Understanding the Technology-Mediated Home Phlebotomy Ecosystem in India

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The increasing platformization of healthcare services in India, in the wake of COVID-19, has resulted in huge demand for home phlebotomy. However, there is a limited understanding of the impact of digitization on home phlebotomists' workflows. To address this gap, we conducted 26 semi-structured interviews with home phlebotomists, riders, and patients, supplemented by observations of the entire workday of 3 phlebotomists. We found that home phlebotomists' technology-mediated workflows are organized in ways that enable them to build strong support networks of human infrastructure, helping them negotiate and optimize their daily workflows. Moreover, while the digitization of their workflows resulted in continued surveillance, it empowered them to justify their decisions and present evidence of work when needed. Based on our findings, we discuss implications for equitable platform work and the future of platformized health and conclude with design recommendations for telehealth platforms offering home phlebotomy services.

CCS Concepts: • **Human-centered computing** → **Human computer interaction (HCI)**; **Empirical studies in HCI**; **Field studies**.

Additional Key Words and Phrases: healthcare, phlebotomy, telemedicine, platformization, gig-worker

ACM Reference Format:
Meghna Gupta, Nimisha Karnatak, and Mohit Jain. 2024. Understanding the Technology-Mediated Home Phlebotomy Ecosystem in India. *Proc. ACM Hum.-Comput. Interact.* 8, CSCW1, Article 144 (April 2024), 26 pages. https://doi.org/10.1145/3637421

1 INTRODUCTION

The penetration of technology in every aspect of our lives has been on an exponential rise, especially in developing countries like India [17, 30]. The increased access and ubiquitous presence of technology has led to rapid digitization of essential services ranging from food delivery to cab aggregation, giving rise to on-demand digital platforms (such as Uber, Zomato, and Urban Company). A recent example of digitization in India is found in the healthcare sector, where there has been an emergence of digital platforms offering on-demand telehealth services, including teleconsultation, medicine delivery, and home diagnostic tests. In particular, during the COVID-19 pandemic, patients were reluctant to physically visit the diagnostic labs because of the fear of contracting the disease [59], which resulted in a spike in demand for home phlebotomy services. This led to private enterprises, including aggregator health platforms (like Tata 1mg, PharmEasy) and diagnostic labs (like Dr Lal PathLabs, SRL Diagnostics) offering digital solutions to facilitate online booking of home phlebotomy services resulting in the digitization of phlebotomists' workflows.

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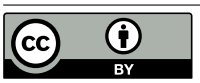

ACM 2573-0142/2024/4-ART144
https://doi.org/10.1145/3637421

Home Phlebotomists are healthcare professionals responsible for collecting bodily fluid samples (such as blood, urine, and saliva) at the patient's house for diagnostic testing purposes. It is important to study how digitization has shaped and impacted their routine workflows to develop better technologies for them. Additionally, since home phlebotomists are the only medically-trained healthcare professionals visiting the patient's house, they could support in last-mile delivery of healthcare services, *e.g.*, as intermediaries to support teleconsultation [7, 9, 38]. Current telemedicine technologies are limited to phone (audio/video) calls and lack physical examinations. In the future, home phlebotomists can capture and share videos required for physical examinations with remote doctors to enable an improved, intermediated telemedicine experience for patients and doctors [9]. Hence, it is essential to understand the roles, responsibilities, workflows, technology usage, and challenges faced by home phlebotomists, who are a crucial component of the healthcare ecosystem. While extensive prior work in HCI has investigated the potential of technology in low-cost diagnostics [21, 64], managing and digitizing health records [42], training of healthcare workers [66], and teleconsultation services [7, 9], none of them have examined the role of home phlebotomists. In this paper, we focus on understanding the technology-mediated labor practices of home phlebotomists amidst the rise in demand for digital telehealth platforms.

The role of home phlebotomists is analogous to platform workers employed in services like food delivery and cab drivers due to the travel-intensive, customer-facing nature of their work and the increasing adoption of digital technology. Researchers from the HCI and CSCW community have been actively investigating the on-demand labor practices, and relations of workers employed on these digital platforms [4, 53, 55]. However, most of these studies investigate platforms employing low-skilled workers (especially drivers for delivery and cab services) [51, 56], except for a few which have studied mid-skilled workers (e.g., beauty workers) [26, 52]. Mid-skilled jobs typically require more education and training than a high school diploma, but less than a four-year college degree [54]. Examples of mid-skilled workers include electricians, beauticians, and carpenters [1]. According to the World Health Organization, mid-skilled healthcare workers are individuals who have received shorter training than doctors (usually 2-4 years) and provide clinical care or engage in preventive care and health promotion [45]. Our paper focuses on mid-skilled healthcare workers possessing professional medical skills on top of routine platform-work skills (like driving).

In this work, we present findings from a qualitative investigation of the digital ecosystem of home phlebotomy. We conducted semi-structured interviews with 16 phlebotomists with experience in home sample collection and essential stakeholders of their ecosystem, including 2 riders and 8 patients. We also observed the entire workday of three home phlebotomists by accompanying them to eight patient houses to understand their situated practices and interactions. Our study was conducted in two urban cities of India, Bengaluru, and Delhi. We found that the digitization of home phlebotomists' workflows resulted in continued location-based surveillance and enforced them to submit digital evidence of their work. While burdensome, such digital work evidence empowered phlebotomists to justify and safeguard themselves in case of discrepancies. Furthermore, we found that the patient-facing, high-precision nature of their medical profession placed them in unfavorable situations due to delays and/or errors in their service delivery. To navigate such situations, we found that our phlebotomists relied on their strong human support networks, which are built over time through formal and informal communications. Such networks also help them feel socially connected and enable them to progress in their career and optimize their earnings. Drawing on these findings, we synthesize key takeaways for HCI researchers, including directions for more equitable futures of platform gig-work, the role of home phlebotomists in augmenting teleconsultation services in the future, and design considerations for platforms offering home diagnostic services addressing issues around constant surveillance and redundant phlebotomy tech-workflows.

2 RELATED WORK

Our work is mainly informed by two areas of relevant research in HCI: technology use within healthcare settings and digital on-demand labor practices. We now discuss how our study builds upon these existing bodies of research through the case of home phlebotomy in the context of digital healthcare in India.

