Towards Intermediated Workflows for Hybrid Telemedicine

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ABSTRACT

The growing platformization of health has spurred new avenues for healthcare access and reinvigorated telemedicine as a viable pathway to care. Telemedicine adoption during the COVID-19 pandemic has surfaced barriers to patient-centered care that call for attention. Our work extends current Human-Computer Interaction (HCI) research on telemedicine and the challenges to remote care, and investigates the scope for enhancing remote care seeking and provision through telemedicine workflows involving intermediation. Our study, focused on the urban Indian context, involved providing doctors with videos of remote clinical examinations to aid in telemedicine. We present a qualitative evaluation of this modified telemedicine experience, highlighting how workflows involving intermediation could bridge existing gaps in telemedicine, and how their acceptance among doctors could shift interaction dynamics between doctors and patients. We conclude by discussing the implications of such telemedicine workflows on patient-centered care and the future of care work.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in HCI**.

KEYWORDS

Telehealth, telemedicine, future of work, hybrid work, remote care, care work

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1 INTRODUCTION

Telemedicine is increasingly being viewed as a viable pathway to care, spurred by the growing *platformization* of health (*e.g.,* [58, 90]). Digital platforms are gradually serving as one-stop solutions for all healthcare-related needs—like consultations with doctors, the purchase and delivery of medications, and at-home blood sample collection—in tandem with the broader shift to hybrid and remote work environments as a consequence of the COVID-19 pandemic. Extensive prior research has examined and unpacked the affordances and promises of telemedicine—such as remote specialized care delivery [20, 27, 74], reduced logistical overhead [78], and lowered costs of care [11]. Simultaneously, it has also uncovered the causes for its relegation to the peripheries of healthcare infrastructures over time—*e.g.,* the inability to perform physical examinations that render telediagnosis infeasible [8], regulatory restrictions around prescriptions [34], and sociotechnical and cultural barriers to adoption [14]. Our work aligns with and augments emerging Human-Computer Interaction (HCI) research on the renewed interest in telemedicine following the relative successes of the infrastructuring work during the pandemic [8, 82].

HCI research has probed a variety of approaches towards facilitating quality healthcare through telemedicine. Prior work has investigated the adoption of communication technologies (*e.g.,* [1, 31]) and designs of mobile technologies (*e.g.,* [6, 35, 96, 106]) towards enabling better patient-doctor interactions, as well as potential avenues for patient empowerment in such caregiving interactions through technologies (*e.g.,* [67, 81]). This body of work has simultaneously been on the quest for design and technological interventions that aspire towards enabling patient-centered care (*e.g.,* [22, 42, 68]). On that front, scholars have underscored the role of intermediaries in patient-centered care—frequently executed by family members and "trusted others" (*e.g.,* [9, 17, 29, 65, 80])—emphasizing their importance in enabling ecologies of care. Our research takes inspiration from this body of work, and seeks to evaluate how telemedicine could similarly be brought closer to patient-centered care. We question how workflows involving intermediation might help overcome some known sociotechnical barriers impacting patient-doctor interactions in telemedicine. We pose the following research question: *"How does a telemedicine workflow involving intermediation impact and alter the healthcare-seeking and -providing experiences of patients and doctors?"*

Our research is situated in the urban Indian healthcare context, where we introduce intermediation into telemedicine workflows for ear-related health conditions. Ear conditions are an exemplar for the limitations of current telemedicine technologies: doctors' physical examinations typically include an otoscopy[1] that is not supported in current teleconsultations. In our study, we focused on how patients' and doctors' experiences with telemedicine could be enhanced through the adoption of a telemedicine workflow involving intermediation—where third-party individuals were tasked with following instructions to capture videos of a patient's ear with potential to aid in patient-doctor interactions. Our primary objective was to uncover how such new workflows to facilitate teleconsultations could impact patients' and doctors' care experiences. Any such workflow would, of course, involve at least three key stakeholders: the patients receiving care, the doctors providing professional care, and the intermediaries facilitating these interactions. We focus our study on the acceptability of such workflows among doctors and patients. We facilitated a total of 27 intermediated teleconsultations across 9 doctors. Drawing on field notes and semi-structured interviews with 9 doctors and 6 patients, our analysis uncovered what existing gaps in telemedicine could be sufficiently bridged by workflows involving intermediation, doctors' changing perceptions of care work across different modalities (teleconsultation and in-person) of care delivery, and the sociocultural factors that affected how workflows involving intermediation could be incorporated into ecologies of care. Throughout this paper, we use "telemedicine" to refer to the broader practice of remote care through digital technologies, and "teleconsultations" to specifically refer to a synchronous interaction between patients and doctors.

Our contributions to HCI are threefold. First, we contribute an empirical evaluation of a new telemedicine workflow involving intermediation in patient-doctor interactions, examining how it could enable patient-centered telemedicine. Second, we enrich a growing body of HCI research on the future of care work, unpacking emergent perceptions around (intermediated) telemedicine and its positioning in healthcare infrastructures. Finally, we present design recommendations and design futures for augmenting telemedicine through intermediation.

2 RELATED WORK

We situate our work within current discourse on the advances in telemedicine and telehealth within HCI and medical domains. Given our focus on health conditions affecting the ear (treated by ENT—Ear, Nose and Throat—specialists) in India, we direct focus towards the research on telemedicine for ENT, and prior telemedicine adoptions, successes, and failures in India. We then present how our work extends prior HCI research on intermediated telemedicine.

2.1 Changing Narratives around Telemedicine and ENT Care

For several decades, telemedicine has been touted as a means for healthcare delivery to remote regions of the world through telecommunication technologies [74]. Primary use cases included healthcare provision to regions that had shortages of healthcare providers [74], healthcare provision to remote, rural areas [21], and other instances where access to healthcare providers was not consistent [45]. The overarching benefit of telemedicine stemmed from access to healthcare professionals and specialists in real-time, unconstrained by geographical and logistical barriers [23]. Additional benefits to telemedicine have included reduced travel and wait times [78, 95], and lower expenses overall on care seeking [11].

Since its origin, telemedicine growth around the world has varied, influenced in part by differences in human, technological, and physical infrastructures. In many parts of the Global North, telemedicine has increasingly been perceived as complementary to physical healthcare, providing patients a choice of modality of treatment. This is particularly true in fields of medicine like dermatology and physiotherapy where years of research and development have made telemedicine a viable alternative [101]. Current conversations in medical literature has focused on the challenges associated with formalizing telemedicine within healthcare infrastructures, exploring how insurance providers play a role in care provision [108], on improving electronic health record usage in telemedicine [32], and evaluating the causes for abandonment or non-adoption of telemedicine technologies [39]. Some of the identified barriers have been centered around the perceived differences between 'traditional' physical consultations and teleconsultations, including the need for organizational workarounds to facilitate video interactions [39], and the inability to support social, informal interactions between patients, doctors, and technologies [38].

ENT researchers and healthcare practitioners have noted the promise for telemedicine to support in-person consultations for many decades now. Early research on the potentials for telemedicine in ENT had posited that store-and-forward ear-related health data collection—images of the eardrum, audiograms, patients' clinical history, and laboratory data—at remote sites by primary care providers could save time for ENT specialists and patients in care delivery. Past research had noted statistically significant agreements in: observations and diagnoses between in-person consultations and teleconsultations [10, 28], and predicting the need for surgery based on in-person consultations and teleconsultations [53]—where the remote doctors had access to patients' clinical histories, images of eardrums, and audiograms. In the past decade, the availability of portable, smart otoscopes—coinciding with wider internet connectivity and stronger technological infrastructures—has returned attention to telemedicine as a viable option for diagnostic ENT consultations [72]. One retrospective cohort study found that ear-related conditions—particularly concerning the middle ear and eardrum—could have been diagnosed and treated through telemedicine with the technologies available at the time [59]. Other studies looked into the viability of smart low-cost otoscopes—that could connect to smartphones and transmit images and videos—as remote diagnostic devices, finding that their reliability in telemedicine depended heavily on the training of the user in using the device [24] and their medical knowledge [91].

