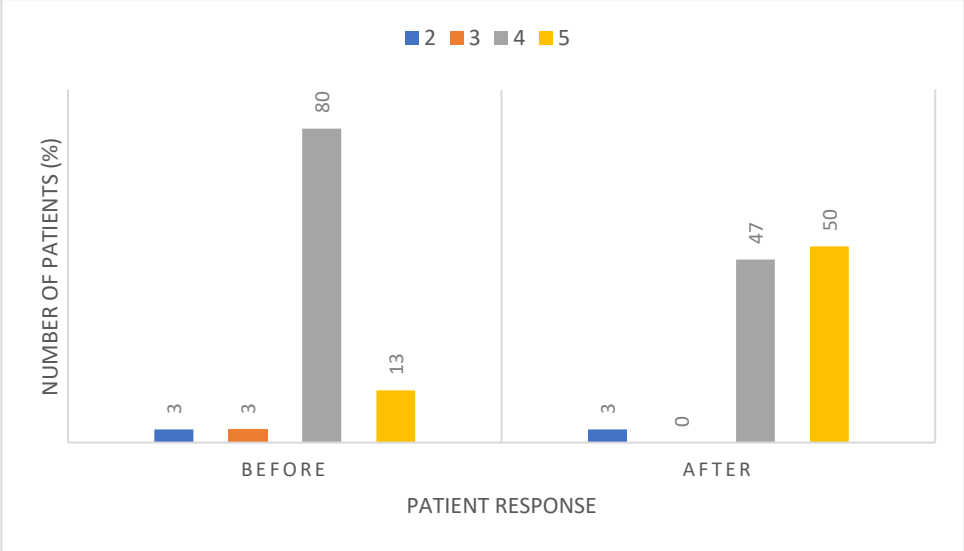

Figure 18: Patients' perception on efficiency of the teleconsultation process for CRD diagnosis and management

The patients were also asked open-ended questions about their additional thoughts, doubts or suggestions for improving the teleconsultation system for CRD diagnosis and management. Some participants' responses indicated a lack of understanding of the overall service delivery method during pre-teleconsultation interactions. However, their responses post teleconsultation suggested a better understanding, and some patients provided additional information as having experienced the teleconsultation, they seemed less confused about the process and were able to provide their better-informed views on it.

After teleconsultation, all participants spoke about their perceptions of the benefits of teleconsultation services. While the most common benefit which the few participants perceived pre-teleconsultation was the availability of reliable health facilities in their village. However, post teleconsultation, the participants mentioned saving time and money on travel.

"Nice facility, No need to travel around [to city] *for health care. Tests* [spirometry] *had been done on the spot and received reports" P12*

A few were concerned that the prescribed medicines might not work and would consider the system good only if they found relief with the medicine prescribed. There was a common theme from the responses in the evaluation of services that people are happier with a service if they have a positive outcome.

"if my complaints subsides after these medicines then really it is a good system" P15

No doubts were expressed about the system, even when patients were sked about this before experiencing a teleconsultation. Post teleconsultation, when asked the same questions, they expressed none either, but rather, the participants specifically expressed their trust in KEMH and its doctors. *"I have full faith in you* [KEMH], *no need, I could talk directly and personally with your specialist. If you* [patient assumed I am a doctor]

will find some problem [diagnose disease condition] *in me I know you will definitely inform me"* P7

I further asked for their suggestions to improve the services or the system. During pre-teleconsultation, they mentioned the range of other specialists they would like to have the services from, primarily an orthopaedic specialist. However, during post teleconsultation interactions, the patients requested to continue the service at no cost and suggested informing more people about this facility. The patients primarily expected free/low-cost consultation.

6.10 Doctors' perceptions towards teleconsultation

The data from the post teleconsultation experiences of the PPs are limited as I interacted with two PPs after they experienced conducting teleconsultation with the specialist for CRD management. Only two PPs used this facility during the course of my data collection. The doctors' post their teleconsultation experiences describe the additional requirement mention the logistics challenges in implementing the centre, which include the infrastructural arrangement of the centre, use of different models and their expectations from the teleconsultation system in terms of technical characters like multiple logins or record availability. They further indicate their perceptions about teleconsultation, including its benefits to the patients and doctors themselves.

However, as the interactions with the PPs post teleconsultation provided information to address the second and third secondary objectives, I integrated the findings in the relevant sections of Chapter 5 as it helped me get a comprehensive view of the requirement, barriers, facilitators and perceptions in total.

In summary, the post teleconsultation interviews with the PPs mostly focused upon patients' approaches towards receiving treatment. According to the PPs, the patients who visited the centre were happy with the convenience the service could offer. They further

mentioned that the patients could receive treatment which otherwise was difficult for them as they lost a day's work and wages to travel to the city.

"…depends on their background situation and other things like there is nobody in the house, children are in other town for jobs and no one to accompany them to the hospital. .. They would not have come otherwise because here they…have easy access to treatment." PP (post teleconsultation)

However, the PPs mentioned that they needed to explain the service to the patients in detail before they agreed to receive the treatment via teleconsultation. The pictorial representations Figure 14 and Figure 15 helped the PPs to explain the service to the patients.

One PP who was trained by the RP was confident in their clinical abilities after the training, especially in auscultation and noting clinical history. The PPs and technicians performed spirometry on patients before the COVID pandemic started and were confident in using and interpreting the data before they shared the reports with the RP. However, post-COVID, the spirometry was not used due to the risk of infection and hence they couldn't express more issues regarding the use of spirometry.

"But…because of the COVID situation we have put spirometry on hold… infection spreading should not be there and the machine will also get this thing infected because of that.. we did not use much……But previously when I had done spirometry I was informing sir about the readings and could diagnose" PP

The PPs also had some suggestions for change in the service. Both the PPs expressed the need for a pharmacy that could provide medicines at discounted rates. In their experience, the ones which were prescribed by the RPs were sometimes not available in local pharmacies. And hence the patients avoided or delayed taking prescribed medicines, which in turn affected the treatment. When strengthening the teleconsultation system, I focused only on making provisions for the respiratory teleconsultations; however, the PPs

expressed their need for support from other specialities like orthopaedics, gynaecology, and dermatology.

"…many (cases of) skin and ortho come on their own, that too after it gets worse so if xxx sir and yyy sir can help us.." PP

This also indicates the acceptance of PPs of the overall doctor to doctor teleconsultation service.

Other suggested changes, as mentioned in section 5.2.3, were that the software must have the facility for simultaneous access to the videoconference system and the clinical records at the PPs end. The current system they used allowed access to the patient records from a single computer, and the PPs were placed in an adjacent OPD.

The PPs further expressed that being local has helped as the patients trusted the PP with the treatment and trusted their decision to take advice from another doctor remotely. The PPs also observed that the female patients preferred the female PP for the treatment and hence suggested appointing at least one female PP at the teleconsultation centre.

One of the PPs also suggested that the Pabal MHC could provide the teleconsultation service to other private practitioners who are mostly AYUSH practitioners, in the area, such that the service could be utilised to the fullest and can act as a virtual referral centre for the patients. Further despite the quality and outcome of service the patients' willingness to pay is still in question if the service is to be upscaled for commercialisation.

Chapter 7. Discussion and recommendations

In this final chapter, I intend to draw together the findings of the study I have presented in the preceding chapters and discuss some possible implications for CRD diagnosis and management using specialist to non-specialist teleconsultations. However, before doing this, I will discuss the strengths and limitations of the thesis. This thesis set out to assess the feasibility of using an established teleconsultation facility (Micro-Health Centre) to provide remote specialist RPs support to rural PPs in CRD diagnosis and management in a resource-constrained rural area.

7.1 Strengths and Limitations of my research

In my study, I used three approaches, including literature review, basic research, which described a phenomenon in collaboration with the participating stakeholders, and design and action research to strengthen the MHC. The literature review sought information on CRDs and was broadened to include learning from other specialities for the specialist to non-specialists teleconsultations. In the second part of my work, I sought a broad range of opinions, many of whom had the experience of telehealthcare, involvement of many kinds of doctors, local community, opinion leaders and patients. These two activities aided the strengthening of the existing teleconsultation centre simultaneously, which was the third component of my research.

In the first three chapters of my thesis, I introduce the thesis topic, provide background and context for the research, and lastly describe the systematic process I conducted to review the existing literature in my field of interest for both CRDs and other diseases and summarise the published review. Although the evidence for the specialist to non-specialist teleconsultation for CRD diagnosis and management was scarce, the review of literature for such consultation in other diseases helped me identify barriers and facilitators for specialist to non-specialist teleconsultation.

During the second stage of my study, all my OL participants were immensely experienced in either setting up or functioning of certain teleconsultation systems across India, which gave me a geographic representation of the participants. My OL participants included one from North India, another from the Southern part of the country, and one participant, although based in Pune, had worked extensively in the country's Eastern region. The remaining five OLs were based in Maharashtra, representing Western India. Given their experience, the data which I gathered from the OLs was extremely rich in terms of practical insights in setting up and implementing a teleconsultation centre. Further, the involvement of doctor participants in the existing teleconsultation centre and the system gave them the experience which they could evaluate and assess during the in-depth interview process. Lastly, the patients who were surveyed had fresh experience in using the specialist to non-specialist teleconsultation systems. I interacted with them right before and after the teleconsultation. This provided me with responses simultaneously for both pre and post teleconsultation experiences without interaction with other confounders that might have otherwise influenced their responses.

Despite the geographic representativeness, the participants included a very few females, all of whom were PPs. I did not find any female RPs in and around Pune, which is not surprising as it is well known that male doctors dominate the number of female doctors in India's overall distribution of health workers (Karan *et al.*, 2021). When trying to identify OL study participants, I came across a very few females working in the field of teleconsultation; however, they were at junior positions, and despite their willingness to participate, they did not receive permission to participate from their superiors depicting the gender imbalance in the field of teleconsultation like any other scientific and technical fields (Chatterjee and Ramu, 2018).

Further, I anticipated collecting data from more participants, especially the PPs and RPs, to understand their post teleconsultation experiences; however, by the time the new strengthened teleconsultation centre was live in February 2020, the COVID 19 pandemic

had started to spread, and India declared the first lockdown in March 2020. Although the use of the teleconsultation system increased due to the pandemic, the doctors, especially the RPs, were busy tending to patients and hence couldn't find time to give me an appointment for the interviews. I could interview only two PPs to record their post teleconsultation experiences.

Additionally, qualitative research methods are susceptible to criticism of being biased. This bias could be introduced at each stage of my research where my assumptions and values could influence the research process. I was actively involved in strengthening the teleconsultation system, I ran the risk of introducing bias during the framing of research question, sampling, data collection, and analysis process. When I designed my study objectives, I initially assumed that the teleconsultation centre would run successfully, which eventually did. The strengthening and functioning of the teleconsultation centre was also dependant on many external factors, like the support for leadership, availability of financial and human resources. However, with support from my supervisors I designed my study objectives which could be fulfilled even if the teleconsultation system did not take of the ground.

Further, the sample selection of the OLs and doctors, although purposive, the primary inclusion criteria was that of those who consented to participate from the pool of enlisted participants. Thus like many qualitative studies, this is a small study that is primarily descriptive with participants selected purposively. Its limitations relate to its generalisability to other contexts and settings. Although my study focused on the Indian population and context, more specifically in the MHC, I lay down practical implications towards the end of this chapter which could help in generalising some findings of my research to the global context. Nonetheless, Lee and Baskerville argue that the generalisability in both qualitative and quantitative research is based on assumptions (Lee and Baskerville, 2003), yet qualitative research has comparatively more limited options of generalisability as it is context-specific.

Some of my study participants were aware of my role in the strengthening of the Pabal MHC; and the patient population may have been influenced by my perceived elite status (as explained under the reflexivity section), they may therefore have tended to speak positively about the service and the centre. To reduce this bias, I introduced some probing questions in the data collection tools; like, limitations and drawbacks of the teleconsultation systems; which might help the participants to discuss their honest opinions if they identified any potential difficulties drawbacks of the teleconsultation processes or systems. With the patient population, I tried to speak in vernacular Marathi accent, dress modestly and make them comfortable before I initiated the interview. Moreover, during the analysis phase, I reflexively coded and analysed the data which helped me to be aware of my biases during the process.

Nevertheless, findings from my study can be empirically tested in different settings and contexts, assuming every setting is unique, and the implications will influence whether similar services can be successfully implemented in different settings. I was involved in strengthening the existing telehealthcare centre, and hence I was aware of the processes involved and the data collection methods were therefore developed based on practical experience and not on planned or hypothetical telehealthcare centres. Further, the study participants were mostly aware of the centre or were informed about the centre when invited to participate and hence provided practical advice for identifying barriers and facilitators of the set-up and implementation of the telehealthcare centre.

One of the prominent limitations of my study was the choice of data collection method for the patient data. I collected the patient data using a simple structured administered questionnaire which also included scale-based responses. I chose this method as it was the least time-consuming and would help obtain patient consent for participation in the study and also because I perceived it to be easier for the patients who were not used to being asked their views. Further COVID pandemic restrictions led me to limited access to patients. I collected data from 12 patients when the lockdown was declared and collected

the remaining data from 18 patients when the lockdown restrictions were eased. Although I followed all COVID related safety protocols, the data collection from patients had limitations in obtaining authentic responses from the patients; all the patient participants provided favourable responses to all the questions.