2.1 Technology Use by Healthcare Workers

An important thread of research in HCI has designed, developed, and evaluated technologies for healthcare workers, mainly to support their communication needs [7, 63], and to digitize and manage their workflows [18, 27, 42].

Researchers have investigated the role of communication technologies in enabling interaction among healthcare workers and between healthcare workers and their patients to provide support and teleconsultation [34, 63]. Early studies focused on delivering teleconsultation services via e-mail [40, 48] and web portals [41]. With the emergence of communication apps (e.g., WhatsApp, WeChat, etc.), recent work explored their usage for facilitating informal patient-healthcare worker communication [19, 31]. For instance, Wang et al. studied the use of nurse-facilitated patient groups on WeChat to compensate for the infrequent in-person consultation with doctors [63]. Several prior studies have also investigated the experience of patients when technology is used to facilitate a health service [8, 33, 43]. Specifically, Montague and Asan [43] studied the role of trust in collaborative technology-mediated healthcare encounters.

Researchers have also examined the use of video-based tools to enable synchronous communication among healthcare workers for skill transfer and training purposes [31, 36]. Larsen et al. discussed how video-based remote teleconsultation allows doctors to transfer their expertise to nurses who are in close physical proximity to the patients [36]. With COVID-19 resulting in the burgeoning digital platformization of the healthcare industry, recent work has studied the experiences of doctors and patients using teleconsultation during the pandemic [7].

Another body of medical work in HCI has focused on understanding the impact of digital tools, such as Electronic Health Records (EHR) [24, 32], mScan [18], CommCare [42], Open Data Kit (ODK) [27], on managing health data and on the workflows of healthcare workers. Berg discussed the challenges encountered by clinicians while using EHR, given the strict input conditions [5]. Due to the complexities involved, clinicians often resorted to paper-based workarounds [5]. The preference for paper-based records over electronic records was evident even among nurses, particularly in high-risk and time-sensitive medical settings [32]. Likewise, in low-resourced settings, several initiatives have been taken to digitize the workflows of community health workers (CHWs) [18, 42]. For example, researchers have examined the use of mScan to digitize paper-based vaccine forms and consequently reported a decrease in the workload of CHWs [18]. However, like nurses, CHWs preferred paper-based data collection over digital tools [31, 46], and less tech-savvy workers relied on intermediaries to complete their digital data entry tasks [62]. While digitizing data was intended to ease healthcare workers' workflows, it has been found to result in redundancies when introduced not in alignment with their routine workflows [31].

These studies focused on investigating technology use by healthcare workers at the extreme ends of the skill pyramid, mainly high-skilled doctors [7, 16] and low-skilled CHWs [31, 42, 46]. There is a limited understanding of mid-level health workers such as phlebotomists who form a core part of the healthcare infrastructure. Hence, it might be of value to understand the workflows and experiences of (home) phlebotomists amidst the rapid digitization in the healthcare sector. Prior work closely related to phlebotomy has focused on devising solutions for distracting patients while drawing blood [58], locating cannulation sites in case of obese and elderly patients [10, 47],

and their experiences of taking blood after completing an educational intervention program [11]. Our research specifically aims to contribute a nuanced understanding of technology-mediated interactions and labor workflows of home phlebotomists amidst the emergence of on-demand healthcare platforms in India.

2.2 Platformized Labor and Governance

HCI studies have examined the digitally-mediated work practices in app-based gig professions such as cab drivers [51, 56], beauty workers [4, 52], web developers and graphic designers [3, 13], and crowd workers [15, 61]. These studies have highlighted that the introduction of on-demand platforms provides workers the flexibility to work as and when they want [23, 26, 37]. While gig-based platform jobs provide women with flexibility and opportunities for upskilling, they also come with additional safety concerns and a stigma attached to them [26]. However, their emergence has also led to work intensification through the introduction of additional digital workflows [20, 23], which requires them to learn new (digital) skills [4, 44], and engage in emotional labor [51]. Additionally, the precarious nature of work and payment uncertainties often force workers to work overtime [39]. Commenting on workplace relationships and social connections, recent studies have highlighted the prevalence of social isolation in on-demand platform work [22, 55, 67]. Factors leading to isolation include the stigmatized, individualistic, and atomized nature of work [55, 67], absence of worker networks [55], and limited communication with employer [22]. To overcome this, platform workers often resort to online social media to access peer networks [50, 55, 67]. These digital networks are not only used for informal and formal communications [55, 67], but also for organizing collective action and unionizing against organizational policies when needed [44, 67].

Apart from the opportunities and challenges offered by platformization, recent literature investigated the role of algorithmic mediation in platform work and found that it has given rise to digital mechanisms for control and surveillance. Singh and Park recently conducted a study on food delivery workers' experiences during the pandemic and argued that using digital surveillance in the name of care is unethical and harmful [57]. In addition, studies have discussed algorithms managing, rewarding, and penalizing workers based on various inputs, including rating, reporting, and surveillance [4, 51, 53, 57]. Anwar et al. found that customer ratings on an on-demand beauty platform were being used to reward or penalize (even terminate) workers [4]. Such performance-based compensation often forced workers to adopt strategies to negotiate and obtain high ratings [4, 26, 44, 51], for instance, engage in 'emotional labor' in exchange for good ratings [51]. *Emotional labor* in this context refers to the management of emotions by workers to create a publicly observable facial and bodily display while interacting with customers [28]. Moreover, these rating systems are mostly opaque to the workers [4]. In addition, workers often distrust the algorithms and resort to manual strategies for self-protection. For example, Shannon et al. found that workers employed self-surveillance measures to track their work to combat payment-related discrepancies [53].

More recently, a few studies have investigated the gendered labor practices on platforms offering on-demand beauty services [4, 26, 52]. Raval and Pal [52] highlighted how flexible work hours acted as an incentive for women beauty workers in India to switch from salon-based work to platform work, despite safety concerns around traveling and working in unfamiliar environments [4, 26]. In addition, Gupta [26] discussed the often neglected threat and tolerance of verbal and sexual harassment faced by women platform workers.