In resource-constrained healthcare contexts in the Global South, however, telemedicine sometimes serves as the primary access to healthcare [20], and also increases the accessibility of quality healthcare to rural and other particularly under-resourced regions [27] while lowering costs associated with care [61, 107]. Previous telemedicine deployments have leveraged countries' information

[1]A physical examination of the internal structure of the ear including the outer ear, ear canal, and eardrum, performed using a small, handheld otoscope device [30]

and communication technology infrastructures towards delivering remote care, noting sociocultural and political challenges towards the same [20]. The Apollo project was among the first telemedicine rollouts in India, intended to deliver specialized healthcare to remote regions of the country. It saw initial promise and success, with later research identifying crucial shortcomings (*e.g.,* [16, 19, 36]). Increasingly since, telemedicine has been pushed to the peripheries of the Indian healthcare system. Unpacking this transition, researchers analyzed telemedicine experiences by observing more than fifty teleconsultations, finding how they differed from in-person consultations and why the latter was considered a better experience, as well as proposing where telemedicine could still be successfully employed in India [12]. Examining telemedicine infrastructures further, prior research has highlighted the human infrastructures that support telemedicine deployments in rural regions of India, and their crucial role in last-mile care delivery [14]. A key consideration across all these works is the high value placed on non-verbal, relational, and emotional aspects of in-person consultations that do not translate to telemedicine due to sociotechnical and cultural barriers. These have served to marginalize telemedicine as the last resort of the rural and the underserved, while in-person care forms the preferred modality of care delivery.

The onset of the COVID-19 pandemic has disrupted the healthcare infrastructures around the world, and resurfaced conversations about the viability of telemedicine as a realistic alternative to in-person care. In India, pandemic-related effects included delayed access to chronic disease care [71], and intense strains on limited healthcare resources [2]. The technology landscape—with widespread access to cheap smartphones and mobile internet—however, had shifted significantly in the years since the early deployments and failures of telemedicine. It allowed for renewed debates about the potential for telemedicine to form new avenues to healthcare provision that leveraged technology access across socioeconomic, cultural, and geographic boundaries (*e.g.,* [49, 66, 86]). We situate our research in this environment, where the shift in sentiment towards adopting telemedicine more broadly has surfaced questions about its sociotechnical viability and research into how people create workflows that allow for broader adoption [8, 82].

2.2 Telemedicine and Remote Care in HCI

Telemedicine and its various related fields—telehealth, e-Health, mHealth—have been topics of research in the HCI community for decades. Research focus has spanned the adoption of various communication technologies for healthcare over a distance (*e.g.,* [1, 31]), the design of mobile technologies (*e.g.,* [6, 35, 96, 106]) and online communities (*e.g.,* [50, 110]) for health, and the growth of technology interventions for self-care (*e.g.,* [26, 83]), health tracking (*e.g.,* [18, 109]), and patient empowerment through information provision (*e.g.,* [67, 81]). This body of work has contributed immensely to a growing area of research within the CHI community around design implications, users' situated needs, and other sociotechnical aspects of telemedicine. In this section, we focus on two domains in particular: (1) the design of sociotechnical systems for, and (2) the role of intermediaries in, telemedicine and remote care.

Design of sociotechnical systems for telemedicine and remote care. Early HCI research into sociotechnical systems for telemedicine looked into how audiovisual assemblages, as facilitators of telemedicine, were used by doctors during surgery, noting how shifts in technology usage and work practice went hand-in-hand [1]. Building on this work, HCI scholarship focused on the design of collaborative surgical telemedicine interventions [62–64]. Prior studies have since centered patients' and doctors' experiences with telemedicine in clinical interactions—specifically out-patient consultations—showcasing the designs of technologies for better verbal [5] and non-verbal communication during teleconsultations [31] through real-time feedback to doctors. These works highlighted how doctors less experienced in teleconsultations focused more on clinical histories, and less on non-verbal cues [31]. More recent work has investigated the role of wearable sensor technologies to complement verbal and non-verbal cues during remote physiotherapy sessions in real-time. This work found that visualizations from sensor data provided crucial information to the therapist, and also allowed for collaborative reflection on the sessions [4]. Longer term pilot studies of teleconsultation systems found that they showed promise by overcoming several known challenges to in-person consultations, but were constrained by doctors disinclined towards their adoption even though patients were generally positive about the uptake in their study [103].

Role of intermediaries in telemedicine and remote care. HCI research has examined different ways for broadening technology access among historically marginalized populations, with intermediated use of technologies showing promise and adoption [87]. A growing body of HCI research in the past decade has looked into intermediated use of information and communication technologies (ICTs) as a workaround to problems related to healthcare access in the Global South (*e.g.,* [25, 92, 98]). Prior work in India had identified community health workers (CHWs) as suitable intermediaries to assist in telemedicine and healthcare provision. Early researchers worked with Accredited Social Health Activists and anganwadi workers as intermediaries in providing mobile-based maternal health education to rural women [85], in an effort to persuade them to access the formal health services available to them [84]. Similarly, researchers evaluated how intermediaries—community nutrition educators—used a mobile data collection platform towards improving prevalent paper-based health data management practices [60]. Subsequent research took on participatory approaches to intermediated health education, employing mobile phones and participatory videography to encourage community members' involvement in health outreach [54, 55].

In our research, we bring together insights from this diverse body of work. We take telemedicine practices in ENT that have been found to show promise in other cultural and geographic contexts (*e.g.,* [53, 72]), and investigate their acceptance in the Indian healthcare context. We adopted a workflow involving intermediation to telemedicine in ENT drawing on prior feasibility studies that had identified how intermediated approaches to remote healthcare—*e.g.,* screening for ENT-related conditions through trained CHWs had shown promise [40]. We leveraged doctors' and patients' forced exposure to telemedicine due to the pandemic to investigate how intermediated telemedicine could overcome challenges or introduce new challenges to their patient treatment practices [8, 82]. In doing so, we intended to uncover both the technological and medical feasibility of intermediated telemedicine workflows in India, and also

the sociocultural factors that could influence patients' and doctors' sentiments towards these new practices.

3 METHODS

We now detail our study design, including how we recruited patients and doctors, how we facilitated the intermediated teleconsultations, and the data collection and analysis methods we used. Our study received Institutional Review Board approval from Microsoft Research and took place between May and August 2022.

3.1 Study Design

The primary goal of our study was to understand if and how workflows involving intermediation—referred to as "intermediated workflows" henceforth—could overcome previously identified technical barriers to telemedicine adoption. We started with the understanding that one of the primary barriers, despite the recent growth in acceptability and prevalence, was the lack of support for doctors to perform physical examinations beyond what was possible through audio or video calls, diagnostic tests, and external photography of the body. We wanted to uncover the potential for telemedicine workflows where intermediaries could help collect certain physical examination data on behalf of doctors, to understand if that would improve the teleconsultation experience for patients and doctors.

The specifics of the intermediated workflow were determined by the context of our study: ear-related health conditions within the ENT specialization. Prior health research, summarized in the previous section, had posited that telemedicine could be a viable option for ear-related conditions if the physical examination barrier could be overcome. Based on our preliminary interactions with ENT specialists, and an evaluation of the devices that could be adapted towards this goal, we chose to investigate whether ear-related conditions could be diagnosed and treated through intermediated workflows. So, we recruited nine ENT specialists to provide synchronous teleconsultations—supported by the intermediated workflows—for patients with ear-related health conditions. In total, we facilitated 27 such intermediated teleconsultations. For each patient, we provided the doctors with a video of the patient's ear—captured through a procedure called otoscopy—in lieu of a physical examination. Following these consultations, we conducted semi-structured interviews with six patients and nine doctors, to understand how their experiences with the intermediated teleconsultations compared to their regular in-person consultations and any prior teleconsultation experiences. Next, we present the details of participant recruitment and the teleconsultation workflow.