In ideal circumstances and with a longer study duration, my study would have been chronologically conducted as follows. Starting with the systematic review, I would have designed the methods and tools and would have collected pre teleconsultation data, analysed it completely and designed and implemented the intervention, which would have been followed by post teleconsultation data collection from the participants. I would have also assessed the intervention for pre and post strengthening. However, practically all these were conducted simultaneously, and the strengthening of the intervention was an iterative process.

This research is unlikely to influence the policymakers unless an economic analysis is also carried out. However, in the interest of time and considering my ability and training to work in health economics, I could not include this as a study objective but instead I aimed to include it in a substantive project if mine proved promising. Some of my interview respondents discussed the effect of patients' ability to pay, recovery of the infrastructure costs, managing the recurring costs, remuneration to the doctors on the feasibility of teleconsultations, However, these data are not enough to draw any inferences on the cost-effectiveness of the system. One of the ways to obtain this information would be a discrete choice analysis for the patients by posing various scenarios and receiving their responses about the paying behaviours in such scenarios. In the next stages of this research, if extended, I could plan this analysis and include the doctors' views on the expected remuneration for provision of the services for teleconsultation.

The patient participants were mostly elderly, and none of them was educated beyond secondary school. Many of the patient participants did not have any formal education and

were either farmers or homemakers. Although data for socioeconomic status was not collected, I presumed that all patient participants belonged to lower-income strata based on the KEMH experience over the last 20 years of service, as only those who are unable to pay look for the free and low-cost service which is provided by KEMH. This background potentially influenced their responses to the questionnaire. They may have feared losing the service if they were critical of the service or were polite to not offend me with their responses. No responses were negative, and all responses from the patients were positive. Some patient participants, especially women participants, also mentioned that they had never been asked their opinions before and hence felt overwhelmed with the questions.

The patient consent process clearly stipulated that their responses to this questionnaire would not affect their services in any form. In the ideal circumstances of a funded study to understand patients' perceptions, I would have employed a local field-based research assistant to collect the patient's information. The local interviewer would have helped in connecting with the participants, and the participants would have been open with the locals and hopefully would have shared more candid responses with the locals.

Although I tried to dress modestly and speak the vernacular language, the patient participants assumed I was a senior doctor and further requested to make the service available for free in the coming months. The dynamic between the patients and me was lopsided, and they assumed me to be a person in a position of authority at the teleconsultation centre (Råheim *et al.*, 2016; Johannah Keikelame and Swartz, 2019). It was difficult for the patient participants to connect with me. Despite all my effort to explain the process to the participants, some might have had misconceptions about the process still and answered as per their understanding.

The scoring in the post teleconsultation experiences improved in all the questions, although the responses pre teleconsultation were generally positive. This indicates that the

patients approved of the system after experiencing the teleconsultation services. These results indicate that the patients were primarily willing to accept the new system and were happy that the service was available. Despite these promising results, more detailed work is needed to understand the economic aspects of such systems, especially when the paying capacities of rural patients are low. Secondly, in my opinion, the structured administered questionnaire was not an ideal tool to obtain such information from the rural patients, and different research methods need to be used for understating patients' perceptions of teleconsultation services. I piloted these questionnaires on my office colleagues; however, I did not consider that the actual study participants would be a marginalised population who are not used to being asked their opinions. Given all these limitations, conducting in-depth interviews with at least some participants would probably have been a superior way to understand their perceptions better. Further, the teleconsultation was done for a meagre fee of INR 50 (~GBP 0.5), and it is not clear how much patients would be prepared to pay and if they would prefer traditional face to face consultation if they needed to pay more for the service. This limitation needs further exploration to determine if the intervention is scalable.

I have interacted with the participants before and after the data collection processes, and some of them shared some information off the record. This 'off the record' information included names of people or places which I knew about, and I could draw some inferences based on the locations, this information also was linked to the unofficial demos given to me by a couple of participants of their teleconsultation systems but was requested to not report it to anyone. Further some participants were aware of how the local systems worked and mentioned about those issues during discussions around the data collection. I knew some of the participants personally before I invited them to participate in my study however, this knowledge was not part of my data. Although, such information affected my thought processes during the data analysis, I could not effectively include this information in the results. Discussion of findings

My research has described the perceived direct and indirect benefits of using telehealthcare to support PPs. I have also delineated the requirements for set-up for CRD telediagnosis and what stakeholders thought was required to implement telehealthcare services for CRD diagnosis and management.

I explore these findings in the sections below using the components of Normalisation Process Theory (NPT) to discuss how sustainable the intervention might be beyond the initial set-up period and in the light of previously published research. They are arranged in order of the objectives as described in the results.

NPT has four core constructs, as mentioned earlier in section xx.

1. Coherence means the ability to apply logic in this context, translated to meaning and sense-making by the participants.
2. Cognitive participation, the second core construct of NPT, explains how people involved in the intervention build and sustain practices around the new intervention.
3. Collective action is the third core construct of the NPT that identifies if there is sufficient support from management, if the individuals are confident about their co-workers' contributions, and if tasks are correctly allocated according to their skill sets. It is the operational work that people do to enact a set of practices, whether these represent a new technology or complex healthcare intervention.
4. Reflexive monitoring, the last construct of NPT, appraises the impact of change or intervention on individuals and the collective impact. My intervention was relatively new, and it would be too early to do its reflexive monitoring.

The intervention, use of telehealthcare systems for CRD diagnosis and management, appears to have coherence for most participants in the research as it is clearly differentiable from current systems and its purpose is clear to the users. It can be clearly distinguished from the traditional ways of working due to the infrastructure used,

including the digital data capture and transfer, and the participants see its potential in delivering quality healthcare to the community using this system.

7.2 Requirements, including equipment and skills to support local primary physicians in remote CRD diagnosis and management

The complete set-up of a teleconsultation centre is time-consuming (Davar, 2012) and takes months to be fully functional. My participants spoke positively and creatively of a range of ways a functional telehealthcare centre could operate, suggesting an enthusiasm to continue the work. This is in accordance with activation, an NPT component, which helps us assess the capacity and willingness of participants to collectively define the actions and procedures needed to keep the new practice going.

There was a reported need for good IT infrastructure to share patient records with the specialists in addition to calling or video-calling options. The technology, network, and connectivity related challenges reported in the early years of teleconsultation (Sahay and Walshman, 2006) have been resolved mainly in urban settings. However, continuity of connectivity is not reliable in rural settings (A. Bhaskaranarayana, L.S. Satyamurthy, Murthy L.N. Remilla, 2009) despite it being a crucial component without which the centre cannot function.

Setting up a teleconsultation centre in remote areas will require space, electricity and backup options for continued electric supply, appropriate software for storing and sharing patient records and human resources (Baker and Stanley, 2018). The choice of location for setting up a centre depends on resources at the selected location and the community needs (Hanna, May and Fairhurst, 2012; Ure *et al.*, 2012); hence it is up to the local leadership and investors to identify an appropriate location for the setting of the teleconsultation centre in consultation with the community representatives. As multiple commercial and non-commercial options of teleconsultation systems and software are available (Mandal, 2020), the choice of system is a challenge. The technology does not

have any proven gold standard, and obtaining suggestions or recommendations from other peer users may not be totally relevant as the requirements depend on multiple local factors, and different organisations might have different experiences. However, important information about reliability, usability and after-sales service from people who have used a system in the field can be helpful. The final choice of the systems will, of course, depend on the model of telehealthcare to be used, the number of users, budget, availability as well as the aforementioned factors.

My choice of teleconsultation system when strengthening the Pabal MHC was pragmatic. A similar approach was reported by Davar when he conducted case studies of Indian telehealth models (Davar, 2012). The A3RMT was available on donation, the reasons for which are mentioned in Section 6.2 and hence I chose to deploy the system. Such similar pragmatic approaches need to be listed and tested in different settings to identify and choose the teleconsultation systems which can eventually be normalised into practice, thus contextually integrating the intervention according to the "collective action" component of NPT, which describes that the intervention is supported by management and other stakeholders, policy, money and material resources.

My study findings, unsurprisingly, indicate that a range of high quality administrative and clinical staff are required to run a successful centre. All participants agreed that the staff positions must include a coordinator and a PP in addition to a technician. Some RPs also suggested counsellors for CRD patient counselling to help them with the continuity of treatment. Employing a counsellor in addition to the crucial staff might be difficult in already resource-constrained settings; however, if the patient case-load were to be high, bringing in additional finance, a counsellor could be employed to support the PP at the telehealthcare centre (Wodskou *et al.*, 2014).

The results indicate that the PP could play a dual role as a coordinator and the physician; however, these two could be separate positions the centre became sufficiently busy. The

coordinator role at the teleconsultation centre is one of the essential personnel. The findings further suggest that the coordinator would better be a local with good rapport with the community who has good communication skills (Gagnon *et al.*, 2006). However, employing a local coordinator has advantages and disadvantages. Being local helps lower staff attrition rates, as city-based staff tend to look for jobs closer to home. However, local staff would be more likely to require training. Such training would be an attractive aspect of the job and would also help sustain continuity at the telehealthcare centre as well as increase the capacity of the local community (Goel *et al.*, 2016). The coordinator is a role player in how the logistics are managed to ensure the continued availability of internet connectivity, time management, staff coordination for teleconsultation services. Although a coordinator plays a significant role, dependency on one person for sustainability is always questionable. Hence, I suggest a team that could work collaboratively and share responsibility for running the service. This approach has been shown to be effective in a previous study on maternal and child health (Unicef, 2013). The team could comprise one or two PPs, a local coordinator and a technician, for the functioning of a telehealthcare centre which will also conduct CRD diagnosis and management.

The last component of cognitive participation is contextual integration which describes if the intervention is supported by management and other stakeholders, policy, money and material resources. In this case, monetary resources remain one of the most critical components of setting up and implementing a telehealthcare system. While the initial investment in setting up is high due to the technical requirements and infrastructure costs, obtaining one-time resources for setting up a telehealthcare system did not come up as a challenge during the discussions. Similar experiences were documented by the case study conducted in 2012 (Davar, 2012). Nevertheless, many participants were concerned about the recurring costs required to sustain the centre.

The implementation and normalisation of the centre require funding for human resources, doctors' salaries or payments, internet and electricity costs, maintenance costs.

Additionally, the medicine stocks required at the centre would require some advance investment. These, in private set-ups, can be earned by charging fees to the patients. However, given that the paying capacities of the rural population are already minimal (Chandra and Patwardhan, 2018), paying for consultations of two doctors would pose additional difficulties. The proposed model involves two doctors, both need to be paid for their time spent on a single patient. The specialist might have to spend less time than usual and hence would probably expect lower remuneration than they would expect during the usual face to face consultation. The PP, on the other hand, would spend more time and hence will expect more remuneration. The patients may save their time and travel expenses; however, they would have to be convinced that the alternative (a PP followed by a face-to-face RP consultation) would otherwise be necessary and would be much more expensive overall. Further exploration on how to sustainably recover the costs for running a teleconsultation centre at a location with relatively few low-income patients is required. The sustainability of a teleconsultation centre will be dependent upon the patients' ability and willingness to pay for two doctors. This could be justified with reference to the time and money saved for travelling; however, more work is required to establish the economic realities of the functioning of the telehealthcare centre. This is more important in light of a recent conference abstract from India, which suggests that of 374 patients who underwent doctor-patient teleconsultation, nearly 37% were not willing to pay for teleconsultations, and 77% of patients would have preferred in-person consultation after the pandemic ended (Saboo, Sheohare and Jaiswal, 2020).

It would be potentially less costly if the telehealthcare services were set up within an existing healthcare facility in rural areas. The Primary Health Centres (PHC) in Indian contexts would be a good starting point for installing the range of equipment for teleconsultation services by public and private healthcare providers. In commercial settings, the larger tertiary care hospitals could install their outreach clinics at remote locations. Such installation would provide them with advertising opportunities in rural areas. Additionally, referral for any surgical procedures or investigations required after

the teleconsultations could potentially increase the revenue of the commercial hospitals in the longer run. It will be vital publicity to inform the community about how teleconsultation services work and their advantages over more traditional services. Although the traditional publicity options like pamphlets and advertisements were effective, word of mouth recommendations from the patients themselves based on their efficient and successful management was considered the most successful approach (Baker and Stanley, 2018).

As rural clinics have relatively less patient flow, given the lesser population density and this varies according to the seasons, there may not be sufficient CRD patients or patients with symptoms of CRD visiting the clinic every day to justify a stand-alone clinic for CRD alone. Given that rural clinics are also usually the first contact for patients and hence cannot be a specialised clinic for any particular disease (Gautham *et al.*, 2011), all the staff, including the PPs, must be trained to provide teleconsultation services for multiple specialities (Liddy *et al.*, 2018), pulmonary being one of them.