However, most of the existing studies investigate on-demand platforms employing low-skilled workers requiring driving skills, apart from a few which have focused on mid-skilled workers such as beauty professionals [4, 52]. In healthcare, prior work has mainly focused on high-skilled healthcare workers such as doctors and low-skilled healthcare workers such as community health workers. Our study extends this body of work by investigating an emerging case of platformized

labor in healthcare in India. Specifically, we examine the roles, responsibilities, and technology-mediated workflows of home phlebotomists, who are mid-skilled healthcare workers possessing medical expertise along with routine platform-work skills such as driving.

3 METHODOLOGY

The goal of this research was to understand the home phlebotomy ecosystem in India, including the end-to-end workflow of home phlebotomists, their roles and responsibilities, their interactions with other stakeholders in the ecosystem, and the technology-mediated interactions enabled by the digital healthcare platforms employing them. Upon receiving approval from the ethics review board of the authors' institution, the study took place over three months between June–Aug 2022, in two cities in India, Bengaluru, and Delhi. The study comprised of semi-structured interviews with 16 phlebotomists having experience in home sample collection, supplemented by observations of the entire workday of 3 home phlebotomists. Essential stakeholders of the home phlebotomy ecosystem including 8 patients and 2 riders were also interviewed. Riders also referred to as field executives, runner boys, or delivery boys, are responsible for collecting the samples from the phlebotomists and delivering them to a nearby diagnostic lab for testing.

3.1 Procedure

To understand the digital ecosystem in the home phlebotomy profession in India, phlebotomists with experience in home sample collection were recruited from diagnostic labs (like Dr Lal PathLabs, SRL Diagnostics) and diagnostic aggregator platforms (like Tata 1mg, PharmEasy) satisfying the following inclusion criteria: (1) must have served at least 1 million customers and (2) must have a corresponding digital platform. Phlebotomists were recruited through direct outreach and physical visits to diagnostic lab centers in Bengaluru and Delhi, followed by snowball and purposive sampling until the data reached saturation. As the first two authors were based in two different cities, we decided to conduct the study in both their cities to identify any differences, which was not the case in our findings. A total of 16 phlebotomists involved in home sample collection were recruited for interviews, out of which 10 were interviewed in-person and 6 were interviewed over the telephone depending on their availability and comfort. The phlebotomist interviews consisted of questions around their phlebotomy career *(e.g., "describe your journey of becoming a phlebotomist", "what motivated you to choose this profession?")*, routine workflow and use of digital platforms *(e.g., "describe your typical workday", "how do you receive patient bookings?")*, and challenges faced while working as a phlebotomist *(e.g., "what are the major challenges of being a phlebotomist?", "what are the workarounds to tackle them?")*.

Apart from phlebotomists, other stakeholders in the home phlebotomy ecosystem, including patients and riders were also interviewed to better understand phlebotomists' interactions with them. Eight patients who had availed diagnostic services in the past 6 months, either home-based or clinic-based were interviewed over the telephone. The patients were recruited from the author's personal contacts, followed by snowball sampling. The interviews consisted of questions around their most recent diagnostic test *(e.g., "why did you book that test?")*, challenges faced *(e.g., "what kind of challenges did you encounter while booking the service?")*, and their preferred mode between clinic- and home-based phlebotomy *(e.g., "describe your experience in phlebotomy services in clinic-based versus home-based settings")*. In addition, two riders from diagnostic labs were also interviewed in-person. Riders often had to communicate with phlebotomists and were responsible for transferring the phlebotomist-collected fluid samples from the patient's home to the diagnostic lab. The riders were asked questions about their job roles and responsibilities, workflows, and technology usage.

All the interviews with the participants began with a brief explanation of the research and obtaining signatures on the consent form. The participants were free to skip answering any

ID	Primary Role/Job	Age	Gender	City	Education	Work Exp / Exp with Home Phlebotomy
P1	Home Phlebotomist	29	Male	Bengaluru	DMLT	2 years
P2	Home Phlebotomist	25	Male	Bengaluru	DMLT	7 years
P3	Home Phlebotomist	29	Male	Bengaluru	DMLT	8 years
P4	Home Phlebotomist	26	Male	Bengaluru	DMLT	9 years
P5	Clinic Phlebotomist*	23	Female	Bengaluru	DMLT	2 years
P6	Home Phlebotomist	30	Male	Bengaluru	DMLT	12 years
P7	Clinic Phlebotomist*	22	Female	Delhi	DMLT	2 years
P8	Home Phlebotomist	24	Male	Delhi	DMLT	2 years
P9	Home Phlebotomist	24	Male	Bengaluru	DMLT	3 years
P10	Home Phlebotomist	23	Male	Delhi	B.Sc. in Nursing	4 months
P11	Home Phlebotomist	26	Male	Delhi	B.Sc. and BMLT	4 years
P12	Home Phlebotomist	26	Male	Bengaluru	DMLT	7 years
P13	Home Phlebotomist	28	Male	Bengaluru	DMLT	9 years
P14	Clinic Phlebotomist*	27	Female	Bengaluru	DMLT	4 years
P15	Clinic Phlebotomist*	27	Female	Bengaluru	DMLT	6 months
P16	Home Phlebotomist	32	Male	Bengaluru	DMLT	5 years
R1	Runner Boy	36	Male	Bengaluru	Middle school	4 years
R2	Rider	38	Male	Delhi	M.Sc. in Agriculture	2 years
S1	Software Engineer	23	Male	Bengaluru	Bachelor's	Yes
S2	Marketing Director	45	Male	Delhi	Master's	Yes
S3	Accountant	31	Female	Bengaluru	Bachelor's	Yes
S4	Retired	71	Male	Delhi	Master's	Yes
S5	Unemployed	24	Female	Delhi	Middle school	No
S6	Cook	32	Male	Bengaluru	High School	No
S7	Security Guard	46	Male	Bengaluru	High School	No
S8	Laborer	23	Male	Delhi	High school	No

Table 1. Demographic information of our phlebotomist (P), rider (R) and patient (S) participants. Note: DMLT: Diploma in Medical Laboratory Technology (minimum requirement to become a phlebotomist in India), BMLT: Bachelor in Medical Laboratory Technology, B.Sc.: Bachelor of Science, M.Sc.: Master of Science.

question during the interview. The interviews were conducted in Hindi and/or English depending on the participant's comfort and were audio-recorded with the verbal consent of the participants. The interviews lasted 30–90 minutes. All our interview participants were compensated with a mobile recharge or an Amazon gift voucher worth INR 500 for their participation after the interview.