3.1.1 Participant Recruitment: Patients. We recruited patients from two separate outpatient clinics in Bangalore, a city in the state of Karnataka in southern India. One clinic was at a Government-run university hospital, and another in a private multi-speciality hospital. In June–July 2022, we presented our proposed study to the hospitals' managements, iterated on them, and received approvals to recruit patients in their outpatient clinics. With approvals from both hospitals, we commenced the study that lasted four weeks in July–August 2022. During this period, the first author was present in one of the clinics for 3–6 hours a day, four days a week, observing the workings of the clinic, recruiting patients, and facilitating intermediated teleconsultations. In recruiting patients, we worked closely with the doctors, senior residents, and post-graduate medical students—whom we will collectively refer to as 'clinicians' in this section. We informed the clinicians of the goals of study as well as our inclusion and exclusion criteria, which were that:

(1) The patient must be over 18 years of age.
(2) The patient must have an ear-related symptom or complaint.
(3) The patient must not have a health condition that puts them in the way of potential harm (exacerbation or complication of health condition and/or pain) by having an otoscopy done.

Once appraised of the study and clear about its objectives and recruitment criteria, the clinicians took on the responsibility of identifying patients—among the patients who consulted them—that met our inclusion and exclusion criteria. That is, the clinicians identified patients for inclusion in the study *after* the patient had already received in-person consultation with them. We designed the study this way to ensure that the patients were not placed at undue risk of worsening their health condition on account of participating in our study, and the patients received the care that they were seeking first before we approached them to be a part of our research study.

Once patients were identified for inclusion, the researcher informed the patient about the study and what was expected of them, and sought their informed consent for participation. We informed them that their participation would involve a second free teleconsultation with a different doctor. As part of this teleconsultation, a research assistant would collect a video of their ear including the outside and inside of their ear with the ear drum visible and share the video with the doctor performing the teleconsultation. We asked the patients to treat this teleconsultation as a second opinion (a common practice in the region as reported in prior research (*e.g.,* [8, 9])). The patients were not compensated for their participation in the teleconsultations. In total, across the two hospitals, clinicians identified 33 potential participants, and we recruited all 27 consenting patients for the study. Demographic details of these patients are available in Table 1.

3.1.2 Participant Recruitment: Doctors. We recruited doctors via our personal, social, and professional networks. In total, we reached out to 14 ENT doctors across the state of Karnataka, and recruited 9 doctors to conduct teleconsultations with the patients. We primarily reached out to doctors from Karnataka to ensure that their preferred languages aligned with the preferred languages of the recruited patients. All doctors who participated in the study were informed of the study design and that they would be treating patients with real health conditions. All doctors had some prior experiences with teleconsultations having adopted the practice during the COVID-19 pandemic. None of the doctors had prior experience with intermediated teleconsultations of this nature. Consequently, we asked each doctor to conduct three or more intermediated teleconsultations as a part of their participation in the study. We did this to account for any novelty or learning-related biases that could affect their experiences with incorporating the videos in their teleconsultations. However, given time constraints and difficulties with recruiting participants at times when D7 and D9 were available to teleconsult with patients—religious holidays, severe weather conditions—they only consulted with two patients each. The doctors were informed that the videos would be captured by individuals with minimal

Table 1: Patient Demographics
(Conversion rate: USD 1 = INR 79)

	Age (in years)	Monthly Income (in INR)	Length of Teleconsultation (in minutes)	Location of Residence	Gender (self-reported)
Mean	39.44	19333	3.40	Bangalore, KA (24)	Woman (14)
Range	18 - 66	5000 - 50000 (3 participants preferred not to answer)	2 - 8	Gulbarga, KA (1) Mulbagal, KA (1) Vishakapatnam, AP (1) Urban (24), Rural (3)	Man (13)

training in using a portable otoscope, in order to reduce implicit biases and expectations around the quality of the videos. Details about the doctor participants are available in Table 2.

3.1.3 Intermediated Teleconsultation Workflow. Our teleconsultation workflow involved three stages. The first stage involved training intermediaries to capture images and videos of the ear. We took the help of research assistants—*e.g.,* undergraduate medical students and nurses who were working in these clinics and were informed about the goals of study—to serve as intermediaries and conduct otoscopies and capture these videos. We used a commercially available, low-cost, portable otoscope[2] that was paired with a research smartphone such that the images and videos could be stored automatically on the smartphone. The research assistants were given verbal instructions of how to capture images and videos. They were to capture a video including the front of the ear, the back of the ear, the pinna, the ear canal, and the ear drum. To supplement this understanding, they were shown a pre-recorded video of a sample otoscopy conducted by an ENT specialist (one of the authors) highlighting the key components of the ear, as well as how to safely navigate the otoscope. Figure 1(a), 1(b), and 1(c) depict the contents of this video. Figure 1(d) contains an example of an infected eardrum. They were then given the time to test out the device on members of the research team to learn to use it.

The second stage of the workflow involved capturing images and videos of patients' ears. Following patients' informed consent as described above, the research assistants proceeded to use the otoscope and capture a video of each recruited patient's affected ear. All captured media was stored on the research smartphone device and provided to the patients if they chose to keep them for their records. This otoscopy was performed in a private area of the waiting room of the clinics of the doctors the patient consulted with in-person. Each otoscopy video that was captured and saved only contained the patient's external ear and ear canal, and did not capture any other identifiable parts of the patients' faces or bodies.

The final stage of the workflow was the teleconsultation. These videos were then sent, via WhatsApp on the research device, to the doctors who would conduct the teleconsultation. Once the doctors indicated that they were free and ready to consult with the patient (within five minutes of the otoscopy), the research team video called the doctor, via WhatsApp on the same device, and handed the smartphone to the patient to have the consultation. We chose this medium because all patients were proficient in using WhatsApp for messaging and calling, and all doctors indicated that they had conducted teleconsultations over WhatsApp in the past. Further, prior research had also recognized how WhatsApp was being leveraged towards teleconsultations in the Indian healthcare context [8], indicating general acceptance of this medium. No researcher was within earshot of the patient during the teleconsultation, and the patient handed over the smartphone to the researcher at the conclusion of the consultation.

3.2 Data Collection and Analysis

During the patient recruitment and teleconsultation phase, the first author maintained handwritten notes documenting observations from clinicians' work practices, the functioning of the outpatient clinic, the interactions between the research assistants and patients, and other details informing an understanding of the context of study. Following each teleconsultation, we conducted a brief demographic and follow-up questionnaire with patients where we collected the optional demographic information presented in Table 1, and a brief reflection of the differences between the care provided by the clinician and the teleconsultation doctor.

The images and videos collected to facilitate the teleconsultations were stored on a research smartphone. No unauthorized individuals had access to this content at any time, and the smartphone was only ever handled by IRB-approved individuals on the research team. The media were shared with the doctors at the time of the consultations with patients' consent. Our research data storage and handling process followed IRB-approved best practices, as India did not have established health data privacy regulations.

We reached out to eight patients for semi-structured interviews based on their responses to the follow-up questionnaire, and interviewed six patients who consented to further participate in the study. These interviews lasted between 15 and 25 minutes, and the patient participants were compensated INR 200 (USD 2.50) for their involvement in this stage of the study. These interviews were primarily in Kannada—the local language of the region—and one was in English, and were audio-recorded. Once each doctor completed

[2]We used the Portronics Cleansify https://www.portronics.com/products/cleansify as an otoscope. It works with the 'Bebird' app that allows for recording and sharing images/videos captured by the device.

Table 2: Doctor Demographics and Teleconsult Details
Note: The platforms listed in the 'Teleconsultation Platforms' column are general purpose, and not specific to the ENT specialization.

ID	Gender	Experience (in years)	In-Person Consult (last week)	Teleconsult (last week)	Teleconsultation Platforms	Location	Patients (our study)
1	F	6	40	40	Apollo, MediBuddy, Practo	Bangalore	4
2	M	12	70	150	MediBuddy, Practo	Bangalore	3
3	F	21	65	3	Hospital's own platform	Mangalore	4
4	F	16	50	8	Practo	Mangalore	3
5	F	12	45	1	FaceTime, WhatsApp	Mangalore	3
6	F	12	100	4	WhatsApp	Bangalore	3
7	M	16	200	0	mFine, Practo	Bangalore	2
8	F	9	50	3	WhatsApp	Bangalore	3
9	M	24	50	0	N/A	Bangalore	2

their scheduled teleconsultations, we conducted semi-structured interviews with them within a day of their final teleconsultation. These interviews lasted between 30 and 60 minutes, and the doctors were compensated INR 2500 (USD 31.50) for their participation in the interviews (loosely based on teleconsultation hourly rates). We stopped recruiting more doctors when we achieved saturation in our interview data. The doctor interviews were all conducted in English and were audio-recorded.