7.3 Barriers to and facilitators of successful implementation of specialist to non-specialist teleconsultation at MHC in CRD diagnosis and management

The study results suggested multiple barriers and facilitators of successful implementation of CRD telediagnosis and teleconsultations. These factors included legal aspects, personnel, choice of telehealthcare model and other logistics.

My study suggests that all the stakeholders were willing to organise themselves to overcome the challenges to implement the teleconsultation centre effectively for CRD diagnosis and management. In turn, they expected appropriate compensation for their time and efforts and to receive enough cooperation from other team members. This finding identifies with ‘enrolment’, which is the third component of cognitive participation, to

assess participants' capacity and willingness to contribute to the work involved in the new practice collectively.

Initiation, another NPT component, describes whether the key individuals are able and willing to get others involved in the new practice. The process of CRD diagnosis and management using teleconsultation is collaborative, and all the participants expected support from others and were willing to support in turn. The teleconsultation process would work only if the PPs and RPs are willing to be involved and further collaborate. Instead, coordination between teams and doctors in terms of time is another important aspect for the overall smooth functioning of the telehealthcare setup. Further logistics and communication between doctors would be smoother if the functioning of the teleconsultations are as per the timetable for the doctors and especially the specialists as per the speciality (Jensen *et al.*, 2015). This would help in confirming the availability of doctors for both synchronous and asynchronous teleconsultation. The timetables could be weekly or biweekly, or even monthly but must be followed, and the coordinator must ensure that the timetable is followed. This regular timetable will particularly help CRD patients where regular follow-up is a requirement for disease management. Thus, this process will require all key individuals to be willing to involve others for successful implementation. The results also suggested that a ‘motivated’ coordinator is essential for coordination between the team. The coordinator can lead the processes and activities, which can help in the smooth functioning of the telehealthcare centre and act as the most prominent facilitator.

Further, the staff would require greater coordination to decide patient management protocols. Some patients have very simple illnesses which PPs can diagnose, some require further investigations possibly guided by RPs, and some require referral to RP after initial screening and assessment. As the competence of the PPs increases primarily because of the interaction with RPs, then fewer cases may need to be referred, and PPs (and their patients) may have more confidence in interpreting investigations and their own

management. However, this is a gradual process, and the RPs need to support the PPs in it. Nonetheless, the issue of RPs' trust in the PPs have frequently arisen in the discussion where RPs suggested that the PPs were to be trained under the RPs such that they have more confidence in their abilities. This issue could be due to the different levels of training and thus knowledge levels of the RPs and PPs further compounded by the perceived superiority of doctors trained in modern medicine over the ones trained in AYUSH (Narayana, Basavareddy and Lella, 2017). This lack of trust between secondary and primary care doctors, has been described elsewhere, and it will be important to find ways to improve this earlier (Pearson, 1999).

For CRD diagnosis and management, patient screening by clinical examination at the primary care clinics is important. A standardised approach in documenting the patient history (Hernandez, Mallow and Narsavage, 2014) and clinical examination (Raza *et al.*, 2009) may help reassure the RPs that none of the vital parameters are missed by the PPs during patient examination, and the documentation will help to compensate for the physical absence of the RPs and potentially reduce the subjectivity (person to person variation in concluding the process outcome) in the CRD diagnosis process. Nonetheless, given the unavailability of specialists in rural areas in India, CRD diagnosis using PPs with remote support from specialists in rural areas is preferred over not having access at all. Additionally, specialist to non-specialist teleconsultations can identify complex or severe cases and the need for further treatment (Hernandez, Mallow and Narsavage, 2014) (Baker *et al.*, 2013).

The Primary care clinics are not equipped with the necessary equipment, for example, a spirometer, X-ray and ECG, for CRD diagnosis. Some PPs might have access to X-ray and ECG machines, given their multiple uses. The PPs tend to rely on patient history and clinical examination for the screening rather than tests in general circumstances. Nonetheless, one possible model for CRD diagnosis using teleconsultation would be a clinical examination of the patients by PP and referral of the patient to conduct all required

diagnostics at a central location. These central locations need to be identified or created with support from the government or charity organisations in the area, followed by teleconsultation between PP and RP for confirming diagnostics. However, this process would reduce the time-saving advantages of teleconsultation for the patient. Given the relatively low cost of spirometry and the centrality of this investigation in diagnosing CRD, the provision of spirometers to Primary care Clinics and training of PPs to use them should be prioritised.

Additionally, the study results described the human resources and their continued training requirement for continuity in the service and provision of appropriate treatment. This observation is also supported by a narrative review which describes findings from 13 studies suggesting that team training can improve teamwork processes and in turn patient outcomes (Weaver, Dy and Rosen, no date). Effective translation of training is further dependant on multiple factors including financial resources, leadership and organisational policies which can affect the training decisions and implementation of training into services (Holeman *et al.*, 2014; Grant *et al.*, 2017). Practical training for different activities can help the decision makers to explore characters which aids the service implementation (Hollick *et al.*, 2019). Further measuring direct impact of training on actual implementation of service is challenging given the obvious implications of other interventions on service delivery (Hollick *et al.*, 2019). Mandatory training further has its own challenges as it might avert the staff against the system if they are not willing or ready to undertake training (Johnson *et al.*, 2020).

The communal specification, the next component of coherence, questions if the participants have or can build a shared understanding of the proposed intervention's aims, objectives, and expected outcomes. Human resources and their combined understanding of the systems are among the most critical requirement for the overall functioning of the systems and processes. The healthcare providers involved in my study had a common goal; they all aimed at better healthcare delivery to CRD patients in rural areas. They all

stated that the use of telehealthcare systems for CRD diagnosis and management would help achieve this goal. These human resources are crucial role-players in implementing and popularising teleconsultations, and hence their acceptance of the system is essential (Martínez Álvarez M, Chanda R, 2011)(Asua *et al.*, 2012). However, my study participants' understanding of the aims and objectives of the centre differed according to their experience and familiarity with the teleconsultation processes. This also meant that the vision of the teleconsultation centre needs to be distinct and explained to the stakeholders before they initiate their involvement in the process.

My findings also showed that a few stakeholders were sceptical about using or had misconceptions that teleconsultation is illegal due to the absence of clear guidelines or laws from the Indian government, which seemed to be a challenge for stakeholders' participation in the process. However, after I collected my data, The Indian Council for Medical Research (ICMR) published the telehealthcare guidelines in India (Board of Governers In supersession of the Medical Council of India, 2020). Although the OLs and RPs mentioned their concerns about the unclear legal framework, the PPs and the treating physicians, in contrast, are most affected by the legal issues, yet they did not discuss their concerns around legalities. Doctors fear legal action in case of trouble, which is true in traditional face-to-face consultations. One needs to instil confidence in the teleconsultation systems and robustness of the systems to guide and help the diagnosis such that the doctors can trust the system for diagnosis and treatment. Moreover, the legal principles applicable to traditional face to face consultation could be valid for teleconsultation, and hence the same legal framework can be applied to teleconsultation where the Indian Guidelines are not clear (Vitacca, Montini and Comini, 2018). This confers legitimation, a component of cognitive participation, which revolves around whether it is seen to be appropriate for the participants' to be involved in the implementation process.

Despite this perceived legal challenge, the doctors generally expressed their willingness to conduct teleconsultations. The PPs were aware that they would receive additional specialist input when conducting teleconsultations, and the expectation of this support may have underpinned their enthusiasm for the idea of receiving teleconsultation. The RPs, on the other hand, were comfortable providing teleconsultation to PPs and not the patients. Although the RPs doubted the knowledge and abilities of the PPs recurrently during the discussions, they did not explicitly mention their mistrust in the PPs and emphasised the need for further training. Strategies to manage these hierarchical challenges arising due to the knowledge gaps or perceived superiority of the doctors trained in modern medicine over the ones trained in AYUSH, need to be considered when implementing such models.

Specialist to non-specialist teleconsultation is the preferred model of teleconsultation for both the RPs and the PPs. The clinical responsibility lies with the PPs during the specialist to non-specialist teleconsultations, and RPs do not wish to take that responsibility for virtual check-ups. The legal framework regarding negligence during teleconsultations in India is ambiguous, and hence RPs not being willing to conduct direct patient consultation is possibly reasonable (Ateriya *et al.*, 2018). However, the recent guidelines by the ICMR (Board of Governers In supersession of the Medical Council of India, 2020) might help in changing this approach by the RPs. Additionally, an RP also expressed the belief that teleconsultation would become monotonous in the long term, and more junior RPs would be involved on a rotational basis at the institutional level.

In contrast, one PP, who practices in the traditional face to face clinic at the location of MHC, raised concerns about teleconsultation. However, their opinion may have been swayed by the notion that it might affect their stature in the community by creating competition and their fear of using technology. A finding reported by Whitten and Mackert conclude in their study that the providers are the most important initial

gatekeepers to the adoption of change, especially for the use of telehealthcare systems (Whitten and Mackert, 2005).

Additionally, my study reveals that the choice of teleconsultation models is an important factor for implementing and operationalising telehealthcare centres. Many factors determine the choice of teleconsultation models, including the centre's purpose, commercial intentions of the organisation, doctor availability and patients' need. Hence no set standards can be suggested for setting up a teleconsultation model. The models can vary from hub-and-spoke (Raza *et al.*, 2009) to spoke-and-spoke (Elliott and Yopes, 2019) and, in rare cases, a hub-and-hub model. The hub-and-spoke model is where a large hospital with specialists usually at a central location- a hub- provides teleconsultation to several smaller hospitals or clinics. These smaller hospitals are referred to as spokes; they are usually multiple and dispersed across various remote areas. In some scenarios, the spokes may take support from each other, and this model is referred to as spoke-and-spoke (Acheampong and Vimarlund, 2015). The teleconsultation between the two consulting parties may be synchronous or asynchronous, depending on the doctor's availability (Elliott and Yopes, 2019).

Further, the doctor to patient teleconsultation, which probably is a commercially viable model according to my findings, suggest that it might be helpful for areas where no doctor is available or in COVID time where the patients cannot physically visit the doctor due to social distancing norms (Ministry of Health and Family Welfare GoI, 2020). However, this doctor-patient teleconsultation requires an informed patient population who have access to technology and internet network and are technology-savvy, which is mostly not the case in rural areas. Nonetheless, this type of consultation was not part of my research objective; hence I did not collect more information on this model. On the other hand, my focus, the specialist to a non-specialist, is not affected by the patient characteristics but is dependent on the availability and willingness of a specialist to take part. The specialist felt they would be reassured if the PP provided a standardised history alongside completed

investigations and a clear description of the nature of the problem on which the PP requires advice. This will reduce the time required by the specialist in providing support and allow them to help more PPs and their patients. Ideally, the PP would have undergone local training by the specialist to enhance trust between them.

7.4 Stakeholders' perception of remotely supported CRD diagnosis and consultations

The fourth component of coherence is 'internalisation', which describes if the participants understand the potential value, benefits and importance of the intervention. The telehealthcare services were perceived to be beneficial for the patients and doctors by my study participants. The primary benefits mentioned by the participants included the travel and time saved for patients and convenience of the patients and doctors, which are also reported in previous studies (Bali and Singh, 2007) (Lee *et al.*, 2018) (Paterson, McAulay and McKinstry, 2017). Further, my study suggests that the availability of access to telehealthcare systems in remote locations could also help in early diagnosis and appropriate, timely treatment of the diseases, including that for CRDs, which can reduce the exacerbations and thus admissions. These benefits also result in the reduced economic burden of the disease (Shah *et al.*, 2017).

My results also add that this would help reduce RPs' workload as PPs will manage most of the OPD patients, and the PPs could brief the RPs with the only required information for the teleconsultation in the more complex cases. This contrasts with the findings of research set in high-income countries where doctors are generally concerned that teleconsultation might increase their workload (Hanna, May and Fairhurst, 2012; McKinstry, 2017; Paterson, McAulay and McKinstry, 2017). Surprisingly, no RP was concerned that the reduced OPD clinic load could reduce their income sources from their pay-for-service OPD. They assumed indirect publicity and increased referrals through the telehealthcare services they would offer would offset this. Although a few RPs described

work satisfaction and giving back to society as indirect benefits, they understand that these services will give them access to a broader population if implemented. However, it is crucial to find cost-effective strategies which will not create any loss to the stakeholders involved in the process; the conclusion is drawn by the authors of a descriptive overview of a similar service functional in Canada (McKellips *et al.*, 2017). This should help reduce the resistance to change from the stakeholders as reported by the systematic review on evaluating worldwide barriers to adopting telehealth (Kruse *et al.*, 2018).

Other than these apparent benefits, the study participants were more vocal about other indirect benefits of setting up telehealthcare services. As the set-up usually requires high bandwidth internet, rural areas previously lacking internet connectivity are connected by virtue of the installation of wider area broadband to support the teleconsultation services in the area. Secondly, the healthcare facilities in the rural region get equipped with updated technology and hardware, which enables diagnosis of various diseases other than CRDs, which makes the villages more self-sustainable for access to healthcare. This, as reported earlier, also provides additional autonomy to the villages in reducing their dependency on other centres (Gagnon *et al.*, 2006) and builds capacity in the local community by providing healthcare alongside an overall improvement in broadband locally.