To supplement the interview data, recruited phlebotomists were requested if the first two authors could accompany them on a regular workday to observe their situated interactions and practices. The goal was to understand their routine, digital workflows, and their interactions with patients, riders, and other stakeholders of their ecosystem. Three of our interviewed phlebotomists (P6, P13, P16) agreed to the observation study. For ethical reasons, we requested the phlebotomists to inform the patients over telephone about the researcher's presence before their home visit and obtain consent from them. The researchers entered the patient's house only if the patient agreed. Moreover, the researchers took necessary precautions inside the patient's house to ensure that phlebotomists' workflows were not disrupted by their presence. For instance, the researchers silently observed

* : Although their primary job was of a Clinic Phlebotomist, we found them to frequently visit patients' home for sample collection, hence we included them in our study and also refer to them as Home Phlebotomist in the rest of the paper.

the phlebotomist-patient interactions from a distance and did not communicate with either the patient or the phlebotomist during the sample collection process. Additionally, no images/videos were captured inside the patient's house to protect their privacy. Instead, only extensive field notes were taken, which were later supplemented by clarification questions to the phlebotomist asked outside the patient's house. The observation study lasted for 16 hours in total with 8 home visits. Phlebotomists were compensated with an additional mobile recharge or an Amazon gift voucher worth INR 500 for participating in the observation study. The detailed participant demographics of all our participants are available in Table 1.

3.2 Data Analysis

The collected data consisted of audio recordings (~23.5 hours) from 26 semi-structured interviews, notes from the interviews and observation study, photos of relevant artifacts (such as phlebotomy application screenshots, and images of medical equipment). The audio recordings were anonymized, transcribed, and translated to English by the first two authors, soon after the interviews were conducted. Furthermore, the authors decoupled phlebotomists' comments from their diagnostic labs to minimize any privacy and ethical concerns. The interview data was analyzed using grounded theory, with open coding in an inductive and interpretive manner [12]. The first two authors, who also conducted the interviews, read the field data several times to identify the initial set of codes. The two authors separately coded the interviews. Regular meetings between the authors were held to discuss the emerging codes and discrepancies if any. Multiple rounds of open coding were conducted and codes were rigorously discussed and refined. The refined codes *(e.g., "peer-referring", "redundant tech workflows", "travel-intensive", "varying digital adoption")* were finally clustered into high-level themes. Examples of high-level themes included additional support for female phlebotomists, digital surveillance, and uncertainty in compensation. We refrained from using any existing theoretical framework or lens to analyze the data to avoid imposing any biases given the relatively unexplored nature of the phlebotomist demography. Instead, we let the themes emerge bottom up.

Although rich data was obtained from the patients' interviews, most of those findings were centered around their experiences opting for a diagnostic service, rather than their experiences with the (home) phlebotomist, because only four of them had experience with a home phlebotomy service (Table 1). The remaining patient participants either did not feel the need for home phlebotomy or lacked awareness about the existence of such services. Regarding the rider's interviews, most of the findings strongly overlapped with our phlebotomist themes. As a result, the Findings section predominantly draws on the phlebotomist interviews. Patient and rider findings were only used to support emerging themes from the phlebotomist interviews.

3.3 Positionality

With regards to positionality, this work has been motivated by our interest and commitment towards designing equitable technologies for healthcare within the Indian context. Our research team consists of two females and one male, all of Indian origin and currently residing in India. All three authors have a background in HCI and have extensive experience conducting fieldwork with diverse healthcare providers, which has significantly informed and shaped the overall study design and data analysis. We all view HCI research from an emancipatory action research mindset, aiming to conduct formative research to examine the opportunities and challenges surrounding platformized healthcare.

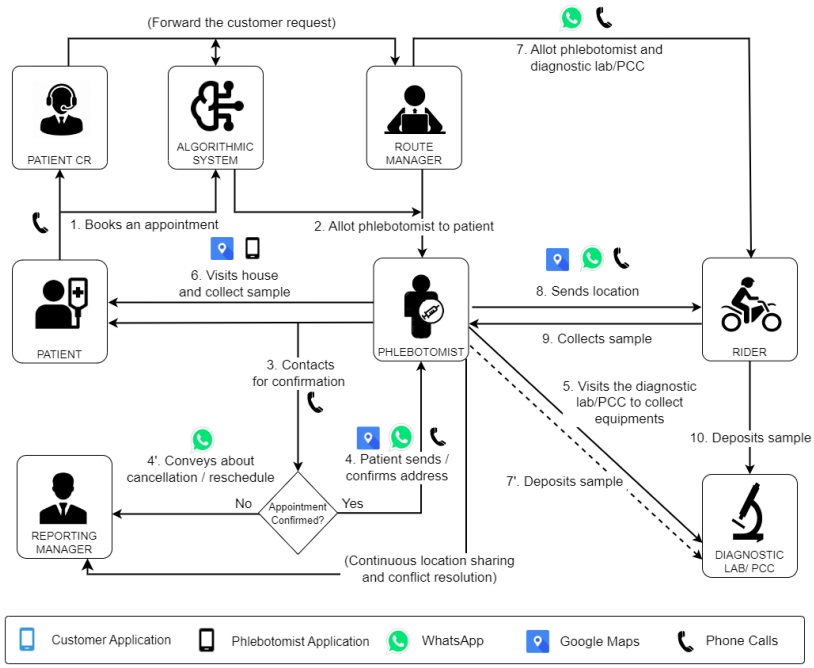

Fig. 1. Ecosystem of the home phlebotomist showcasing the key stakeholders, workflows and interactions. (CR: Care Representative)

4 FINDINGS

The healthcare system in India is complex and diverse, with a range of workers having different skill levels and training—with some having received extensive medical education, such as doctors and nurses, to others having received shorter training, such as mid-skilled health workers, and to healthcare providers with no professional medical training, such as community health workers. One prime example of mid-skilled health workers are phlebotomists, who are responsible for blood collection and sample testing. With the health platformization and consequences of COVID-19, home phlebotomy has seen a rapid uptake in India. Home phlebotomy allows trained phlebotomists to collect blood samples from patients in their own homes rather than requiring the patient to visit a hospital or clinic. Our findings detail the workflow, roles, and responsibilities of home phlebotomists, the role of technology in acting as an enabler and inhibitor in their workflows, the human infrastructures, and their relationship with the different stakeholders in the phlebotomy ecosystem.