Our interviews with patients focused on the differences in their experiences in consulting with doctors in-person and through teleconsultation, their experiences with having intermediaries conduct the recorded examination, and their expectations around telemedicine in the future. Our interviews with doctors focused on their experiences with providing teleconsultations that have the videos as supporting evidence, how these intermediated teleconsultations compared to their regular teleconsultations, and what shortcomings or challenges they faced in the intermediated teleconsultations. Our final set of questions was around their thoughts on individuals such as community health workers, gig workers, and pharmacists serving as intermediaries in teleconsultations.

The first author (fluent in Kannada and English) conducted all interviews for this study, and translated and transcribed all interviews into English soon after they were conducted. This author also drafted memos [15] summarizing *in situ* observations and insights during fieldwork in the research sites, and informing both our understanding of current practices, as well as in identifying topics to probe in future research activities. All authors periodically discussed the observations and recent interviews to identify emerging themes of interest. In analysing the interview transcripts, we used an inductive coding approach and noted emergent themes. The first author open-coded all interviews line-by-line in the first iteration. All authors then discussed these codes to identify interesting themes in the data. At this stage, we incorporated ideas emerging from the memos as themes to investigate going forward. We iterated on these themes to identify higher level themes (like "bridging the gap", "diagnosis but not care", and "shifting the power") that we present in our findings below.

3.3 Positionality

All authors are of Indian origin: three authors currently reside in India, and the rest spend considerable time conducting research in India. One author is a practising ENT surgeon, and was involved in the design of the study and research questions, training the intermediaries in the otoscopy procedure, and ensuring that any risk of harm to the patients was mitigated. Three authors have a background in HCI. We approached this research drawing on our individual learnings from working at the intersection of computing and healthcare in the Indian context. Our interest in making telemedicine and specialized healthcare more accessible to the masses has informed this study design and shaped our data analysis.

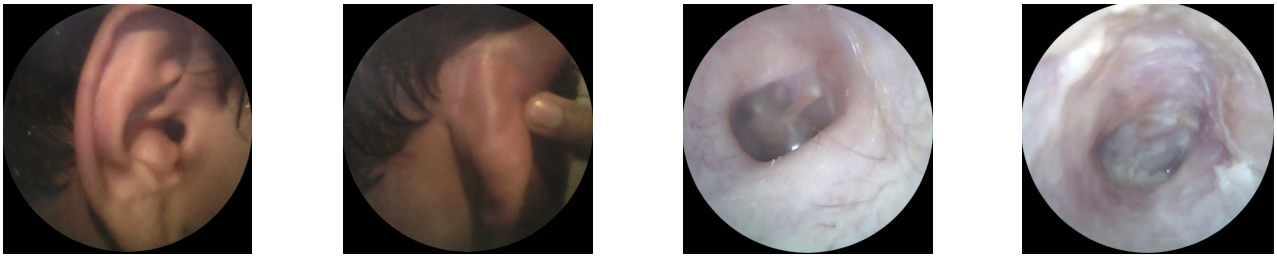
4 FINDINGS

In this section, we first present how intermediated workflows overcame some known barriers to telemedicine and where it met resistance. Next, we unpack doctors' care work to analyze how the modality of patient-doctor interactions influenced their caregiving practices. Finally, we bring critical focus to the role that intermediation could play in existing patient-doctor interaction practices.

4.1 Bridging Gaps in Telemedicine

Several gaps in telemedicine practice have been apparent to researchers and practitioners in the decades since it was introduced as a mode of healthcare provision (*e.g.,* [8, 38, 39]) Our related work section highlights some of the major shortcomings. In this section, we present findings around intermediated telemedicine workflows to potentially bridge some of the existing gaps. We further contribute additional nuance to discussions around the gaps that persist with intermediated telemedicine, serving as potential avenues for future research.

4.1.1 Physical Examinations. One of the primary limitations of current telemedicine practices is the inability for doctors to physically examine their patients. With patients not being in the physical presence of any doctor at the time of consultation, doctors rely heavily on patient-provided medical history to come to any understanding of the patient's health condition—as identified by prior health and HCI research [8, 38, 39]. Bridging this examination gap, therefore,



(a) Frontal view of the ear **(b) Posterior view the ear** **(c) A healthy eardrum** **(d) An infected eardrum**

Figure 1: Example Images Captured through Otoscopy

involved providing doctors with more information that would serve as a proxy for their own physical examinations. D4 described the differences as:

> "Usually what happens is, in teleconsultation, most of the time it is only the patient showing the ear. So they will show only the exterior part of the ear… So whatever [video] you showed me, it could make sense for me. Because you showed me the pinna, as well as the posterior part, the anterior part, and then you went inside the external auditory canal. So it was as good as oto-endoscopy… The clarity was good… It was neither too magnified, nor very normal. The lighting was good, you could see the tympanic membrane very well." (D4)

An added benefit of having this examination data was that it enabled doctors to ask more probing questions to patients, obtaining a more accurate clinical history as a result. The doctors noted that they previously relied on patients' caregivers and other family members, where possible during teleconsultations, to supplement the patients' medical history. They stated that such an approach still carried elements of unreliability. Using one of the intermediated consultations as an example, D5 pointed out that the gender and relationship dynamics within the family affected her ability to collect accurate history, where the husband would drown out the wife—also the patient: *"He didn't let me talk to her, because he said 'she's getting a gada gada sound.' I mean, that's not the kind of sound she would have heard I'm sure… He didn't even ask her 'What kind of sound was it?'… She would be able to tell me what kind of tinnitus she would have had." (D5)* Along similar lines, doctors noted how stigmatized habits like smoking cigarettes were commonly difficult to discern during regular teleconsultations given the stigma-driven motivations to be untruthful around family members. D5 explained:

> "Sometimes some people don't give their entire history. They won't give you the actual thing they would have done prior to having consulted you on the phone. You get those kinds of information, the deeper bits, only after you talk for a little while. [You read] their body language as to whether they want to lie to you. For example, [if] you ask them if they're smoking… if they're around their parents or something, they say 'no.' You don't know whether it's [true]." (D5)

D5 continued that these concerns were generally obviated during physical consultations as the doctors could learn from their examinations and the patients' body language. Having videos of physical examinations as supporting evidence served to overcome such challenges as they provided doctors with additional insights into the patients' health.

Our standard instructions on what to capture in the videos resulted in cases where doctors identified ways in which the examination videos could be improved to serve them better. The doctors explained that this was particularly true in cases where the problem was not immediately apparent. In comparison to patients where the abnormalities were easily noticeable, there could be cases where a generic video could fail to aid doctors, as D1 explained:

> "Sometimes I've had patients… There is a small ant inside and it's biting the ear canal, and they come with a ear pain… So, there are so many turns, right, in the canal? So, you *have* to look at all the parts to search for the ant. And most of the time, they (the intermediaries) will not know what is it. So you go in, you see the ant and you take it out… So that's the importance of seeing all the parts of the ear canal and eardrum. Even fungus also, sometimes there might be a very mild fungal infection, and that small piece of fungus will be there somewhere in the ear canal… It will just be in the starting stages. So, if you miss it, you will end up treating it… just for the itching or something like that. If you see that everything is normal." (D1)

Such edge cases point out not only where training could be improved, but also a structural limitation of an intermediated telemedicine experience. Doctors, especially specialists like those involved in our study, receive several years of medical training to learn the skills of examination. As D1 pointed out, the absence of obvious points of interest—as observable by an untrained or lightly trained eye—during an otoscopy did not indicate an absence of a problem. It instead indicated a need for more thorough investigation that could not easily be reduced to a generic 30-second video as in our workflow. Explaining how intermediaries could be better trained to capture useful videos and account for edge cases, regardless of their lack of medical expertise or training, D7 said:

> "Once you see the [eardrum], focus on a drum for a couple of at least 10-15 seconds and then come back slowly… Because there's so many things on the drum

> we have to examine. Some ossicles, [if] there is a perforation, [where] is the edge of the perforation, the middle ear mucosa… So, I mean, there's so many things [I would want to look for]. And... one more thing is like, thankfully your patient didn't have a [fluid] discharge. Suppose the patient had a discharge at that time, then the discharge needs to be cleaned. And then you have to examine the eardrum." (D7)

Ultimately, video examinations facilitated through intermediaries by and large allowed doctors to overcome a major limitation of telemedicine that had hampered their ability to provide timely and appropriate treatment to their patients.