Traditionally the Indian healthcare delivery systems do not have structured data documentation systems and scarce usable datasets for healthcare As data documentation is an essential component of using telehealthcare services, OLs thought that using these systems would provide health data for multiple purposes in the long term (Jawhari *et al.*, 2016; Agrawal, 2020). These datasets can also be leveraged for economic or in-kind transactions for more sustainability of the telehealthcare services (Agrawal *et al.*, 2013), and some of my study participants mentioned this. However, such transactions would require utmost care to maintain the accuracy and confidentiality of the datasets (Were and Meslin, 2011). The doctors felt that the documented data would provide them with legal safety in case of any problems. This contrasts with what the participants from another LMIC have

expressed, where healthcare providers resisted health records to allow deniability and prevent potential liability (Akhlaq, McKinstry and Sheikh, 2020). The availability of electronic medical records can be used for billing and audits of treatment quality and outcomes

Data documentation has been described as having a significant role in the functioning of telehealthcare centres and in being key to the doctors' communication and coordination (Agrawal *et al.*, 2013), and my study confirms this role. However, the doctors need to make full use of the potential to use electronic records to improve access to information by all the doctors involved in their care. Despite the electronic data capture and usage, some doctor participants still preferred hard copies to record patient information (Fraser *et al.*, 2005) and suggested that someone else should digitalise the information to save time during a patient consultation. The hard copy use might be cumbersome for creating electronic data but convenient for the doctors for ease of access to a record when providing treatment, also probably due to resistance to change (Scott Kruse *et al.*, 2018). The use of hybrid systems of hard and soft copy data can make this shift gradual.

Further, my study results indicated that Artificial Intelligence (AI) could be used in long-term telehealthcare practices, as mentioned by a couple of OLs. Telehealthcare provides the benefit of electronic data documentation and storage. These data, in the long term, could create rich health databases that could be utilised to train the artificial intelligence algorithms and make them more robust and more accurate (van der Heijden *et al.*, 2013; Agrawal, 2020). In general, using a teleconsultation system is acceptable to the stakeholders, especially the clinicians and the patients, given the direct and indirect benefits of the system.

7.5 Practical and global implications

The COVID pandemic has changed the scenario of the use of telehealthcare globally (Smith *et al.*, 2020). The WHO strategy on digital health lays down general and specific principles to implement globally (World Health Organisation, 2021). Telehealthcare

will be widely implemented in low resource settings given the increase in infrastructure for digital health and the availability of updated technology(Smith *et al.*, 2020). My study has provided some practical implications for implementing the telehealthcare centres for specialists to non-specialists teleconsultations in low resource settings. I have listed some practical implications which can be generalised for any low resource settings below.

Telehealthcare aims to provide a holistic approach to health and well-being by improving access. However, multiple barriers across the globe still exist to implement telehealthcare and to scale up the available technology (Greenhalgh *et al.*, 2018; Donaghy *et al.*, 2019). My study has helped to identify requirements for setup and implementation, explore barriers to and facilitators of successful implementation of teleconsultation and understand the stakeholders' perception of using telehealthcare.

The use of telehealthcare for managing CRDs might help to achieve one of the Sustainable Development Goals (SDG) health-targets - to reduce premature mortality from non-communicable diseases -by improving access to quality, safe, effective, essential healthcare services at an affordable price (Merrell and Doarn, 2016; Social Statistics Division Ministry of Statistics & Programme Implementation Government of India Central Statistics Office, 2017; Asi and Williams, 2018). Although the health goals of SDG3 are ambitious, attaining those demands reliable and accurate health data. Low- and Middle-Income Countries could leverage telehealthcare as one possible solution in attaining overarching health priorities as well as generating health data. Thus, telehealthcare is an upcoming possible solution to bridge the gap in healthcare disparities in LMICs.

Further, my qualitative study has provided data to stimulate potential future studies to explore quantitative health and economic outcomes and can help to prioritise these research questions based on the need. In addition, in the below boxes, I list down some

suggestions which may help in the setup and implementation of a telehealthcare centre for CRD diagnosis and management in any resource constraint area.

7.6 Practical Recommendations

7.6.1 Job description of the telehealthcare centre coordinator

As the results suggested, a coordinator for the telehealthcare centre is one of the most important role players. Below job description for a coordinator could be used by the organisations to identify appropriate personnel to run the teleconsultation centres in remote areas.

Below job description for a coordinator could be used by the organisations to identify appropriate personnel to run the teleconsultation centres in remote areas.

Eligibility:

- Ability to learn new things
- Graduate with English reading and writing abilities
- Local resident
- Coordinator and communicator
- Willing to take responsibility
- Highly motivated and passionate to provide healthcare services to the rural population
- Basic knowledge of chronic respiratory diseases
- Being a clinician (MBBS/ BAMS/ BHMS) is an added advantage

Job Profile:

- The telehealth coordinator will have to manage the routine activities of a telehealthcare centre
- Maintaining the documentation at the telehealthcare centre
- Advertising the centre for improved patient footfalls
- Coordinating the timings of the PPs and specialist doctors for teleconsultation
- Coordinating with the IT and technical team for a technical breakdown
- Performance reporting regularly to institutional head and administration
- Keeping track of medicines and other consumables, making sure of the availability

Box 2: Job description of a coordinator of a telehealthcare centre

7.6.2 Training requirements for the staff members

All the clinicians, PPs and also RPs need to be trained in the processes for conducting teleconsultations. Moreover, a detailed orientation would be required for the clinicians to accept the training needs, particularly by the RPs. Training on communication, bedside manners, and soft skills, especially for PPs, is needed in the training components even though these skills are anyway required by all the clinicians for all kinds of consultation, including teleconsultation. Further training for technical skills would differ as per the staff role. The staff must also be informed about the governance and financial responsibilities of the staff for transparency and better functioning of telehealthcare centres. Thus the training modules must include the following

1. Aims and objective of the telehealthcare centre
2. Technical training for the use of teleconsultation systems
3. Communication training for remote communication
4. The governance structure of the organisation
5. Roles and responsibilities of all staff members

7.6.3 Equipment and technical requirements

The below box provides a list of the technical requirements for any telehealthcare centre for telediagnosis and management of CRD. The list includes but is not limited to the following

1. Appropriate hardware and software for good documentation of patient history
2. Checklist for conducting clinical examination
3. Hardware for digital auscultation by a trained physician which can be recorded and transferred to the specialist
4. Spirometer with trained spirometry technician or facility for spirometry
5. Access to X-rays and ECG either at the telehealthcare centre or any central location
6. Blood diagnostics or availability to transfer the blood samples to a standard laboratory and receiving digital reports

Box 2; Technical requirement for setup

Further, the technology used for teleconsultation must be compatible with standard equipment. For example a standard spirometer must be compatible for data transfer to the system for ease of sharing the reports with specialists. The software should have the flexibility to be used by multiple users but must have restricted access.

7.6.4 Set-up Requirements

Setting up any teleconsultation centre in remote areas will require

1. Space
2. Electricity and backup for continuity
3. Internet connectivity
4. Facilities for sharing the patient records with the specialists in addition to calling or video-calling options
5. Appropriate software for storing and sharing patient records and human resources.

Further, The CRD diagnosis and management using teleconsultation requires-

6. Good documentation of patient history
7. Clinical examination and auscultation by a trained physician
8. Spirometer
9. X-rays
10. ECG machine
11. Facility for blood diagnostics

Box 3 Setup requirements of a teleconsultation centre

Figure 19 below describes the standard requirements and process for conducting teleconsultation for CRD diagnosis. The white boxes indicate the process, and the coloured boxes mention the role-players and the location of the process.

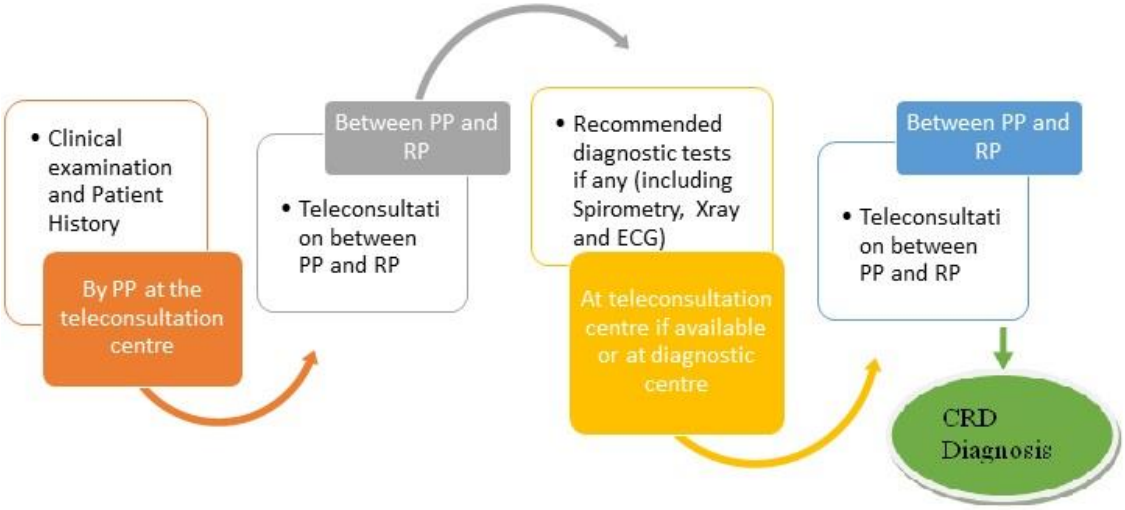

Figure 19: The Teleconsultation process for CRD Diagnosis

7.7 Recommendations

India has a high CRD burden (Salvi *et al.*, 2018)(Bhome, 2012)(Salvi, Manap and Beasley, 2012)(Pandey *et al.*, 2021) and comparatively a very few RPs (*Indian Chest Society: List of Life members*, 2018)(World Health Organization, 2006). Given this scenario, CRD diagnosis and management in remote places where specialists are not available can be achieved using telehealthcare. However, if developed for such interventions, a standard set of guidelines could help in the appropriate adaptation of the telehealthcare services. My study highlights some requirements for CRD telediagnosis and remote management for the set-up and functioning of telehealthcare centres. However, more studies are required to identify appropriate teleconsultation equipment for specialist to non-specialist teleconsultation in various scenarios. Although there are commercially available telehealthcare equipment and models in the Indian market, to my knowledge, no studies report a comparison of these models.

Further exploration of doctor expectations with respect to remuneration in a shared diagnostic set-up such has been suggested in this thesis is required. Additionally, patients' willingness to pay for these types of services need to be investigated. While many clinical resources were given freely in the context of what was a pilot project, this would not be sustainable if the service grew. The teleconsultation process involves the time of two doctors, and thus remuneration for both is expected in regular practice; resources for such double remuneration need to be tapped, and patients' willingness to pay for two doctors also need to be studied.

Further, implementing such interventions require background information on the availability of internet network, service providers, and other infrastructure, including electricity in remote areas. There are multiple sources of such information; however, one consolidated document to access the infrastructure-related information could help the healthcare providers to plan the intervention and their locations.

Despite the publication of guidelines for the use of telemedicine in India, the legal framework for the use of telehealthcare is still unclear. My study recommends the need for robust legal guidance for the use of telehealthcare. Further, my study recommends the capacity building of healthcare providers in using digital technologies communication strategies in addition to clinical training. Community engagement, education and awareness on the use of teleconsultation for accessing healthcare is another major recommendation from my PhD. These awareness programs can be part of the national digital health strategy.

7.8 Conclusion

The use of a specialist to non-specialist teleconsultation for diagnosis and management of CRDs is broadly feasible. The equipment required to set up the system and services are similar to the traditional face to face consultations with the additional technical requirement to facilitate the communication between the doctors. The human resource requirement focuses on a dedicated site coordinator drawn preferably from the local area. Training to improve the skills of PPs and enhance trust between the clinicians' groups was deemed essential by all stakeholders. Further use of standardised protocols for clinical history, patient examination and testing would facilitate the teleconsultation process, and EMR would enhance the benefits. Further, the teleconsultation to PPs by RP was found to be generally acceptable to doctors and patients.

The strengthening of the existing teleconsultation centre was based on the views of stakeholders, which resulted in designing a working model which was successfully tested out with a small number of patients and doctors. However, the site was largely run on ‘goodwill’ with patients making small payments for services and RPs providing advice for free. This would not be sustainable at scale, and it will be important moving forward to establish a fiscal basis for such centres. Further, the patients should be informed of the benefits of teleconsultation and weigh up for themselves the costs and benefits, adding a level of complexity to the unanswered question around their willingness to pay.

My PhD has addressed the aim of the study and has generated data to understand the process of setting up and implementing a telehealthcare centre, especially for the diagnosis and management of CRD. The results will help in creating guidelines for establishing and managing a telehealthcare centre. The WHO strategy on digital health published in 2020 lays down general and specific principles to implement digital health globally. Telehealthcare will now be widely implemented in low resource settings given the increase in infrastructure for digital health and the availability of updated technology. Given this background, my study has provided some practical implications for implementing telehealthcare centres for specialists to non-specialists teleconsultations in low resource settings.