4.1 Phlebotomy Workflow and Characteristics

Based on our interview and observation study, here we describe a typical workflow of a home phlebotomist sample collection process based on our interviews and observations (Fig 1). Diagnostic labs and diagnostic aggregator platforms provide multiple ways for the patient to book an appointment for home sample collection (Fig 1 #1), such as by using their smartphone/web application, or by calling/messaging their phlebotomist or patient care representative. Depending upon the booking mode, the patient is either auto-assigned a phlebotomist by the digital platform or manually by a team of route managers and customer care representatives. The route manager is

mainly responsible for assigning neighborhoods (based on zip code) where the phlebotomists (and riders) will operate (#2). Riders are in charge of collecting the samples from the phlebotomists and dropping them at a nearby diagnostic lab for testing. Once a phlebotomist is assigned, the patient's details, such as address, date and time of sample collection, phone number (by some organizations), and tests to be performed, are shared with them over the phlebotomist's application (Fig 2c) or WhatsApp. The phlebotomist usually calls the patient to confirm the appointment time (#3) and requests the patient to share their 'exact' location over WhatsApp (#4). If the patient cancels the appointment, the phlebotomist must inform their reporting manager about the cancellation (#4').

As per the requirement of sample collection, the phlebotomist visits the Patient Collection Center or the diagnostic lab to collect the required medical equipment (like syringes and containers) (#5). With the equipment, the phlebotomist reaches the patient's house at the scheduled time (#6). Inside the patients' house, the phlebotomist introduces themselves, puts on their gloves, sanitizes their hands, and takes out the required equipment (such as a syringe, tourniquet, container, and bandage) from their sample collection bag (Fig 2a, 2b) to collect the sample (mainly blood, saliva, or urine). After that, the phlebotomist sticks a barcode on the collected sample container(s), scans the barcode using their diagnostic lab smartphone application, and clicks and uploads a photo of the collected sample (Fig 2d). Depending upon the organization's policy, the phlebotomist either deposits the sample at the diagnostic lab themselves (#7') or communicates with a rider to pick up the sample from them (#7, #8, #9) and deposit it at the diagnostic lab (#10).

The workflows of home phlebotomists' are often precarious in terms of compensation, schedule, and job responsibilities. Below we outline the key characteristics of their workflows:

4.1.1 Travel-Intensive and Packed Work Schedule. All of our phlebotomist participants reported that their work starts early in the morning (~5 am) and they work till 2 pm. In this 9-hour work shift, the phlebotomists spend most of their time (~6-7 hours) traveling on their motor scooter/bike (Fig 2a), while the actual process of sample collection takes 2-10 minutes per house. This unique work timing (5am to 2pm) allowed home phlebotomists to work another job part-time in the evenings. For example, P13 worked as a food delivery worker for Rapido[2]:

> "Whenever I get time, I check for orders on Rapido. I turn on my availability, and I start to receive orders... I usually work as a delivery person from 5-8 pm, earning 40 rupees (INR) for each order." (P13)

Similarly, P17 reported working in the marketing department of a diagnostic lab after his home phlebotomy shift. The underlying motivation behind the uptake of additional work among our participants was to generate extra streams of income. However, a few organizations (like Dr Lal PathLabs and Apollo Diagnostics) expected their home phlebotomists to be available till 5 pm. During that lean period of 2pm-5pm, the home phlebotomists usually reported waiting at their respective diagnostic labs (or Patient Collection Centers) to fulfill ad hoc orders acting as clinic phlebotomists. However, they received no additional compensation for these services. On the flip side, the clinic phlebotomists often went beyond their assigned responsibilities to accommodate critical patients (e.g., senior citizens, bed-ridden patients) and reported visiting such patient's house for sample collection [6]. The clinic phlebotomists did not receive any extra compensation for those visits, only the transportation cost was reimbursed. Thus, the unpredictable schedule and context of sample collection often resulted in blurred boundaries of work between the clinic and home phlebotomists.

[2] *Rapido* is an Indian bike taxi aggregator and logistics service provider based out of Bengaluru.

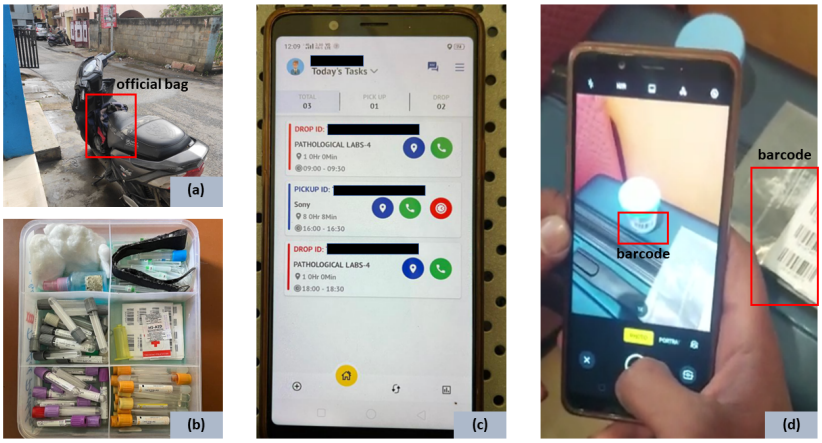

Fig. 2. Images captured during the observation study: (a) Motor scooter of the phlebotomist with the official bag, (b) medical equipment inside the bag, (c) interface of the phlebotomist application listing the pickup and drop details of three samples, and (d) phlebotomist clicking an image of a sample container with barcode pasted on it using the phlebotomist application.

Amidst their packed sample collection schedule, our phlebotomists reported juggling between travel, sample collection, and essential activities like eating and using the washroom. The travel-intensive nature of the job, coupled with technology usage, often led them to compromise on their road safety, as P3 said, "*we have to talk continuously while driving... we keep getting calls from customers.*" Our home phlebotomists did not have dedicated time slots to communicate with the patient, hence they have to manage such communications on the go. They further complained that no extension in the scheduled time slot is provided to account for traffic and weather-related delays. Specifically, the rainy season not only results in increased travel time (due to heavy traffic caused by waterlogging on the Indian roads [60]) but also an increased number of bookings.