4.1.2 Differential vs. Conclusive Diagnosis. Given the over-reliance of patient history in regular teleconsultations, doctors expressed experiencing difficulty in making diagnoses and creating treatment plans for their patients. In essence, without the ability to physically examine a patient, the doctor's *"understanding would be like a differential diagnosis*[3] *" (D3).* When working in specialized areas of medicine, like our ENT specialists, diagnosis is a complex sense-making process drawing on patient history, physical examinations of the diseased organ and related organ systems, and diagnostic lab reports as relevant. D3 explained one case study to make this point:

> "If a patient says that ear discharge has been there for many years, it is reasonably certain that it's going to be some sort of a chronic ear disease, and it is most probably coming from the middle ear, so it is most probably CSOM (Chronic Supparative Otitis Media). However, what is the size of the perforation? What is the kind of discharge? What is the kind of the perforation? Is it a safe disease or an unsafe disease? Is it a safe disease which is turning towards unsafe disease? Is it resistant to medication? Does it need surgery or does it look like it will heal without it? All these things you can make out only by having a look at the actual size of the perforation, and as well as if there is discharge. You can't get this from the history alone, and there is not even a scan which will help us to figure these things out." (D3)

Having videos of the physical examination enabled a transition from being only able to make differential diagnoses to being able to make better conclusions about the patient's health condition, and creating appropriate treatment plans. When such examinations—otoscopy in our case—were *"done correctly, I can see the perforation, I can see if there's a discharge or not. So all those things makes it instantly clear what would otherwise take a lot of investigation… It takes the guesswork out of the arrival of the diagnosis" (D3).* Concurring with this sentiment, D5 compared her experiences between intermediated teleconsultations and her earlier regular teleconsultations as: *"teleconsultation without these [videos, where] I would have probably had to talk to the [patient] for a longer time. But this went down… it zeroed in onto [the condition.] It's a spot diagnosis. You look at it, you know what it is."*

[3]A differential diagnosis is a set of potential diagnoses, each of which could cause the symptoms experienced by a patient

A further benefit of being able to make more conclusive diagnoses through teleconsultations was that it served to lower the time to treatment and recovery for patients as well. Our doctor participants explained that their treatment practice in prior, regular teleconsultations involved initial medical management to ascertain the nature of the patient's disease. This was in part due to the fact that they could not physically examine the patient, and had to find alternative ways to rule out some differential diagnoses before they could chart out patients' final treatment plans. With the availability of the videos, however, they explained that they could treat the cause directly without spending time ruling out alternative diagnoses in the first place. D2 explained this distinction as:

> "If I had not seen the photos and the videos of this patient, which was the unsafe type of ear, I would have given a medical line of management, and I would have told them to re-consult me after 15 days. In the safe type of ear: if I give medications, the ear discharge and everything will stop, and it will improve. But in an unsafe type of ear, how much ever medications we give, the ear discharge will not improve at all. The patient will have continuous ear discharge throughout the ear. So [at that time], I would have asked them to come in [to see me]. So this time period of 15 days or 20 days, where the patient would have just been taking this medication has been cut off… so we have advised them surgical intervention immediately." (D2)

In this way, our participants highlighted how intermediated consultations could potentially streamline current teleconsultation practices by making telediagnosis more feasible.

4.1.3 Barriers for Intermediated Telemedicine. Despite being able to address the examination and diagnostic limitations of regular telemedicine, we surfaced some sociocultural, legal, and infrastructural factors that are in need of further investigation towards understanding the opportunities and barriers of a smooth intermediated telemedicine experience.

Policies around telemedicine in India have been updating frequently especially due to the COVID-19 pandemic [34], with the future being unclear. The Telemedicine Practice Guidelines, issued by the Government of India in 2020 [73], for example, gave doctors the freedom to adopt their preferred technologies for conducting teleconsultations. Since then, doctors across specializations and geographies have incorporated telemedicine into their regular practice. Alongside, aggregator health platforms and telemedicine platforms have seen a drastic rise in public interest and uptake. Commenting on this market trend, D2 said:

> "Initially I had registered only with a few things like… *Practo, mFine* and all. Now there are other new apps like *DocsApp, MediBuddy* and all… Again [there is] a lot of advertisements and everything. So patients are also more aware of these teleconsultation [platforms]. That is how it is picking up now… From past one and a half years, it has increased a lot. [This is] mainly because of the apps: they give a lot of commercials for the same… And the [consultation] fees also is very less, compared to our physical consultation. [So that

> is] one of the major factor why patients are more attracted towards teleconsultation rather than physical consultation." (D2)

This growing adoption of health and telemedicine platforms has surfaced additional considerations for the role of telemedicine—both regular and intermediated—in healthcare. An important aspect that requires further investigation is its *"legal validity. [That is], who takes the responsibility if the treatment goes wrong?" (D9).* The nascence of platformized telemedicine has led doctors like D9 to be wary of the legal ramifications of conducting diagnostic teleconsultations. The risk of missing diagnoses and being accused of medical negligence could disincentivize doctors from providing care remotely—even with an intermediary involved, as D9 explained:

> "If you miss something very sinister, whose responsibility is it? Do I take the responsibility? Or the person who screened it (captured the ear video) takes the responsibility?... If you go into NMC[4] guidelines... there was a guidelines which came: they squashed all the teleconsultation. So I don't do teleconsultation. [I am] very clear, OK? Because of legal issues surrounding it. I don't know what I'm treating. I don't know what I'm missing. So no chance of doing this. I will not do it." (D9)

D9's opposition to telemedicine—both regular and intermediated—stemmed from a legality-based standpoint, but other doctors brought up different reasons for their reluctance to conduct teleconsultations. Several doctors explained that they needed to set and manage expectations in (regular) teleconsultations in the past. Patients expected to receive some form of diagnosis, treatment plan, or counselling as an outcome of the teleconsultation. For conditions that were not directly apparent through patient-history, as described earlier, doctors were largely unable to meet these expectations and requested that patients meet them in-person—largely rendering the completed teleconsultation redundant. D1 explained that patients *"should be given like a set of 'terms and conditions', like 'This is not a thorough thing. Don't expect 100% results, like how you would get in a direct consultation.'... like a statutory warning"* around the affordances of teleconsultations. Our findings hint that the frequency at which doctors encounter these limitations could be reduced through intermediated teleconsultations.

4.2 Evolving Perceptions of Formal Care Work

Having identified the ways in which intermediated workflows addressed some known shortcomings of telemedicine, we now shift attention to doctors' experiences with telemedicine—both regular and intermediated—and its comparisons to in-person care. We disentangle the 'care' and 'work' in formal care work to shed light on how doctors' perceptions of caregiving and labor changed with the modalities of interaction.

4.2.1 Caring through Care Work. Our findings highlighted the care that went into doctors' everyday care work in treating patients. The doctors discussed factors responsible for preferring physical, in-person care over telemedicine—in any form—as they catered to their patients' needs. In this section we tease apart the differences in how doctors perceived their responsibilities in physical consultations and in teleconsultations to gain insights across these two modalities that are fast becoming mainstream in their profession.