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Appendix 1: Search Strategy 1

Database: Embase <1980 to 2019 Week 6>

Search Strategy:

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1 Remote Consultation/ (8560)

2 Telemedicine/ (21862)

3 remote diagnosis.mp. (247)

4 remote medical consultation.mp. (7)

5 Tele consultation.mp. (116)

6 Tele opinion.mp. (0)

7 Tele diagnosis.mp. (34)

8 Tele health care.mp. (12)

9 bronchial diseases/ or lung diseases/ or respiration disorders/ (30800)

10 asthma/ or pulmonary disease, chronic obstructive/ (239792)

11 Chronic Obstructive Pulmonary Disorder.mp. (321)

12 COPD.mp. (83394)

13 Asthma/ (211744)

14 1 or 2 or 4 or 5 or 6 or 8 (29363)

15 3 or 7 (279)

16 9 or 10 or 11 or 12 or 13 (325567)

17 14 and 16 (641)

18 15 and 16 (1)

19 14 and 15 and 16 (0)

20 face to face consultation.mp. (389)

21 videoconferencing.mp. or VIDEOCONFERENCING/ (4294)

22 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 20 or 21 (32416)

23 9 or 10 or 11 or 12 or 13 (325567)

24 22 and 23 (687)

25 20 or 21 (4651)

26 14 and 25 (1775)

27 doctor to doctor.mp. (280)

28 physician to physician.mp. (795)

29 doctor to doctor consultation.mp. (5)

30 referral.mp. or "Referral and Consultation"/ (207776)

31 27 or 28 or 29 or 30 (208769)

32 26 and 31 (148)

Database: Ovid MEDLINE(R) <1946 to February Week 2 2019>

Search Strategy:

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1 Remote Consultation/ (4605)

2 Telemedicine/ (20501)

3 remote diagnosis.mp. (150)

4 remote medical consultation.mp. (7)

5 Tele consultation.mp. (41)

6 Tele opinion.mp. (0)

7 Tele diagnosis.mp. (19)

8 Tele health care.mp. (6)

9 bronchial diseases/ or lung diseases/ or respiration disorders/ (82830)

10 asthma/ or pulmonary disease, chronic obstructive/ (155320)

11 Chronic Obstructive Pulmonary Disorder.mp. (149)

12 COPD.mp. (37348)

13 Asthma/ (122185)

14 1 or 2 or 4 or 5 or 6 or 8 (24272)

15 3 or 7 (167)

16 9 or 10 or 11 or 12 or 13 (244226)

17 14 and 16 (539)

18 15 and 16 (1)

19 14 and 15 and 16 (0)

20 face to face consultation.mp. (206)

21 videoconferencing.mp. or VIDEOCONFERENCING/ (2152)

22 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 20 or 21 (25253)

23 9 or 10 or 11 or 12 or 13 (244226)

24 22 and 23 (553)

25 20 or 21 (2337)

26 14 and 25 (1425)

27 doctor to doctor.mp. (184)

28 physician to physician.mp. (486)

29 doctor to doctor consultation.mp. (3)

30 referral.mp. or "Referral and Consultation"/ (125814)

31 27 or 28 or 29 or 30 (126413)

32 26 and 31 (162)

Pubmed

Search	**Query**	**Items found**

#6	Search ((((((((((Remote consultation) OR telemedicine) OR remote diagnosis) OR teleconsultation) OR teleopinion) OR tele diagnosis) OR telehealthcare) OR face to face consultation) OR videoconferencing)) AND (((((((Bronchial diseases) OR pulmonary diseases) OR lung diseases) OR chronic respiratory diseases) OR chronic obstructive pulmonary disease) OR COPD) OR Asthma)) AND (((((doctor to doctor consultation) OR physician to physician) OR physician to pulmonologist) OR referral) OR consultation)	368
#5	Search ((((doctor to doctor consultation) OR physician to physician) OR physician to pulmonologist) OR referral) OR consultation	802287
#4	Search ((((((Bronchial diseases) OR pulmonary diseases) OR lung diseases) OR chronic respiratory diseases) OR chronic obstructive pulmonary disease) OR COPD) OR Asthma	1046404
#3	Search ((((((((Remote consultation) OR telemedicine) OR remote diagnosis) OR teleconsultation) OR teleopinion) OR tele diagnosis) OR telehealthcare) OR face to face consultation) OR videoconferencing	56404

Appendix 2: Search Strategy 2

Database: Embase <1974 to 2019 Week 47>

Search Strategy:

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1 telemedicine/ or telepulmonology/ or telehealthcare/ (22075)

2 Telemedicine/ (22071)

3 Telehealth.mp. (8790)

4 ehealth.mp. (3497)

5 tele*.mp. (250529)

6 telediagnosis.mp. or Remote Consultation/ (8903)

7 electronic consult*/ or teleconsult*.mp. (9635)

8 Videoconferencing/ (3560)

9 econsult.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word] (135)

10 remote diagnosis.mp. (251)

11 face to face.mp. (34756)

12 virtual/ or online consultation.mp. (169)

13 electronic referral/ or ereferral.mp. (45)

14 e diagnosis.mp. (63)

15 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 (281938)

16 respiratory tract diseases/ or bronchial diseases/ or ciliary motility disorders/ or lung diseases/ or hepatopulmonary syndrome/ or lung abscess/ or lung diseases, interstitial/ or lung diseases, obstructive/ or asthma/ or bronchitis, chronic/ or pulmonary disease, chronic obstructive/ or pulmonary emphysema/ (367206)

17 Pulmonary Disease, Chronic Obstructive/ or Chronic Obstructive Pulmonary*.mp. (93626)

18 Asthma/ (221535)

19 pulmonary*.mp. (716345)

20 Chronic Respiratory Dis*.mp. (5037)

21 16 or 17 or 18 or 19 or 20 (990650)

22 doctor to doctor.mp. (294)

23 physician to physician.mp. (826)

24 expert to non-expert.mp. (187)

25 doctor to nurse.mp. (6556)

26 physician to nurse.mp. (2801)

27 General Practice/ or General Practitioners/ or outpatient.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word] (433301)

28 subspecialist/ or specialist.mp. (145118)

29 physicians, primary care/ or pulmonologists/ (97770)

30 chest physician.mp. (357)

31 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 (571653)

32 15 and 21 and 31 (1043)

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Database: Ovid MEDLINE(R) and In-Process & Other Non-Indexed Citations <1946 to November 22, 2019>

Search Strategy:

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1 telemedicine/ or telepulmonology/ or telehealthcare/ (20667)

2 Telemedicine/ (20667)

3 Telehealth.mp. (4075)

4 ehealth.mp. (3225)

5 tele*.mp. (184245)

6 telediagnosis.mp. or Remote Consultation/ (4723)

7 electronic consult*/ or teleconsult*.mp. (1123)

8 Videoconferencing/ (1396)

9 econsult.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (83)

10 remote diagnosis.mp. (181)

11 face to face.mp. (24822)

12 virtual/ or online consultation.mp. (84)

13 electronic referral/ or ereferral.mp. (33)

14 e diagnosis.mp. (32)

15 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 (208494)

16 respiratory tract diseases/ or bronchial diseases/ or ciliary motility disorders/ or lung diseases/ or hepatopulmonary syndrome/ or lung abscess/ or lung diseases, interstitial/ or lung diseases, obstructive/ or asthma/ or bronchitis, chronic/ or pulmonary disease, chronic obstructive/ or pulmonary emphysema/ (289154)

17 Pulmonary Disease, Chronic Obstructive/ or Chronic Obstructive Pulmonary*.mp. (59596)

18 Asthma/ (122583)

19 pulmonary*.mp. (658016)

20 Chronic Respiratory Dis*.mp. (3432)

21 16 or 17 or 18 or 19 or 20 (830749)

22 doctor to doctor.mp. (221)

23 physician to physician.mp. (544)

24 expert to non-expert.mp. (135)

25 doctor to nurse.mp. (912)

26 physician to nurse.mp. (3946)

27 General Practice/ or General Practitioners/ or outpatient.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (150011)

28 subspecialist/ or specialist.mp. (52604)

29 physicians, primary care/ or pulmonologists/ (3260)

30 chest physician.mp. (193)

31 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 (207709)

32 15 and 21 and 31 (308)

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PubMed

Search	Query	Items found
#4	Search ((((((((((((((((((("telemedicine") OR "telehealth") OR "ehealth") OR "tele") OR "telediagnosis") OR "remote consultation") OR "teleconsultation") OR "videoconferencing") OR tele opinion) OR "remote diagnosis") OR "face to face") OR "online consultation") OR "e cure") OR "e diagnosis") OR "online consult*") OR "econsult") OR "virtual consult*") OR "electronic consult*"))) AND (((((((("respiratory tract disease") OR "chronic bronchial") OR lung dis*) OR "chronic obstructive") OR "asthma") OR pulmonary dis*) OR "chronic respiratory") OR chronic pulmonary dis*) OR "chronic obstructive pulmonary disease")) AND ((((((((((("doctor to doctor") OR "physician to physician") OR expert to non-expert) OR doctor to nurse) OR physician to nurse) OR "general practice") OR "general physician") OR "outpatient") OR "general practitioner") OR "subspecialist") OR "specialist") OR "primary care physician") OR "pulmonologist") OR "chest physician")	237

#3	Search ((((((((((("doctor to doctor") OR "physician to physician") OR expert to non-expert) OR doctor to nurse) OR physician to nurse) OR "general practice") OR "general physician") OR "outpatient") OR "general practitioner") OR "subspecialist") OR "specialist") OR "primary care physician") OR "pulmonologist") OR "chest physician"	329418
#2	Search (((((((("respiratory tract disease") OR "chronic bronchial") OR lung dis*) OR "chronic obstructive") OR "asthma") OR pulmonary dis*) OR "chronic respiratory") OR chronic pulmonary dis*) OR "chronic obstructive pulmonary disease"	379281
#1	Search ((((((((((((((("telemedicine") OR "telehealth") OR "ehealth") OR "tele") OR "telediagnosis") OR "remote consultation") OR "teleconsultation") OR "videoconferencing") OR tele opinion) OR "remote diagnosis") OR "face to face") OR "online consultation") OR "e cure") OR "e diagnosis") OR "online consult*") OR "econsult") OR "virtual consult*") OR "electronic consult*")	61441

Database: Global Health

Search Strategy:

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1 telemedicine/ or telepathology/ or teleradiology/ (1165)

2 Telemedicine/ (1165)

3 Telehealth.mp. (369)

4 ehealth.mp. (317)

5 tele*.mp. (18920)

6 telediagnosis.mp. or Remote Consultation/ (8)

7 teleconsultation.mp. (45)

8 Videoconferencing/ (0)

9 tele opinion.mp. (0)

10 remote diagnosis.mp. (20)

11 face to face.mp. (6856)

12 online consultation.mp. (26)

13 e cure.mp. (0)

14 e diagnosis.mp. (6)

15 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 (25365)

16 respiratory tract diseases/ or bronchial diseases/ or ciliary motility disorders/ or lung diseases/ or hepatopulmonary syndrome/ or lung abscess/ or lung diseases, interstitial/ or lung diseases, obstructive/ or asthma/ or bronchitis, chronic/ or pulmonary disease, chronic obstructive/ or pulmonary emphysema/ (59186)

17 Pulmonary Disease, Chronic Obstructive/ or Chronic Obstructive Pulmonary*.mp. (6792)

18 Asthma/ (15113)

19 pulmonary dis*.mp. (8635)

20 Chronic Respiratory Dis*.mp. (632)

21 16 or 17 or 18 or 19 or 20 (62321)

22 doctor to doctor.mp. (14)

23 physician to physician.mp. (33)

24 expert to non-expert.mp. (11)

25 doctor to nurse.mp. (159)

26 physician to nurse.mp. (134)

27 General Practice/ or General Practitioners/ (3126)

28 specialist.mp. (5317)

29 physicians, primary care/ or pulmonologists/ (0)

30 chest physician.mp. (12)

31 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 (8570)

32 15 and 21 and 31 (20)

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Appendix 3: Consent form 1

Feasibility of using a teleconsultation facility (Micro-Health Centre -MHC) in management of Chronic Respiratory Diseases in remote rural areas.

Participant Information Sheet and Consent form

(Opinion Leaders/Clinical staff)

Introduction

Hello. My name is Rutuja Patil. I am a PhD student at University of Edinburgh and work with Vadu Rural Health Program of KEM Health Research Centre, Pune, India. I am inviting you to participate in a study titled "The Feasibility of using a teleconsultation facility (Micro-Health Centre -MHC) in the management of Chronic Respiratory Diseases (CRDs) in a remote rural area". This leaflet provides information about this study. Please feel free to ask if you have any queries/doubts about anything I describe to you.

Why is this study being done?

Respiratory diseases are common and if not treated optimally can result in serious deterioration or death. In many rural communities, specialist expertise is difficult to access. One way this may be overcome is to use new technology to help local doctors from the remote area to consult with experts like respiratory physicians through the internet about more complex problems. However, we don't know whether such a service would be considered helpful by clinical staff or patients, how best it could be used and what would need to be done to set up such a service. I want hear your views on this.

Do I have to take part?