> "In the (rainy) season, we get around 10-15 orders a day, whereas in the non-season, only 5-6 orders... Summer is over, so the weather will be very cloudy and rainy. During this time, many people will experience fever and other symptoms... and doctors will ask for more tests." (P3)

Finally, we found the home phlebotomy work to be often unexciting and repetitive in nature, requiring minimal learning of new skills. During the observation study, we noticed that P16 once neither wore a mask nor gloves, risking both their own and the patient's safety. While this may have been an individual behavior, we speculate that the monotonous nature of the work may result in phlebotomists skipping key steps in their workflow.

4.1.2 Uncertainty and Unpredictability in Compensation and Career Growth. We observed that the payment structure for clinic and home phlebotomists was similar across the organizations: clinic phlebotomists received a fixed monthly salary, while home phlebotomists received an incentive of 50-200 INR per house of sample collection along with the fixed monthly salary of 20,000-30,000 INR. However, this differs from other platform workers (like cab drivers or food delivery workers), whose compensation structure lacks a fixed component [26]. We found their incentive component to depend on factors such as the type of the test and distance traveled by the phlebotomist. Our

phlebotomists reported that a significant portion of their incentive was used for their vehicle's maintenance and fuel cost.

Before COVID-19, a majority of our home phlebotomists were clinic phlebotomists. The pandemic accelerated the uptake of the home phlebotomy phenomenon in India, and organizations started offering clinic phlebotomist incentives for home visits. Interestingly, over the past two years, the incentives for home visits have reduced, and even the incentive structure has evolved. For instance, moving from per patient incentive to per house incentive:

> "The sample collection incentive now is based on a house level. If there are four customers in the same house, we will get only 100 (INR). During the second wave and third wave (of COVID-19), it was patient-based... we would get 400 (INR), if there are four customers, even in the same house." (P9)

P9 further explained the rationale behind the high incentive during COVID-19: "*there were very few home collection staff at that time, because all phlebotomists were getting tested* (COVID-19) *positive.*" Thus, to address the high demand for COVID-19 testing and lack of COVID-19 negative phlebotomists, organizations incentivized them with higher pay.

In addition, our participants disclosed that their salary and yearly increment were mainly dependent on the organization's policies rather than on their years of experience as a phlebotomist. Discussing their career trajectory, a few of our phlebotomists aspired to become lab technicians as it is a "*less travel-intensive job*" and utilizes their sample testing skills learned during their phlebotomy education. However, most of our participants lacked a vision for their career growth. They were unaware of the designation after their next promotion. This uncertainty is partly due to the absence of well-defined career paths across digital healthcare platforms, which could be attributed to the fast-evolving nature of home phlebotomy work due to recent digitization. This has led to the introduction of new job roles such as route managers. Despite limited exposure to these newly introduced job titles and associated responsibilities, a few expressed the desire to be promoted to reporting manager or route manager. With high hopes, P11 said,

> "Who knows? Maybe the company would promote me to route manager. I know all the routes, so I am eligible... The current route manager used to be a phlebotomist with us earlier." (P11)

Despite the unclear career progression, our participants aspired for "senior" roles, enabling them to earn more money and/or ease the travel-intensive nature of their work.

4.2 Role of Technology in the Phlebotomy Ecosystem

We observed a varying level of digital adoption among organizations offering home phlebotomy services. Most organizations (like Dr Lal Pathlabs and Apollo Diagnostics) had their own digital platform for both the phlebotomists and the customers, while those without a digital phlebotomist platform (like Aarthi Scans & Labs) relied on WhatsApp/Telegram for communication. In addition, none of the organizations, except Healthians, had a digital platform for riders. Below we discuss the role of technology in surveilling the phlebotomists, the opaqueness of the reward structure with respect to rating, and our participants' coping strategies when technology breaks down.

4.2.1 Digital Surveillance as Inhibitor and Facilitator. All our home phlebotomists reported being constantly monitored through location-based tracking during their regular work routines. This was either conducted through their phlebotomist work application, which required them to keep the GPS turned on, as phlebotomist P6 said "*the app does not function without GPS*", or by the organizations' policy that mandates phlebotomists to regularly share their location to their reporting manager on WhatsApp. None of the phlebotomists expressed any apprehensions surrounding location-based

tracking. Specifically, when asked, most of the phlebotomists appeared to be in acceptance of this form of location-based tracking and considered it as a "*routine aspect*" of their job. Interestingly, a few phlebotomists even believed that by tracking their location during work hours, the organization would safeguard them against any unwanted situation. Apart from location, a few participants were required to share their selfies and more every morning to mark their attendance:

> "In the (phlebotomist work) app, when we login (in the morning), the app asks us for a selfie, photo of our bag, temperature gun, and bike's photo." (P8)

Prior work [57] has documented similar photo-based surveillance techniques by food delivery platforms to monitor workers' usage of masks during COVID-19. In addition, our phlebotomists were instructed to use the in-app calling feature instead of using their personal phone numbers to contact the patients to preserve the privacy of both parties. However, two participants expressed their apprehensions, stating that "*the company (organization) people record these calls*" (P8). It is interesting that although phlebotomists were fine with the location tracking and image-based surveillance of their work life, there was still hesitancy with respect to the organization's listening to the patient-phlebotomist conversations.

Furthermore, our phlebotomists were required to submit digital evidence for every step of their workflow. For example, upon leaving for a sample collection order, our phlebotomists needed to click the "Start" (button) in their application, and upon reaching, the "Reach" button. They also had to capture and upload a photo of the collected sample (Figure 2d). These photos acted as proof that they collected the correct number of vials (tubes) and that each vial is correctly labeled. While our phlebotomists used digital platforms extensively, we observed that they had limited controls over certain functionalities. For instance, phlebotomists could not reschedule/cancel a booking:

> "To reschedule an appointment, we message in the WhatsApp group, '*please reschedule, patient doesn't want to get tested now*'... We do not have the rights to reschedule. It can be done by either the backend team or our manager or the patient. We cannot do it. Similarly we cannot modify patient details." (P8)

Such limited controls often resulted in redundant workflows involving other team members. For instance, if the phlebotomist raised the request for rescheduling due to personal reasons (like an emergency at home, bike accident), they were asked a multitude of questions by the phlebotomist care representative, e.g., "*It wasn't easy to get it rescheduled, we had to provide a lot of justification... like why are you getting it rescheduled? what work do you have? etc etc... they would ask us to complete our bookings and then do our personal work.*" Even if the patient asked the phlebotomist to reschedule or if the patient is unreachable, the phlebotomists were required to submit proof such as call recordings of the patient requesting rescheduling/cancellation or screenshots of call logs showing an unresponsive patient. This hints that the organizations placed minimal trust in their phlebotomists for crucial decision-making, which contrasts with the immense trust placed by the phlebotomists in their organizations.