Corroborating prior work [8, 13], the doctors in our study noted that they too spend a large chunk of their consultation time establishing a rapport and making their patients feel comfortable during their in-person consultations. D6 argued that these affective aspects of care were crucial in ensuring patients' recovery, saying that *"As a doctor, the main thing is: when we connect with the patient is when they actually believe in us, and [then] the medicines actually start working! I've noticed that over years."* Additionally, and especially for doctors consulting at private hospitals and in their own clinics, these relationships were invaluable in building their medical practice. Showing empathy, having personal conversations, and creating a space for vulnerability allowed for both a meaningful patient-doctor consultation in the moment, and for doctors to build continuing trust with their patients as D6 mentioned:

> "Something that I like to do is, I talk to them [about] personal stuff... I generally take about 15 to 20 minutes in a patient's consultation. And I like to take it slow. Because if you give them the time, they're happy to come back, maybe. Even if they don't have a problem, they will come visit you just to talk to you about some other problems. They'll ask you [health concerns around] another doctor's [specialization] also to you, because that's how, you know, that's how I build relationships with my patients. I don't like to talk sob stories. Sometimes they tend to talk about who's getting married and other personal stuff. So I really enjoy that part of my consultations." (D6)

As described here, in-person consultations tended not only to be longer and involve more empathetic conversations, but also enabled a more comprehensive care experience for patients and doctors. That is, doctors frequently recognized and tested for conditions that patients did not explicitly bring up during their consultations, based on their medical judgement and experience. Such comprehensive examinations particularly helped in preventative care—identifying risk factors for other health conditions, and addressing hidden underlying health conditions in patients. For instance, ENT specialists consider ear, nose, and throat as a single structure, as D4 said *"it is a routine practice... to examine all three things together for every patient. It might take another extra 5-10 minutes, but it doesn't matter, it has to be examined to have a comprehensive picture."* D9 provided additional context to drive home the importance of comprehensive examinations—that currently only happen in-person—as:

> "If you want a comprehensive examination, you need to look at the patient as a whole, which means that an ENT examination is sometimes an extended examination of the respiratory system and cardiac system. So, a lot of ear things might be linked to other things... There are reasons which sometimes coexist amongst the nose and throat, and you're not examining them [in teleconsultation]." (D9)

Doctors' reflections on their teleconsultation experiences, both regular and intermediated, painted a greatly different picture around their mindset about, approach towards, and expectations of telemedicine.

[4]National Medical Commission of India

In contrast to their affective, care-driven approach to in-person consultations, doctors reported that their earlier teleconsultations were largely dispassionate, shorter, and with lesser time invested towards building rapport and relationships. A primary factor driving this sentiment was that patients were not habituated to consistently consult with the same doctor through telemedicine. On one hand, the platformization of healthcare had led to a scenario where patients were spoilt for choice in choosing doctors (also reported in [7, 8]), and tended to change doctors more frequently depending on their needs and requirements at the time. This resulted in difficulty in building relationships even when patients did return to the same doctor online, since they were *"not able to, you know, generally connect with their progress. It would be a one time thing. I would have forgotten also! Next time when they call me, I wouldn't even know it was the same person [that I had treated before.]" (D6).*

On the other hand, doctors' preference for providing diagnoses and treatment in-person led them to request their teleconsultation patients to visit them in-person anyway to provide better care. D8 explained that *"[During teleconsultations,] I tell them that this is the probable diagnosis and give them some medicines, and tell them, 'At least come back if you're not better.' But they haven't come back." (D8).* Patients who eventually did visit their telemedicine doctor in-person, then were able to build this relationship with doctors more easily as D5 explained:

> "I started my teleconsultation during the COVID times. So, majority of the patients are in and around Mangalore. So, once the COVID [was over]… there was not much of a restriction, they preferred coming to my clinic… It continued like the old practice, so, I didn't continue with my teleconsultation [with these patients]." (D5)

In sum, there is a seeming divergence in how doctors perceived expectations of care during in-person and teleconsultations with patients. Where doctors perceived in-person consultations as necessitating more emotional support and investment, teleconsultations were rather perceived as more dispassionate and transactional.

4.2.2 The Labor of Care Work. We now direct attention towards the intellectual labor performed by doctors doing care work, and present findings on how expectations and practices are changing with the uptick in telemedicine adoption.

With lesser time spent on small talk with patients, doctors' labor in both regular and intermediated teleconsultations were restricted to the bare necessities: understanding patient history, viewing the intermediated physical examination (as applicable), and providing a diagnosis and prescription. The 27 intermediated teleconsultations we facilitated, for example, took an average of 3.4 minutes per consultation, excluding the time taken to view the ear otoscopy video. D6 explained that, when the affective aspects of care were discounted, *"[I] just need one minute and one or two questions, and that's all I require to get the diagnosis… I didn't actually need to talk to the patient [after viewing the video]. But then you made me talk to the patient! So I mean, I had to ask them… I had to say something."* Even though all telemedicine cannot necessarily be reduced to the labor of care work, fast changing trends in the platformization of health—like online pharmacies that are a burgeoning industry—influence the nature of interactions in telemedicine. D2 reflected on his experiences as:

> "I don't think that the… 'doctor has to touch me and see' [sentiment is true]. I don't think the scenarios are now like that… In a week, I see around almost 100-150 patients by teleconsultation only. Most of the patients, as I mentioned earlier, they just want the disease to be cured. They want some prescription. And now, because everywhere you can see even the medicines also you can buy it online, they want a valid prescription. So at least for that sake they will take a teleconsultation." (D2)

Despite doctors' general discontent with the idea of anything other than a traditional in-person examination, they noted that there were scenarios where greater adoption of intermediated telemedicine could benefit their patients and the general public as a whole. Screening large populations, in rural areas for example, for preventable and manageable ear health conditions was a major use case where our doctors saw the promise of intermediated telemedicine. Considering the realities of infrastructural constraints and the demands of care work on the doctors, D6 stated:

> "Because of the abundance of the disease, the number of patients and doctors ratio is less. For everyone to physically visit a doctor—a certified doctor—that too, especially a super specialist, it is very less [possible]… So even in my clinic if, say I see 100 patients in a month, out of that [I am] only operating on five patients… A majority of the diseases are cured by medical line of management… I feel only [a maximum of] 10-15% might need surgical intervention [and] require a physical consultation. Around 80% of people will definitely be benefited through [intermediated] teleconsultation only." (D6)

In this way, the doctors indicated towards potential future use cases for intermediated telemedicine, in their domains of expertise, that could provide access to specialized healthcare to the masses. This came with the recognition, however, that the access to healthcare would largely be restricted to telediagnosis and treatment, with lesser scope for emotional support and care.

4.3 Introducing Intermediaries to Ecologies of Care

In this section, we draw attention to the potential futures of telemedicine based on patients' and doctors' experiences with our intermediated telemedicine workflow. Below we examine the redistribution of responsibilities and the reconfiguration of interaction dynamics that resulted from the introduction of new intermediaries in a patient's ecologies of care.

4.3.1 Mediating Doctors' Clinical Examinations. One of the major foci of our research was to understand how doctors would perceive, accept and adapt to intermediaries being involved in the physical examination and consultation interactions. Multiple doctors were of the opinion that individuals within the clinical healthcare professions would be best suited to intermediate these consultations.

Their primary concern was with respect to the safety of the patient during examinations and video capture. D9 explained how intermediaries *"should be qualified, of at least being a nurse"*, given that they are trained in clinical and invasive procedures. D8 expounded on the potential need for intermediaries to be trained in care:

> "So I think a nurse for me. I would be more comfortable with a nurse or somebody who actually deals with patients regularly on day to day care, and patient care. If they can counsel them better, maybe be gentle with the examination and all that, [I would prefer that]… " (D8)

Discounting circumstances where intermediaries would need to provide care, however, some doctors were more open to people with no formal medical backgrounds serving as intermediaries in this regard as long as they were properly trained. While D2 was of the opinion that *"any trained person is fine. Even an SSLC-pass*[5] *guy also can do this… definitely they can get trained within two days and they can take [videos]."*, other doctors took a more reserved stance noting the risks to these maneuvers. Especially given the delicate nature of ear examinations, D7 argued that *"they can be trained. Only the thing is, they have to be careful, obviously. Not to enlarge the perforation, not to damage any other structures… but they can be trained."* Reflecting on whether ancillary medical stakeholders like pharmacists and phlebotomists could potentially play the role of intermediaries, D5 remarked:

> "Pharmacists, I don't know, I don't know how coarse they are in their movements. The movement in the ear has to be very, very gentle. They will be ending up with blood on their fingers if they go a little too violently… [Phlebotomists would be better] because they would have a better… you know, the way they maneuver it, if they can get into a vein, I think they can get into the ears… Because the vein is much, much thinner in its caliber than the ears. So they'll be a little more careful with the ear." (D5)

Ultimately, however, with regards to the collected data, doctors were largely amenable to having intermediaries from any background providing them examination videos, noting: *"for a doctor per se, whether the video has been taken by another doctor, or it has been taken by a machine, or it has been taken by a trained person... it is of no relevance as long as the [video] is good." (D6)*

A key consideration that doctors highlighted was the potential need for pre-examination tasks—like ear cleaning and wax removal prior to diagnostic examination—in some patients. D1 explained that cleaning consisted of the removal of *"[ear]wax. Fungal infection also you need to clean out the fungal disease and then [prescribe] the ear drops."* D1 continued about the importance of cleaning in making accurate diagnoses, pointing out:

> "Even to see what is happening inside, sometimes we need to clean it before prescribing any medicine. If you clean out the discharge, we can see if there's a hole in the eardrum? How big is the hole? Is there anything else going on?" (D1)

[5]SSLC is the 'Secondary School Leaving Certificate'. SSLC-pass refers to a person that has finished at least 10 years of schooling.