No, it is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a

reason. Deciding not to take part or withdrawing from the study will not affect your legal rights.

What will happen if I take part?

After reading this patient information sheet, you will be given an hour to decide whether or not to participate in this study. The whole study will last about 10-12 months, however your contribution will be for an hour or so. To find out people's views on these issues I wish to interview opinion leaders, primary physicians, respiratory physician, nurse, technicians and patients, about their perceptions and opinions about the feasibility of using telehealthcare for remote management of CRDs. Interviews will be either individual or in focus group discussions. These interviews will be audio recorded to aid later analysis if you agree. This will require less than one hour of your time.

Potential Risks and Benefits

There is neither direct risk nor benefit to you by participating in this study There will be no consequences if you decide not to participate in the study or if you wish to stop mid-way through the process. The choice to take part in this study is completely up to you. However, the outcomes of this study are expected to benefit society at large. The information you give will be very helpful to create evidence to inform national policies to manage CRDs in remote rural area in India.

What will happen if I don't want to carry on with the study?

Your participation in this study is voluntary. You do not have to be in this study if you do not want to. If you volunteer to be in this study, you may withdraw from it at any time. This means that you will no longer be taking any further active part in the research. However, you will have the option of withdrawal from

(i) all aspects of the study but continued use of data collected up to that point, or

(ii) all aspects of the study with removal of all previously collected data.

What happens when the study is finished?

Data from the study will be archived and may be transmitted outside the country for the purpose of analysis, but your identity will not be revealed at any time. All the consent forms, clinical report forms and questionnaires will be stored in a locked filing cabinet accessible only by the researcher team for 5 years. After this time information will be shredded and disposed in secure bins. The participants will not be identified individually in publications or report writing. Participants are allowed to access their results from the study, if they wish for three months after completion of the study. A summary of final report will be submitted within a year after completion to the study to the Research Ethics Committee and all findings will be notified to the University of Edinburgh.

Confidentiality

I would like to assure you that the discussion will be confidential and anonymised. The recordings will be kept safely in a secure environment until they are transcribed word for word. The transcribed notes of the focus group will contain no information that would allow your name to be linked to specific statements and your records will be stored with a code number rather than by your name. Your name or other private information will not appear when we discuss this study publicly or when we publish the results. Your privacy confidentiality of the information obtained would be protected as required by law.

What will happen to the results of the study?

The study results will be presented in reports and published in peer reviewed journal. At times, the results will also be presented in conferences and meetings, however none of your personal information will appear when we discuss this study publicly or when we publish the results.

Cost & payment

We are very grateful for the time you are giving to this project. Other than that, there is no cost to you associated with participating. We are unfortunately unable to pay you for your participation.

Who is organising and funding the research?

This study is sponsored by the University of Edinburgh, United Kingdom for this study based in India. This study has been organized by researchers from Vadu Rural Health Program, KEM Hospital Research Centre Pune

Who has reviewed the study?

The study proposal has been submitted for review to the KEM hospital research centre, Ethics committee and ACCORD, University of Edinburgh

What if there are any problems?

If you have any questions or concern about any aspects or your participation in the study, you may feel free to contact my local supervisor Dr Sanjay Juvekar.

If you have questions about this study with someone independent of the study or if you have any questions about your rights as a participant in this study, you may feel free to contact the ethics committee of KEM Hospital Research Centre:

Dr. Sanjay K. Juvekar	Member Secretary, Ethics Committee
Vadu Rural Health Program VRHP	KEM Hospital Research Centre Pune
KEM Hospital Research Centre Pune	Sardar Moodliar Road
Vadu Budruk, Taluka Shirur, Pune 412216	Rasta Peth, Pune – 411011
Tel. +91-9881057959	Tel. no: +91-20-66037339

Complaints:

If you wish to make a complaint about the study please contact:

Dr. Sanjay K. Juvekar	Member Secretary, Ethics Committee

Vadu Rural Health Program VRHP	KEM Hospital Research Centre Pune
KEM Hospital Research Centre Pune	Sardar Moodliar Road
Vadu Budruk, Taluka Shirur, Pune 412216	Rasta Peth, Pune – 411011
Tel. +91-9881057959	Tel. no: +91-20-66037339

Privacy Notice:

The University of Edinburgh is the sponsor for this study based in India. The Sponsor has overall responsibility for the running of the study. To follow the United Kingdom's data protection regulation, we must inform you of how we will use and store your personal data.

As a university, we use personally-identifiable information to conduct research to improve health, care and services. As a publicly-funded organisation, we have to ensure that it is in the public interest when we use personally-identifiable information from people who have agreed to take part in research. This means that when you agree to take part in a research study, we will use your data in the ways needed to conduct and analyse the research study. We will use information from you and/or your clinical records in order to undertake this study. The sponsor will keep identifiable information about you for 5 years after the study has finished.

The University of Edinburgh will act as the data controller for this study. This means that they are responsible for looking after your information and using it properly. Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

Feasibility of using a teleconsultation facility (Micro-Health Centre -MHC) in management of Chronic Respiratory Diseases in remote rural areas.

Consent form

(Opinion Leaders/Clinical staff)

Tick/Select where applicable:

1.	I confirm that I have read and understand the information sheet (Version 2.0) for the above study. I have had the opportunity to consider the information, ask questions and have had these questions answered satisfactorily.	☐
2.	I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without my medical care and/or legal rights being affected.	☐
3.	I give permission for my personal information (including name, address, date of birth, telephone number and consent form) to be passed to the University of Edinburgh, KEM Hospital Research Centre Pune and/or for administration of the study.	☐
4.	I agree to participate in the focus group discussion/interview	☐
5.	I agree to my interview being audio/video recorded	☐
6.	I agree to my audio/video recorded interview being transcribed by a third party contractor	Yes ☐ No ☐
7.	I am fully aware that the results of this project will be used for scientific purposes and may be published. I agree to this, provided my privacy is guaranteed	Yes ☐ No ☐
8.	I agree to take part in the above study	☐
9.	I understand that relevant sections of data collected during the study may be looked at by individuals from the Sponsor (University of Edinburgh), from regulatory authorities where it is relevant to my taking part in this research. I give permission for these individuals to have access to my data.	☐

Name of Person Giving Consent	Date	Signature

Name of Person Receiving Consent	Date	Signature

1x original – into Site File; 1x copy – to Participant

An NIHR Global Health Research Unit on Respiratory Health (RESPIRE) at the University of Edinburgh project.
www.ed.ac.uk/usher/respire
This research was commissioned by the National Institute of Health Research using Official Development Assistance (ODA) funding. The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health and Social Care.

Appendix 4: Consent form 2

Feasibility of using a teleconsultation facility (Micro-Health Centre -MHC) in management of Chronic Respiratory Diseases in remote rural areas.

Participant Information sheet and consent form

(Patients)

Introduction

Hello. My name is Rutuja Patil. I am a PhD student at University of Edinburgh and work with Vadu Rural Health Program of KEM Health Research Centre, Pune, India. I am inviting you to participate in a study titled "The Feasibility of using a teleconsultation facility (Micro-Health Centre -MHC) in the management of Chronic Respiratory Diseases (CRDs) in a remote rural area". This leaflet provides information about this study. Please feel free to ask if you have any queries/doubts about anything I describe to you.

Why is this study being done?

Respiratory diseases are common and if not treated optimally can result in serious deterioration or death. In many rural communities, specialist expertise is difficult to access. One way this may be overcome is to use new technology to help local doctors from the remote area to consult with experts like respiratory physicians through the internet about more complex problems (sometimes called telehealthcare). However, we don't know whether such a service would be considered helpful by clinical staff or patients, how best it could be used and what would need to be done to set up such a service. I want hear your views on this.

Do I have to take part?

No, it is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If

you decide to take part, you are still free to withdraw at any time and without giving a reason. Deciding not to take part or withdrawing from the study will not affect your legal rights.

What will happen if I take part?

After reading this patient information sheet, you will be given an hour to decide whether or not to participate in this study. The whole study will last about 10-12 months, however your contribution will be for an hour or so. To find out people's views on these issues I wish to interview patients with CRDs, about their perceptions and opinions about the feasibility of using telehealthcare for remote management of CRDs. I will show you story boards which will help you imagine the situation where local doctors could use this technology to consult specialists and ask you some questions. If you later agree to take treatment using teleconsultation, I will ask similar questions after you go through the actual process. This interview will require less than 20-25 min each time.

Potential Risks and Benefits

There is neither risk nor benefit to you by participating in this study There will be no consequences if you decide not to participate in the study or if you wish to stop mid-way through the process. The choice to take part in this study is completely up to you. However, the outcomes of this study are expected to benefit the society at large. The information you give will be very helpful to create evidence to inform national policies to manage CRDs in remote rural areas in India.

What will happen if I don't want to carry on with the study?

Your participation in this study is voluntary. You do not have to be in this study if you do not want to. If you volunteer to be in this study, you may withdraw from it at any time. This means that you will no longer be taking any further active part in the research. However, you will have the option of withdrawal from

(i) all aspects of the study but continued use of data collected up to that point, or

(ii) all aspects of the study with removal of all previously collected data.

What happens when the study is finished?

Data from the study will be archived and may be transmitted outside the country for the purpose of analysis, but your identity will not be revealed at any time. All the consent forms, clinical report forms and questionnaires will be stored in a locked filing cabinet accessible only by the researcher team for 5 years. After this time information will be shredded and disposed in secure bins. The participants will not be identified individually in publications or report writing. Participants are allowed to access their results from the study, if they wish for three months after completion of the study. A summary of final report will be submitted within a year after completion to the study to the Research Ethics Committee and all findings will be notified to the University of Edinburgh.

Confidentiality

The information you provide will be kept safely in a secure environment until end of the study and will contain no information that would allow your name to be linked to specific statements and your records will be stored with a code number rather than by your name. Your name or other private information will not appear when we discuss this study publicly or when we publish the results.

Cost & payment

I am grateful for the time you give in taking part in this study. Your medical diagnosis, treatment and management costs at this KEMH facility will not affected by your participation in the study. It means, you will have to only pay for the KEM Hospital costs as you would have otherwise paid if you were not participating in the study. You will not have to pay anything towards participation in the study

What will happen to the results of the study?

The study results will be presented in reports and published in peer reviewed journal. At times, the results will also be presented in conferences and meetings, however none of your personal information will appear when we discuss this study publicly or when we publish the results.

Who is organising and funding the research?

This study is sponsored by the University of Edinburgh, United Kingdom for this study based in India. This study has been organized by researchers from Vadu Rural Health Program, KEM Hospital Research Centre Pune

Who has reviewed the study?

The study proposal has been submitted for review to the KEM hospital research centre, Ethics committee and ACCORD, University of Edinburgh

What if there are any problems?

If you have any questions or concern about any aspects or your participation in the study, you may feel free to contact my local supervisor Dr Sanjay Juvekar.

If you have questions about this study with someone independent of the study or if you have any questions about your rights as a participant in this study, you may feel free to contact the ethics committee of KEM Hospital Research Centre:

Dr. Sanjay K. Juvekar	Member Secretary, Ethics Committee
Vadu Rural Health Program VRHP	KEM Hospital Research Centre Pune
KEM Hospital Research Centre Pune	Sardar Moodliar Road
Vadu Budruk, Taluka Shirur, Pune 412216	Rasta Peth, Pune – 411011
Tel. +91-9881057959	Tel. no: +91-20-66037339

Complaints:

If you wish to make a complaint about the study please contact:

Dr. Sanjay K. Juvekar	Member Secretary, Ethics Committee
Vadu Rural Health Program VRHP	KEM Hospital Research Centre Pune
KEM Hospital Research Centre Pune	Sardar Moodliar Road
Vadu Budruk, Taluka Shirur, Pune 412216	Rasta Peth, Pune – 411011
Tel. +91-9881057959	Tel. no: +91-20-66037339

Privacy Notice:

The University of Edinburgh is the sponsor for this study based in India. The Sponsor has overall responsibility for the running of the study. To follow the United Kingdom's data protection regulation, we must inform you of how we will use and store your personal data.

As a university, we use personally-identifiable information to conduct research to improve health, care and services. As a publicly-funded organisation, we have to ensure that it is in the public interest when we use personally-identifiable information from people who have agreed to take part in research. This means that when you agree to take part in a research study, we will use your data in the ways needed to conduct and analyse the research study. We will use information from you and/or your clinical records in order to undertake this study. The sponsor will keep identifiable information about you for 5 years after the study has finished.

The University of Edinburgh will act as the data controller for this study. This means that they are responsible for looking after your information and using it properly. Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

Feasibility of using a teleconsultation facility (Micro-Health Centre -MHC) in management of Chronic Respiratory Diseases in remote rural areas.