Although the process of submitting digital evidence (as photos, call logs, and audio recordings) is burdensome, we found that these evidences can help to defend themselves and justify their actions, e.g., P8 described an incident,

> "Clients can lie sometimes (to the customer care representative)... for example, one of my clients said: '*I was waiting for the phlebotomist. I did not receive any calls... I am in a network reachable area only*'. My call history saved me at that time." (P8)

Similarly, in situations involving lost samples, the digital evidence in the form of uploaded photographs helped our phlebotomists to defend themselves. For instance, P06 expressed their viewpoint, *"It's not mandatory to upload the photo, but I still do it... the sample might get lost on its way or*

their might be a leakage... these people would falsely claim that we collected less sample... but I have a photo that I had collected the sample in this much quantity." This demonstrates that phlebotomists trust their organization to utilize this data for their benefit and safeguard them when required. Overall, we found these digital platforms being used by organizations to exercise and govern control over the workflows of phlebotomists, also reflective of their authority; however, on the flip side, they can help safeguard phlebotomists' interests in unprecedented situations.

4.2.2 Digital Ratings induce Penalties and Rewards. We found all the organizations (where our phlebotomists were employed) allowed the customer to rate the phlebotomist and provide feedback. However, the phlebotomist could not rate their patients. A few phlebotomists reported having no monetary impact of customer ratings, while others reported getting penalized and rewarded based on ratings. Our phlebotomists lacked a definitive understanding of the rating's impact on their compensation. Interestingly, one of our phlebotomists hoped to get a monetary incentive for his high rating: "*Patients have to rate us... My rating is 4.9* (out of 5). *See it's shown here in the application along with my name and photo. This rating has no impact on my salary... I wish it had an impact.*" On the other hand, phlebotomist P3's incentive was dependent on the customer's feedback. He reported, "*For every sample collection, we get paid between rupees 160 to 190, based on the customer's rating in the app.*" However, P3 was unclear on how the exact amount is calculated on the basis of the patient's rating. Similar to our findings, prior literature on the gig economy and on-demand platforms has extensively discussed the impact of ratings on worker's incentive [4, 51]. Our patient interviews revealed that they assumed there was no direct impact of rating on the phlebotomist's compensation. If they would have been made aware of the impact, they would have rated the phlebotomists more generously.

In addition to customer rating, all our phlebotomists were tracked for delays in home sample collection, usually with a buffer period of 10-30 minutes from their scheduled time. Depending on the organization, a few phlebotomists mentioned weekly/monthly delay reports being shared in their WhatsApp group to receive appreciation or humiliation from other phlebotomists group members, without any monetary deduction.

> "We receive a message on WhatsApp group every week showing who completed their collections on-time, who all delayed how many orders... Others comment on it... They say that this much salary will be deducted, but they haven't deducted anything till now... They do these things to scare us." (P11)

However, few organizations did penalize phlebotomists for such delays. P3 described a tech-facilitated penalization:

> "If the first customer's appointment is early morning like 5 am, then we cannot delay that... It's the company's rule... If I am late by more than 10 minutes on my first visit, then 200 rupees (INR) get deducted... If we do not get any penalties in a month, then the company pays us 2000 rupees extra." (P3)

Overall, we observed a mixed impact of rating and delay in sample collection on the phlebotomist's compensation. Moreover, we found the impact to be opaque for both the patient and the phlebotomist.

4.2.3 Technology Breakdown, Limitations, and Workarounds. Although the adoption of digital platforms within home phlebotomy is accelerating, the technology is still in its nascent stage, and we found it to fail often, with the phlebotomists resorting to innovative workarounds, which aligns with prior work [53]. To begin with, the patient location displayed in the phlebotomist's application was often inaccurate. As a result, our phlebotomists relied on alternative workflows, using a combination of phone calls, location sharing over WhatsApp, and Google Maps to navigate

to the patient's house, resulting in redundancy. Organizations usually mask the contact details of both the phlebotomist and the patient in their respective smartphone application. However, patient sharing their location over WhatsApp results in both the parties sharing their phone number with each other, thus unintentionally compromising their privacy.

Home phlebotomists require a working smartphone with a good internet connection for communication, navigation, and to complete their workflow. In our observation study, one of the phlebotomists realized his smartphone's battery was low during his first sample collection of the day. He quickly contacted a few of his friends and borrowed a power bank from one of them. Our phlebotomists thus remained resilient and seek help from their personal networks and/or developed other workarounds to cope with technology breakdown. Another phlebotomist P3 described borrowing patients' WiFi due to low network connectivity in certain regions. In case the WiFi is unavailable, he reported going "*outside their home to check the details on the app, come inside and collect the samples, and again go outside to complete the work order entry* (in the app)." In addition, the algorithmic assignment of a phlebotomist to patient is based on zip codes. However, the technology is not robust enough to account for unforeseen circumstances, such as a phlebotomist taking leave or a last-minute vehicle breakdown. The route manager was responsible to handle such cases.

Besides unexpected breakdowns, our participants mentioned several limitations of current technologies. State-of-the-art technology cannot verify the information entered by the patient while booking. For example, most organizations prohibit home sample collection for children below 5 years of age. P3 mentioned,

> "Home sample collection of someone less than 5 years old, that is kids, is a bit difficult. So sometimes they (customers) enter an increased age of the kid and book the test. We then face problems once we reach their home for sample collection." (P3)

In addition, a few digital platforms require their phlebotomists to collect sensitive patient-health data (such as blood group, weight, and height). Our observation study highlighted the importance of educating phlebotomists about the sensitivity and criticality of collecting such health data. Specifically, we observed an incident wherein P16 inaccurately filled in the health data as per his own judgment without even asking the patient indicating a lack of understanding about its significance and usage. On the other side, a patient participant (S1) shared that the customer application of his preferred diagnostic lab recommends diagnostic tests, most likely based on his age, gender, height, and weight. Thus, inaccurate demography data entry by the phlebotomist can have a negative impact on the patient. It is crucial for digital healthcare platforms mandating the collection of such data to ensure that phlebotomists are informed and trained to collect and handle it appropriately.