The doctors, however, had split opinions about the skills and training required to perform these tasks. Some doctors were of the opinion that *"training is quite easy… I mean, if they can keep the endoscope in the ear, they can do the [cleaning]" (D5)*. On the contrary, some doctors argued the need for medical training and a true understanding of the medical and legal ramifications of any mistakes that could occur during the course of this procedure. Given the risks of the procedure, D2 opined *"a certified ENT doctor only has to clean the ear… So once a patient is [in] the hand of a ENT surgeon physically, they only clean and they examine the patient,"* indicating that patients that required cleaning might not benefit from intermediated telemedicine.

4.3.2 *Configuring Patient Experience with Intermediated Telemedicine.*

Participating in the intermediated telemedicine experience allowed patients to have the ability to view images and videos of their own ears, and make sense of their own health conditions. HCI research within the Indian healthcare system had previously reported on the tensions around patients possessing too much and too little information about their own health, identifying how it affected patient-doctor interactions [13], and their ability to process their own illnesses [9]. In this case, however, the patients and doctors both agreed that there were significant benefits to this approach. P20 reflected on the video of her ear infection saying that *"last week I had a pain in the jaw [and] they said, 'Okay you have an infection.'… they gave me ear drops [and] said three times in a day you have to put… I was just putting the drops once in a day because of a busy schedule… Now seeing the video… Outside looks good, but inside [there is still] the infection... my seriousness [in medication] is [back]."* D8 noted that this served as a great tool for patient education, explaining:

> "I don't see any drawbacks. I think it's better they have it… because they are first of all, they are more convinced… When there is an actual problem, they can talk to somebody known to them, they can take a second opinion, and if they need definitive treatment, probably… that will convince them." (D8)

The doctors we interviewed reflected on the viability and trustworthiness of an intermediated telemedicine experience for patients as being key to its success. They, however, also were wary of the scope for the intermediaries to abuse the system. They opined that involving currently ancillary stakeholders—like pharmacists, alternative medicine practitioners—as intermediaries would reshape power dynamics in healthcare. Drawing on prior interactions with patients and her professional communities, D1 said:

> "If you give this sort of a thing in the hands of the pharmacist… they can start their own consultation! That thing is already going on… they'll say 'I know for this problem, [the doctor] will give this [medicine]. You take this.' And it becomes that... He might end up taking money from the patient like 'Give me Rs. 200… instead of paying Rs. 500 to the doctor.' " (D1)

This argument highlights a potential avenue for power redistribution in healthcare where doctors perceive a loss of control and responsibility in caregiving due to currently peripheral stakeholders being empowered as intermediaries. These perceptions could

serve not only to hinder intermediated patient-doctor interactions, but has potential to cause unwanted harm to the patients themselves. Pointing to how the existence of healthcare platforms could work towards instilling trust in both the patients and the doctors in this regard, D1 suggested that a platform-based model, similar to existing home-based phlebotomy solutions might be suitable:

> "If they're coming through some company… like, you know when you call for a blood test, they come through the Lab or something. They have the bag that is given to them by that particular company. They don't carry it home with them, so that is okay. Because [otherwise] they can open up a clinic in their house! I am sure they will do that!" (D1)

Ultimately, however, these stereotypes and preconceived notions around intermediaries might need to be revisited and addressed as intermediation takes foot.

Finally, the cost of care was a consideration that both doctors and patients brought up over the course of the study. There was no consistent trend in cost comparisons between in-person and teleconsultations among the doctors who participated in our study, with some charging higher for in-person and others lower. Indeed, one participant indicated a willingness to pay a premium for an intermediated teleconsultations saying, *"If a person is coming to my home and taking the sample or video… we are okay to pay more than [for regular consultation]." (P11).* A concern that doctors voiced around teleconsultations was that they were not always sufficient but *"when a fees is paid, you are expected to deliver something" (D9).* Adding an intermediary to this uncertain workflow, then, creates a potential situation where patients might pay for unsatisfactory services. Even though the general practice was that *"when they get a teleconsultation, and we asked them to come back [and meet in-person] because we're not able to give them a proper diagnosis in the teleconsultation, they don't get charged." (D8)*, there is a possibility that the intermediary's labor in such cases is uncompensated. Any platform that incorporates the intermediated telemedicine model would have to identify a feasible solution to this problem.

5 DISCUSSION

Our findings offered insights into how gaps in existing telemedicine workflows could be bridged by the introduction of intermediated teleconsultation workflows. From aiding doctors in remotely examining a patient to potentially arriving at conclusive diagnoses, our data indicated that intermediated workflows served to improve the overall efficacy of telemedicine. In addition, we uncovered sociotechnical and infrastructural gaps that remain in intermediated telemedicine, presenting doctors' perspectives on how intermediaries could fit into existing ecologies of care, and the challenges this integration could introduce. Crucially, we surfaced the shifting perceptions around formal caregiving, finding how platformization of health and greater access to telemedicine solutions have led to reconfiguration of interaction dynamics between its different stakeholders. Drawing on these findings, we now focus on how intermediated workflows could improve telemedicine overall and help in realizing the goals of patient-centered care. We further reflect on the future of care work where modalities of patient-doctor interaction influence the experiences of caregiving.

5.1 Bringing Telemedicine Closer to Patient-Centered Care

Patient-centered care aims to empower patients in their own care by supporting greater engagement in their care journey, which usually involves the adoption of information and communication technologies in care provision [22, 46]. Within HCI, scholars have largely taken a information-centered approach towards realizing patient-centered care by focusing on improving patients' information engagement in-hospital and post-discharge from hospitals (*e.g.,* [44, 48, 56, 67, 68, 76]). Towards assisting healthcare providers in administering patient-centered care, researchers have studied technologies such as patient portals (*e.g.,* [41, 42]) and electronic health records (*e.g.,* [77, 97]), in addition to sociotechnical assemblages, *e.g.,* nurses' use of mobile technologies towards providing continuing care (*e.g.,* [52, 105]). Recent work has since taken a critical stance on where the focus of research and intervention should lie: with some arguing for repositioning information technologies as digital companions in care ecologies [69], and others recommending a focus on informal caregivers and their situated knowledge in patient-centered care as recipients of intervention [7, 93].

A common underlying focus of much of this prior research has been around supporting patient-centered care *in person*, with little focus spared towards telemedicine and remote care. Arguably, telemedicine was originally envisioned to broaden access to care among the masses (*e.g.,* [21, 45, 74]), with quality of care not immediately prioritized. Seemingly as a consequence, telemedicine access did increase around the world—as presented in Section 2—but fell short on large scale adoption, potentially given the significant differences in quality of care between telemedicine and traditional, in-person care. In the Indian context, telemedicine ultimately occupied a largely peripheral role in healthcare infrastructures as a result [36, 37], with little research on patient-centered care through telemedicine. The COVID-19 pandemic and related infrastructural disruptions rejuvenated telemedicine as a realistic alternative to traditional caregiving [8]. Since then, policies around telemedicine have become more conducive [34, 73] and technology platforms have been built to support telemedicine [8], resulting in telemedicine becoming more mainstream among the masses, overcoming earlier resistance [9, 13]. This has shifted the attention towards ensuring quality, patient-centered care through telemedicine, and has spotlighted shortcomings in existing telemedicine practices and infrastructures [8].