Consent

(Patients)

Tick/Select where applicable:

1.	I confirm that I have read and understand the information sheet (Version 2.0) for the above study. I have had the opportunity to consider the information, ask questions and have had these questions answered satisfactorily.	☐
2.	I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without my medical care and/or legal rights being affected.	☐
3.	I give permission for the research team to access my medical records for the purposes of this research study	☐
4.	I understand that relevant sections of my medical notes and data collected during the study may be looked at by individuals from the Sponsor (University of Edinburgh), or other regulatory authorities where it is relevant to my taking part in this research. I give permission for these individuals to have access to my data and/or medical records.	☐
5.	I give permission for my personal information (including name, address, date of birth, telephone number and consent form) to be passed to the University of Edinburgh, KEM Hospital Research Centre Pune and/or for administration of the study.	☐
6.	I agree to participate in the discussion/ interview	☐
7.	I agree to my interview being audio/video recorded	Yes ☐ No ☐
8.	I agree to my audio/video recorded interview being transcribed by a third party contractor	Yes ☐ No ☐

9. I am fully aware that the results of this project will be used for scientific purposes and may be published. I agree to this, provided my privacy is guaranteed ☐

10. I agree to take part in the above study ☐

11. I understand that relevant sections of data collected during the study may be looked at by individuals from the Sponsor (University of Edinburgh), from regulatory authorities where it is relevant to my taking part in this research. I give permission for these individuals to have access to my data. ☐

Name of Person Giving Consent	Date	Signature/ Left hand thumb print

Name & Signature of impartial witness *(if participant is unabel to read or write)*	Date	Signature

Name of Person Receiving Consent	Date	Signature

1x original – into Site File; 1x copy – to Participant; 1x copy – into medical record

An NIHR Global Health Research Unit on Respiratory Health (RESPIRE) at the University of Edinburgh project.
www.ed.ac.uk/usher/respire
This research was commissioned by the National Institute of Health Research using Official Development Assistance (ODA) funding.
The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health and Social Care.

Appendix 5: Interview Guide (Opinion Leaders)

Feasibility of using a teleconsultation facility (Micro-Health Centre -MHC) in management of Chronic Respiratory Diseases in remote rural areas.

Guide for conducting Indepth Interview

(Opinion leaders)

Key informant interview number: □□

Interview Location:

_____

Date: _DD_/_MM_/_YY_

Start time: _HH_:_MM_

End time: _HH_:_MM_

Audio recorder ID: _____

Interviewer's Name: _____

Signature: _____

Name/ ID number of Interviewee: _____

Reason for recruitment as Opinion Leader: _____

_____

Establishing a telehealth centre:

- You have established/ were part of _____ centre in _____.
- Your motivation behind it
- Challenges you faced when establishing the centre
  (Probes: Legal, ethical, logistics, technology, human resources, patient perceptions, financial, administrative)
- Factors which facilitated the process of establishment
  (Probes: any personnel, motivation, financial, need)
- Suggestions would you give to an institution which plans to establish a teleheathcare centre

Implementing a telehealth centre:

- How do you run the telehealth centre?
- Number of human resources
- Type of facilities available
- Challenges you face when implementing the current telehealth centre?
  (Probes: Legal, ethical, logistics, technology, human resources, patient perceptions, financial, administrative)
- Experience in acceptability of the telehealthcare by the medical professionals
- Approximate time duration for your team to accept the system
  - Persuasion
  - Other motivations
  - Moral
  - Economical
- Did you feel the need to promote the service?
- Strategies to attract patients to your centre *(Advertisement, word of mouth, any other strategy?)*
- Your experience in acceptability of the telehealthcare by the patients

- Types of patients at this centre *(Pediatric, dermatology, psychiatric, respiratory, gynaecology, other)*
- Characters of patients who use the telehealth centre *(Age, digital literacy, social background, location)*

Chronic Respiratory Diseases (CRD):

(Explain the process for diagnosis and management of CRDs if non-medical or new to CRDs)

- Do you think telehealthcare would be a good solution to manage chronic diseases especially CRDs? Why/ why not?
- Do you think it is a scalable solution for rising CRD burden the country?
- Do you think it is sustainable?

Remote Rural areas?

- What according to you might work better in remote rural system for CRD management? *Doctor to patients consultation or doctor to technician/ nurse consultation or doctor to doctor consultation*
- What are the hurdles do you expect to run a teleheathcare system in remote rural region? *(Roads, internet connectivity, human resources)*
- What are your suggestions for use of telehealthcare system for management of CRD in remote areas?

Do you any questions for me?

Thankyou for your precious time. I will convey the study results to you after completion of the study.

Appendix 6: Interview Guide (Respiratory Physicians)

Feasibility of using a teleconsultation facility (Micro-Health Centre -MHC) in management of Chronic Respiratory Diseases in remote rural areas.

Guide for Indepth Interview

(Respiratory Physicians)

Key informant interview number: □□

Interview Location: _____

Date: _DD_/_MM_/_YY_

Start time: _HH_:_MM_

End time: _HH_:_MM_

Audio recorder ID: _____

Interviewer's Name: _____

Signature: _____

Name/ ID number of Interviewee: _____

Reason for recruitment: _____

_____

Purpose: To understand your views in using telehealthcare for Chronic Respiratory Diseases (CRD) management at remote location

Thankyou for agreeing to respond to this interview. You have been asked to participate as your point of view is important. I realize you are busy and I appreciate your time. I would like to remind you that there are no right or wrong answers

This interview will document your views in using telehealthcare for Chronic Respiratory Diseases (CRD) management at remote location. This activity will take less than an hour and I would like to tape our discussions to recollect it later if you agree (if yes, switch on the recorder).

Introduction:

Hello I am Rutuja Patil and I am here to understand your views in using telehealthcare for Chronic Respiratory Diseases (CRD) management at remote location. Before we start with the interview process, I would like to briefly explain you about the telehealthtcare facility which is based in Women Trainings and Development Centre, Pabal, run by KEMHRC Pune.

(Present the MHC facilities and explain the proposed process flow of teleconsultation.)

Guiding questions

Applicability of diagnostic tools

- In your experience what are the most important chronic respiratory illness in adults in India and in this region? *(probes: Asthma, COPD, Cancer)*
- In your experience what are the most common chronic respiratory illness in adults in India and in this region? *(probes: Asthma, COPD, Cancer)*
- Which are the most common CRDs in our area? *(important vs common)*
- What is the approximate proportion of patients suffering from CRD symptoms with different conditions? (probes: Asthma, COPD, Cancer)

- Can you talk me through how you would go about diagnosing a patient's respiratory condition? *(probes: questionnaire, symptoms, spirometer, other equipment)*
- What according to you is the minimal set-up for diagnosis of CRD? *(probes: questionnaire, symptoms, spirometer, X-ray, diagnostics, other equipment)*
- Who do you think are eligible personnel who are qualified to diagnose CRDs in your absence or in a remote location where you can't travel regularly?
- Do you have any previous experience of teleconsultation?
- If anyone sends the digital reports for your assessment and details of management of CRD through internet application, would that be sufficient to allow you to be able to make a diagnosis?
    - Why or why not?
- If anyone sends the digital reports for your assessment and details of management of CRD through internet application, would that be sufficient to allow you to be able to give advice on how treat the patient?
    - Why do you think so?
- If you feel a teleconsultation was appropriate, what place and time would you prefer to conduct such teleconsultation with the primary physicians? What are your thoughts on real time consultation?
    - The hospital OPD or your private OPD
- Whom would you prefer to communicate with, primary physicians or the patients directly?
- Do you think you require any training from experts in the field to conduct tele-consultations for CRD management? Any other training needs
- Any suggestions to change the existing set up and infrastructure to make the facility more convenient and feasible for CRD diagnosis?

Use of telehealthcare for management of CRD

- Have you used facilities like video calling, skype or similar for any communication?

- Have you used facilities like video calling, skype or similar for giving your clinical opinions to patients or other doctors?
- Do you think the remote diagnose and manage of CRDs using telehealthcare system is a viable idea?
- What support do you expect from the treating primary physican in order to effectively treat patients with CRDs remotely?
- What is your understanding of the patients' attitude to teleconsulting? Will they accept the remote treatment?
- What is your overall perception of using telehealthcare for remote management for CRD management?
- What advantages of teleconsultation do you see over the traditional face to face consultation (probes: travel, time, cost, accessibility)
- Any probable disadvantages?

General:

- Do you think using telehealthcare facility for CRD management is feasible?
- What are your thoughts on telehealthcare as compared to traditional face to face consultation?
- What according to you are advantages of telehealthcare?
- What according to you are advantages of telehealthcare in CRD diagnosis and management?
- Do you think of any disadvantages for using telehealthcare in CRD diagnosis and management?
- What are the barriers of its successful implementation?
- Do you think telehealthcare is a sustainable model for diagnosis and management of CRD?

Concluding questions

- Of all the things we've discussed today, what would you say are the most important issues you would like to express about use of diagnostics tools in

telehealthcare setup for CRD management and overall use of telehealthcare in management of CRDs in remote areas

- Do you have any more thoughts beyond what we have discussed today?
- Thank you for participating. This has been a very successful discussion
- Your opinions will be a valuable asset to the study
- I hope you have found the discussion interesting
- If there is anything you are unhappy with or wish to complain about, please contact my mentor Dr. Sanjay Juvekar or speak to me later
- I would like to remind you that any comments featuring in this report will be anonymous

Appendix 7: Interview Guide (Primary Physician)

Feasibility of using a teleconsultation facility (Micro-Health Centre -MHC) in management of Chronic Respiratory Diseases in remote rural areas.

Guide for conducting Indepth Interview

(Primary Physicians- post teleconsultation)

Key informant interview number: □□

Interview Location:

_____

Date: _DD_/_MM_/_YY_

Start time: _HH_:_MM_

End time: _HH_:_MM_

Audio recorder ID: _____

Interviewer's Name: _____

Signature:_____

Name/ ID number of Interviewee: _____

Reason for recruitment as Opinion Leader _____

_____

Implementing a telehealth centre:

- You have experienced the teleconsultation system
- Your motivation/ reason behind it
- Describe your overall experience

- How do you run the telehealth centre?
- Number of human resources who work with you
- Type of facilities available
- Challenges you face when implementing the current telehealth centre? *(Probes: Legal, ethical, logistics, technology, human resources, patient perceptions, financial, administrative)*
- Approximate time duration for your team to accept the system
- Did you feel the need to promote the service?
- What strategies did you use to attract patients to your centre *(Advertisement, word of mouth, any other strategy?)*
- Your experience in acceptability of the telehealthcare by the patients
- Types of patients at this centre *(Pediatric, dermatology, psychiatric, respiratory, gynaecology, other)*
- Characters of patients who use the telehealth centre *(Age, digital literacy, social background, location)*

Telehealthacre for CRDs:

- What do you consider to be the most important common chronic respiratory illness in adults in India? *(probes: Asthma, COPD, Cancer)*
- Which are the most common CRDs in our area? What do you consider to be the most important CRD?
- Have you treated CRDs during your practice? What was an approximate proportion of patients suffer with CRDs patients who suffered from CRD symptoms?
- How do you diagnose these diseases? *(probes: questionnaire, symptoms, spirometer, other equipment)*
- As per your knowledge, what are the primary techniques/ instruments which required for primary diagnosis and management of CRDs in primary care set-up?

(probes: questionnaire, symptoms, spirometer, X-ray, diagnostics, other equipment)

- How confident are you to read the reports and diagnose?
- Do you think remote support from a respiratory expert, was helpful in diagnosing the CRDs?
- Do you think remote support from a respiratory expert, would be helpful for follow up visits for management of CRDs?
- Will you need any additional training to use instruments for CRD management?
- Do you think these instruments will be maintained well in the current scenario?
- Will you be able to identify the maintenance needs of the equipment and take necessary action to inform the concerned for the maintenance?
- Any suggestions to change the existing set up and infrastructure to make this facility more convenient and feasible for CRD diagnosis

General

- Do you suggest any change to further improve the facility for telehealthcare for CRD management?
- Do you think using such facility for CRD management is a feasible in long run?
- Do you think using such facility for CRD management is a better option? What advantages do you perceive over the traditional method of face to face consultation?
- What according to you are advantages of telehealthcare?
- What according to you are advantages of telehealthcare in CRD diagnosis and management?
- What components of telehealthcare in CRD diagnosis and management are better than the face to face consultation, which you think are facilitating the process?
- Do you see any disadvantages in using telehealthcare in CRD diagnosis and management?
- Do you think telehealthcare is a sustainable model for diagnosis and management of CRD?

- Will this system for CRD management be successful in a long run? Why *(probe: cost, maintenance, human resources, patient flow)*
- What do you think are the barriers to effective implementation of this activity for CRD management?
- What has facilitated the functioning of this centre for CRD management?
- Any more suggestions on to effective implementation of this activity for CRD management

Do you any questions for me? Thankyou for your precious time. I will convey the study results to you after completion of the study.

Appendix 8: FGD Guide (Respiratory Physician)

Feasibility of using a teleconsultation facility (Micro-Health Centre -MHC) in management of Chronic Respiratory Diseases in remote rural areas.

Guide for Focused Group Discussion

(Respiratory Physicians)

Welcome and thank you for volunteering to take part in this focused group discussion. You have been asked to participate as your point of view is important. I realize you are busy and I appreciate your time.

Introduction: This focus group discussion is designed to document and assess your current thoughts and feelings of **using telehealthcare for Chronic Respiratory Diseases (CRD) management at remote location.** This activity will take less than an hour and I would like to tape our discussions to recollect it later if you all agree *(if yes, switch on the recorder)*

Anonymity: I would like to assure you that the discussion will be confidential and anonymised. The recordings will be kept safely in a secure environment until they are transcribed word for word. The transcribed notes of the focus group will contain no information that would allow your name to be linked to specific statements and your records will be stored with a code number rather than by your name. Your name or other private information will not appear when we discuss this study publicly or when we publish the results. Your privacy confidentiality of the information obtained would be protected as required by law.

Expectations from you: You should try to answer and comment as accurately and truthfully as possible. I and the other focus group participants would appreciate it if you

would refrain from discussing the comments of other group members outside the focus group. If there are any questions or discussions that you do not wish to answer or participate in, you do not have to do so; however please try to answer and be as involved as possible.

Ground rules

- The most important rule is that only one person speaks at a time. There may be a temptation to jump in when someone is talking but please wait until they have finished.
- There are no right or wrong answers
- You do not have to speak in any particular order
- When you do have something to say, please do so. There are many of you in the group and it is important that I obtain the views of each of you
- You do not have to agree with the views of other people in the group
- Does anyone have any questions? (answers).
- OK, let's begin

Warm up

First, I'd like everyone to introduce themselves. Can you tell us your name and your educational details?

Introductory question

I am just going to give you a couple of minutes to think about your thoughts on use of telehealthcare for management of CRDs. Can someone please share your experience?

Guiding questions

Applicability of diagnostic tools

- In your experience what are the most important chronic respiratory illness in adults in India and in this region? *(probes: Asthma, COPD, Cancer)*
- In your experience what are the most common chronic respiratory illness in adults in India and in this region? *(probes: Asthma, COPD, Cancer)*

- Which are the most common CRDs in our area? *(important vs common)*
- What is the approximate proportion of patients suffering from CRD symptoms with different conditions? (probes: Asthma, COPD, Cancer)
- Can you talk me through how you would go about diagnosing a patient's respiratory condition? *(probes: questionnaire, symptoms, spirometer, other equipment)*
- What according to you is the minimal set-up for diagnosis of CRD? *(probes: questionnaire, symptoms, spirometer, X-ray, diagnostics, other equipment)*
- Who do you think are eligible personnel who are qualified to diagnose CRDs in your absence or in a remote location where you can't travel regularly?
- Do you have any previous experience of teleconsultation?
- If anyone sends the digital reports for your assessment and details of management of CRD through internet application, would that be sufficient to allow you to be able to make a diagnosis?
    - Why or why not?
- If anyone sends the digital reports for your assessment and details of management of CRD through internet application, would that be sufficient to allow you to be able to give advice on how treat the patient?
    - Why do you think so?
- If you feel a teleconsultation was appropriate, what place and time would you prefer to conduct such teleconsultation with the primary physicians? What are your thoughts on real time consultation?
    - The hospital OPD or your private OPD
- Whom would you prefer to communicate with, primary physicians or the patients directly?
- Do you think you require any training from experts in the field to conduct tele-consultations for CRD management? Any other training needs
- Any suggestions to change the existing set up and infrastructure to make the facility more convenient and feasible for CRD diagnosis?

Use of telehealthcare for management of CRD

- Have you used facilities like video calling, skype or similar for any communication?
- Have you used facilities like video calling, skype or similar for giving your clinical opinions to patients or other doctors?
- Do you think the remote diagnose and manage of CRDs using telehealthcare system is a viable idea?
- What support do you expect from the treating primary physican in order to effectively treat patients with CRDs remotely?
- What is your understanding of the patients' attitude to teleconsulting? Will they accept the remote treatment?
- What is your overall perception of using telehealthcare for remote management for CRD management?
- What advantages of teleconsultation do you see over the traditional face to face consultation (probes: travel, time, cost, accessibility)
- Any probable disadvantages?

General:

- Do you think using telehealthcare facility for CRD management is feasible?
- What are your thoughts on telehealthcare as compared to traditional face to face consultation?
- What according to you are advantages of telehealthcare?
- What according to you are advantages of telehealthcare in CRD diagnosis and management?
- Do you think of any disadvantages for using telehealthcare in CRD diagnosis and management?
- What are the barriers of its successful implementation?
- Do you think telehealthcare is a sustainable model for diagnosis and management of CRD?

Concluding question

- Of all the things we've discussed today, what would you say are the most important issues you would like to express about use of diagnostics tools in telehealthcare setup for CRD management and overall use of telehealthcare in management of CRDs in remote areas
- Do you have any more thoughts beyond what we have discussed today?

Conclusion

- Thank you for participating. This has been a very successful discussion
- Your opinions will be a valuable asset to the study
- We hope you have found the discussion interesting
- If there is anything you are unhappy with or wish to complain about, please contact my mentor Dr. Sanjay Juvekar or speak to me later
- I would like to remind you that any comments featuring in this report will be anonymous

Appendix 9: FGD Guide (Primary Physician)

Feasibility of using a teleconsultation facility (Micro-Health Centre -MHC) in management of Chronic Respiratory Diseases in remote rural areas.

Guide for Focused Group Discussion

(Primary Physicians)

Welcome and thank you for volunteering to take part in this focused group discussion. You have been asked to participate as your point of view is important. I realize you are busy and I appreciate your time.

Introduction: This focus group discussion is designed to document and assess your current thoughts and feelings of **using telehealthcare for Chronic Respiratory Diseases (CRD) management at remote location.** This activity will take less than an hour and I would like to tape our discussions to recollect it later if you all agree *(if yes, switch on the recorder)*

Anonymity: I would like to assure you that the discussion will be confidential and anonymised. The recordings will be kept safely in a secure environment until they are transcribed word for word. The transcribed notes of the focus group will contain no information that would allow your name to be linked to specific statements and your records will be stored with a code number rather than by your name. Your name or other private information will not appear when we discuss this study publicly or when we publish the results. Your privacy confidentiality of the information obtained would be protected as required by law.

Expectations from you: You should try to answer and comment as accurately and truthfully as possible. I and the other focus group participants would appreciate it if you would refrain from discussing the comments of other group members outside the focus group. If there are any questions or discussions that you do not wish to answer or participate in, you do not have to do so; however please try to answer and be as involved as possible.

Ground rules

- The most important rule is that only one person speaks at a time. There may be a temptation to jump in when someone is talking but please wait until they have finished.
- There are no right or wrong answers
- You do not have to speak in any particular order
- When you do have something to say, please do so. There are many of you in the group and it is important that I obtain the views of each of you
- You do not have to agree with the views of other people in the group
- Does anyone have any questions? (answers).
- OK, let's begin

Warm up

First, I'd like everyone to introduce themselves. Can you tell us your name and your educational details?

Introductory question

I am just going to give you a couple of minutes to think about your thoughts on use of telehealthcare for management of CRDs. Can someone please share your experience?

Guiding questions

Applicability of diagnostic tools

- What do you consider to be the most important common chronic respiratory illness in adults in India? *(probes: Asthma, COPD, Cancer)*

- Which are the most common CRDs in our area? What do you consider to be the most important CRD?
- Have you treated CRDs during your practice? What was an approximate proportion of patients suffer with CRDs patients who suffered from CRD symptoms?
- How do you diagnose these diseases? *(probes: questionnaire, symptoms, spirometer, other equipment)*
- As per your knowledge, what are the primary techniques/ instruments which required for primary diagnosis and management of CRDs in primary care set-up? *(probes: questionnaire, symptoms, spirometer, X-ray, diagnostics, other equipment)*
- If the required equipment are provided to you how confident are you to read the reports and diagnose?
- Do you think remote support from a respiratory expert, would be helpful in diagnosing the CRDs?
- Do you think remote support from a respiratory expert, would be helpful for follow up visits for management of CRDs?
- Will you need any training to use such instruments for CRD management?
- Do you think these instruments will be maintained well in the current scenario?
- Will you be able to identify the maintenance needs of the equipment and take necessary action to inform the concerned for the maintenance?
- Any training needs for using telehealthcare system based on your previous experience.
- Any suggestions to change the existing set up and infrastructure to make this facility more convenient and feasible for CRD diagnosis

Use of telehealthcare for management of CRD

- Have you used any telehealthcare system previously?
- Have you used facilities like video calling, skype or similar for any communication?

- Have you used facilities like video calling, skype or similar for getting opinions from other doctors?
- Will you require any support from respiratory physicians to effectively treat patients with CRDs?
- Do you think the respiratory physicians at remote location will support you to diagnose and manage CRDs using telehealthcare system?
- Do you think that you could approach a respiratory physician using a telehealthcare system for treating patients who come to our centre?
- What is your understanding of the patient mindset? Will they accept the remote treatment?
- What is your overall perception of using remote management for CRD management?

General:

- Do you suggest any change to improve the facility for telehealthcare for CRD management?
- Do you think using such facility for CRD management is a feasible?
- Do you think using such facility for CRD management is a better option? What advantages do you perceive over the traditional method of face to face consultation?
- What according to you are advantages of telehealthcare?
- What according to you are advantages of telehealthcare in CRD diagnosis and management?
- What components of telehealthcare in CRD diagnosis and management are better than the face to face consultation, which you think are facilitating the process?
- Do you see any disadvantages in using telehealthcare in CRD diagnosis and management?
- Do you think telehealthcare is a sustainable model for diagnosis and management of CRD?

- Will this system for CRD management be successful in a long run? Why *(probe: cost, maintenance, human resources, patient flow)*
- What do you think are the barriers to effective implementation of this activity for CRD management?
- What has facilitated the functioning of this centre for CRD management?
- Any more suggestions on to effective implementation of this activity for CRD management

Concluding question

- Of all the things we've discussed today, what would you say are the most important issues you would like to express about use of diagnostics tools in telehealthcare setup for CRD management and overall use of telehealthcare in management of CRDs in remote areas
- Does anyone want to add any other thoughts on this issue which were not discussed today?

Conclusion

- Thank you for participating. This has been a very successful discussion
- Your opinions will be a valuable asset to the study
- We hope you have found the discussion interesting
- If there is anything you are unhappy with or wish to complain about, please contact my mentor Dr. Sanjay Juvekar or speak to me later
- I would like to remind you that any comments featuring in this report will be anonymous
- Before you leave, please hand in your completed personal details questionnaire

Appendix 10: Structured Questionnaire (Patients)

Feasibility of using a teleconsultation facility (Micro-Health Centre -MHC) in management of Chronic Respiratory Diseases in remote rural areas.

Guide for conducting Semi-structured Interview

(Patients)

At Baseline only:

1	Name	
2	Study ID	
3	Date of Birth/ Age	__/__/____
4	Gender	Male/ Female
5	Village name	
6	Address	
7	Contact number	
8	Education	a. No formal education b. Primary c. Secondary d. Higher secondary e. Graduate f. Post Graduate g. Other _____
9	Occupation	_____
10	Respiratory symptom/s	

11	Reason/s for attending the clinic	
12	Do you own a smart phone?	Yes/ No
13	Do you use any type of technology on day to day basis?	Yes/ No
14	Have you used any type of video calling, skype or similar for any communication?	Yes/ No If Yes mention _____ If No skip 15
15	What are your thoughts on video calling? (probes: convenience/ realistic/ cost)	
16	How often do you consult a doctor for your _____ *(mention the issue as answered in Q11)*	

At Baseline and after use of teleconsultation:

Please answer below questions on the scale of 5 (1 is the lowest and 5 being the highest). If you do not have any opinion on the respective question please leave it blank.			
		Before	After
17	How reliable do you think this process is? भारोश्याची	1 2 3 4 5	1 2 3 4 5
18	How effective do you think telehealth consultation is? परिणामकारक	1 2 3 4 5	1 2 3 4 5

19	How confident do you feel to receive treatment for your CRD using teleconsultation? विश्वास	1 2 3 4 5	1 2 3 4 5
20	How convenient as per you this process is? सोयीचे	1 2 3 4 5	1 2 3 4 5
21	How cost effective, do you think this process is? आर्थिक रित्या परिणामकारक	1 2 3 4 5	1 2 3 4 5
22	How time saving is this process for you? वेळ वाचवते	1 2 3 4 5	1 2 3 4 5
23	How efficient is this process for you? कार्यक्षम	1 2 3 4 5	1 2 3 4 5
24	Are you further willing to take treatment using teleconsultation?	a. Yes b. No c. Not sure	NA

25. Can you please tell me your thoughts on the overall teleconsultation process?

Before:_____ After:_____

_____ _____

_____ _____

_____ _____

_____ _____

_____

26. Do you have any doubts about the process? If yes what?

Before:_____ After:_____

_____ _____

_____ _____

_____ _____

_____ _____

_____

27. What according to you will be an added value to the process of treating your respiratory condition at this telehealth centre?

Before:_____

_____ After:_____

_____ _____

_____ _____

_____ _____

_____ _____

Doctors notes:

28	Telehealthcare opted	Yes/ No
29	Specialist Name	
30	Consultation Time	_____:_____ to _____:_____
31	Complaints	
32	Diagnosis by Primary Physician	
33	Diagnosis by Consultant	
34	Treatment suggested by Consultant	
35	Investigations informed if any	
36	Follow up suggested	Yes/ No
37	Date	____/____/_____