Our study on introducing intermediated workflows was an experiment into overcoming these existing shortcomings and rendering patient-centered care feasible through telemedicine. Indeed, our findings described the ways in which intermediation allowed for better patient care: enabling more thorough physical examinations, and allowing for more conclusive diagnoses. Specifically, having access to video data of physical examinations not only helped doctors in better understanding their patient's health condition, it also allowed them to use these videos as educational material in explaining diagnoses and care requirements to patients in a way that was not possible in regular telemedicine, or sometimes even during in-person consultations where physical examination were typically done without a recording device. Additionally, being able to provide conclusive diagnoses and explanations to patients—even if it meant

informing them that they need to see them in-person—resulted in a consultation experience that left both parties satisfied with the outcome of the teleconsultation. These affordances together could improve doctors' ability to provide better quality care to patients through telemedicine. We highlight here that our findings do not point towards telemedicine—neither intermediated nor regular—replacing in-person healthcare. Instead, we spotlight how telemedicine and in-person medical care are both increasingly becoming viable choices for patients seeking care in our context of study, despite the known shortcomings of telemedicine with regards to quality of care. We posit that our findings afford a better understanding of the gulf between current telemedicine practice and patient-centered care, with the recognition that intermediated telemedicine could potentially bridge this gap.

The growing platformization of health [58, 90] could be leveraged towards scaling access to intermediated telemedicine. Prior work in the Indian telemedicine context [8] has highlighted how trust in telemedicine platforms could translate to trust in the healthcare providers using those platforms and vice versa. With telemedicine platforms becoming part of the healthcare infrastructures [94], intermediated telemedicine provided through established and trusted digital healthcare platforms could help quickly scale improved quality of telemedicine care. The intermediaries could include both recognized caregivers (like nurses) as well as other trained individuals (like phlebotomists, pharmacists). Specifically in the Indian healthcare context, extensive prior research has focused on community health workers and the role they play in last-mile healthcare delivery [47, 75, 102]. More recently, scholars have proposed an 'assisted telemedicine model' looking into community health workers as intermediaries in rural healthcare delivery [82]. Future research could extend this line of inquiry to investigate whether, and how, community health workers could best be leveraged in scaling up intermediated telemedicine.

A key prerequisite step, however, is understanding intermediaries' experiences in performing these responsibilities. Our study design and findings were targeted towards establishing acceptability of such workflows among doctors and patients. The third key stakeholder in this workflow is the intermediaries themselves. Before we can truly discuss the scalability of such interventions, it is imperative to center the intermediaries as key stakeholders in this process, and unpack their situated experiences in such teleconsultations. Such work would help identify and mitigate any risks and challenges that might arise from adoption of intermediated telemedicine. This remains an open research question.

5.2 Intermediation and the Future of Care Work

Care work has varied definitions and has been adopted as a lens to examine human labor across a variety of domains including schools [51], maker spaces [104], and philanthropy [43]. Primarily, though, care work has been studied in the context of healthcare, with the broad definition as being the labor involved in improving the physical and mental health and wellbeing of the care recipient (*e.g.,* [100]). Prior research has examined care work performed by formal healthcare workers like nurses [52] and medical teams [33], as well as informal workers such as family members (*e.g.,* [80, 89]) and community health workers [47, 102]. Furthermore, prior research on the interaction dynamics of formal care work in the Indian healthcare context has noted a shifting balance of power between patients and doctors [9, 13]. Arguably, the flourishing platformization of healthcare is catalyzing telemedicine adoption, and instigating further changes in the traditional roles and responsibilities of doctors, patients, and caregivers.

Our findings spotlighted how the modality of care provision influenced doctors' care work practices and perceived responsibilities to their patients. During traditional in-person consultations, doctors accented their empathetic responsibilities by investing time and care in building relationships with patients. Our findings revealed that this approach served not only to build trust and rapport with the patient, but also to foster longer term relationships with them. On the contrary, teleconsultations (both intermediated and regular) primarily foregrounded and aided doctors' medical deductive responsibilities, requiring them to prioritize diagnosis and prescriptions over empathy and relationship building. This indicates a shifting dynamic in care seeking where patients' choices around modality of consultations are driven by their prioritization of their immediate care needs. With increasing platformization of care, all indications are towards the persistence of telemedicine as an avenue for care even as in-person care is preferable in most circumstances. We posit that the future of formal care work would involve both consultation modalities coexisting with each other and serving different needs—potentially with telemedicine being improved through intermediation. Next, we offer design futures for formal care work.

Intermediated telemedicine could serve as a suitable pathway to diagnostic care for patients that prioritize a more targeted teleconsultation experience, centered on medical history and physical examinations (through intermediaries), followed by diagnosis and prescriptions. These narrowly scoped consultations could help overcome known barriers to care seeking—such as fear of diagnosis [9], financial considerations [88], and gendered avoidance of care [57, 70, 79]—and allow for broader access to care. To make this a reality, advancement is necessary on technical and sociocultural fronts. Novel sensing technologies that are capable of reliably capturing touch and sensation-related data could be leveraged by healthcare providers to diagnose conditions that require palpation—*e.g.,* thyroid, liver inflammation, skin conditions—through intermediated teleconsultations. Technologies capable of capturing diagnostic data about the eye (*e.g.,* [3, 35]) could similarly realize intermediated ophthalmology consultations. On the sociocultural front, advancement would require greater openness to the inclusion of non-medical intermediaries in patient-doctor interactions, overcoming preconceptions and prejudices.

In parallel, traditional physical consultations would remain the primary pathway to care for conditions requiring complex physical examinations that draw on formal medical education, invasive or surgical interventions, or expensive equipment. With the recognition, now, that empathetic care is unique to the in-person modality, future innovations could aim to create more unremarkable technologies for use in patient-doctor settings [99] like automated notetaking through conversational agents. These technologies could serve to enhance outcomes of clinical interactions and simultaneously unburdening doctors from the responsibilities of using technologies, thus allowing them to focus fully on patient care.

6 LIMITATIONS AND FUTURE WORK

Our research was centered around the experiences of doctors and patients with intermediated telemedicine. Our interviews and data collection, as a result, elicited comparisons between our facilitated intermediated consultations, and prior regular teleconsultations and in-person consultations. For ethical reasons, we did not request each patient to undergo *two* additional consultations for their health condition given the emotional, mental, and time costs of consultations. As a result, we did not collect any data to inform a three-way comparison among the modalities—in-person, regular telemedicine, and intermediated telemedicine. Our exclusion criteria points to further limitations of our study design. We excluded patients with certain ear conditions to protect them from potential harm, and could not meaningfully ascertain the feasibility of intermediated workflows for those teleconsultations. We further excluded patients with particularly severe conditions—like excessive fluid discharge in the ear—to prevent damage to the otoscope. These exclusions limit the transferability of our findings. Future work could look into overcoming these limitations, as well as expanding the scope of intermediated telemedicine to other domains of healthcare. Given that our study centered on doctors' and patients' experiences to establish the potential for intermediated workflows, we did not interview the intermediaries involved in the study. Future studies could center around these stakeholders in their analysis to gain a situated understanding of the challenges faced by the intermediaries, and consequently a more thorough perspective on the potentials for intermediated telemedicine.

7 CONCLUSION

HCI research has increasingly been investigating patient-centered care as a goal to design technological interventions in healthcare. Simultaneously, telemedicine has increasingly been viewed as a viable pathway to care, owing in part to the growing platformization of health and the shift to remote work environments as a consequence of the COVID-19 pandemic. Our research extended this body of work, by investigating how workflows involving intermediaries might contribute towards enabling patient-centered care through telemedicine. The contribution of this paper is an empirical evaluation of a telemedicine workflow involving intermediation towards enhancing patients' and doctors' experiences during teleconsultations. We presented a qualitative analysis of field observations and semi-structured interviews with patients and doctors. Our findings revealed that telemedicine workflows involving intermediaries have the potential to enhance doctors' diagnostic and caregiving abilities. We further surfaced shifting perceptions around formal caregiving, identifying how different modalities of consultations accented different aspects of doctors' care work. Based on our findings, we discuss future of care work and patient-centered care in light of greater telemedicine adoption, and we provide design recommendations and design futures for augmenting telemedicine through intermediation.

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