4.3 Human Infrastructures in Phlebotomy Work

Besides technological infrastructures, our phlebotomist participants leveraged several human infrastructures at various stages of their professional journey. Here, we discuss phlebotomists' labor relations and interactions with other stakeholders in the phlebotomy ecosystem, including riders, patients, and organizations. We also discuss the role of their personal and professional networks acting as their support system, particularly for female phlebotomists.

4.3.1 Interactions within Phlebotomist Ecosystem. The phlebotomy ecosystem comprises multiple stakeholders. We focus on the three key stakeholders–rider, patient, and organization–and discuss their interactions with the phlebotomist.

Phlebotomist-Rider Relationship: Riders are key to the home phlebotomy service but are completely invisible to the patients. The prerequisite for the rider position is that the individual

must have a driving license and access to a motor scooter/bike. One of our riders stated that females are not preferred for the job because:

> "It's a very risky job. Sometimes even at night, we have to ride a bike... Ladies can't be hired for our job. It's not that they can't do the work, but it might be hard for the ladies to ride 200 km everyday. Some (of us) even have to ride 300 km a day." (R1)

Moreover, riders are expected to be smartphone users. Riders were subjected to location-based surveillance and were required to provide frequent sample delivery-related updates, similar to phlebotomists (as described in Section 4.2.1). To collect the sample, the rider met the phlebotomist either at the Patient Collection Center (PCC) at fixed schedules throughout the day, or they met on the roadside at a mutually convenient location. P9 shared,

> "A runner comes here at 1 pm... There are several PCCs... There are several batches—the first batch is at 10 am, the second batch is at 1 pm, and then at 3 pm and 5 pm. A runner arrives to collect the sample at each batch time and transports it to the main diagnostic lab." (P9)

In the case of P16 and his rider, their meeting location was fixed, and the timing of the meeting was conveyed to the rider by the phlebotomist based on the sample collection status. We present a vignette from our observation study:

> After collecting samples from the patient's house, the phlebotomist stops at a small tea shop on the road to have a cup of tea with biscuits and cigarettes. He smokes a cigarette as he waits for the runner. The runner arrives, scans the barcode pasted on the sample test tubes using his smartphone app, and marks it as "received". After completing the task, the phlebotomist shares a cigarette with the runner. Then the runner departs to drop the sample in the diagnostic lab.

This workflow helped home phlebotomists to socialize and strengthen their relationships with other stakeholders in the ecosystem, particularly riders.

Phlebotomist-Patient Relationship: Home phlebotomists directly interact with patients, acting as the face of the organization. This provides phlebotomists with an opportunity to build deep relationships with patients. Such relationships helped them obtain more sample collection orders. For instance,

> "I used to take patients' complete medical history, like which diseases they have? Then I used to send reminder messages for their upcoming tests. For example, if there's a thyroid patient, then I used to call once every three months and say, '*Ma'am, it has been three months, did you get your thyroid tested? If you haven't gotten it done, then should I come tomorrow?*' They will usually say, '*Yeah, just come.*' (P12)

P12 displayed care for his patients and developed great relationships with them, encouraging him to open a diagnostic lab with his trusted base of customers. We found our patient participants reciprocating that relationship by referring their trusted home phlebotomist within their social circle.

While most patient-phlebotomist interactions were positive, during our interviews, a few participants shared negative experiences. Among our patient participants, such complaints comprise of errors in the sample collection technique of the phlebotomist, or the phlebotomist reaching late for sample collection. For instance, patient S2 shared that she lost her temper, and "*called the patient care* (representative) *as the person* (phlebotomist) *who was sent did not have enough experience in taking blood samples... even after pricking twice, he failed to draw blood.*" Similarly, P13 was publicly humiliated by an elderly patient on reaching his location late. He narrated,

> "I already informed him an hour back that I will reach by 8 o'clock... Because of the traffic, I was 10 minutes late. When I went (reached) to the customer's location, he started scolding me outside of his house. Everybody was watching that... We are professionals. How can we take all this? I left and informed the team (manager) that the customer did that." (P13)

Irrespective of the patient's behavior, we found our phlebotomists to be empathetic towards their patients. Such incidents highlight patients' high expectations of on-time, error-free service from home phlebotomists, which they might have come to expect because of their past positive experiences with phlebotomy services in India. Defying these expectations, a sentiment that echoed across our phlebotomists was put into words by P6: "*In any work you do, 100% accuracy cannot be guaranteed.*" In addition, despite having a professional degree, our phlebotomists reported being treated with minimal respect by a few patients. P8 stated that the phlebotomist's job is a "*very thankless job where every moment we have to justify ourselves...* (for the organization) *the client is always correct.*" The absence of a grievance redressal mechanism for the phlebotomists' work-related issues demonstrates the organization's preference of patients over phlebotomists.

Phlebotomist-Manager Relationship: We found that home phlebotomists working for diagnostic aggregator platforms (like Tata 1mg and PharmEasy) were hired on a contractual basis, similar to a typical platform economy model. In contrast, phlebotomists associated with diagnostic labs (like Dr Lal PathLabs and Apollo Diagnostics) were permanent employees of the organization. Although none of our phlebotomists received benefits like health/vehicle insurance from their organizations, all of them reported receiving reimbursement for their smartphone monthly bills. Our phlebotomist participants said they refrain from arguing with the customer, even after receiving disrespectful comments, as it would negatively impact their organization's reputation. This illustrates the organization-first approach followed by our phlebotomists. P12 adopted the following strategy:

> "When the patients begin to yell, I try to calm them. If they are calm and convinced, then that's good. If they are not, I leave and tell my manager about the entire event. I tell him: '*If you receive a call about it, please handle the situation*'... The manager does not support anyone. He will shout at us first, and later he will shout at the patient behind his back." (P12)

Despite P12's concerns about the manager's lack of action in response to patient misbehavior, our phlebotomists reported such encounters to ensure that their manager was aware of any potential complaints from the patient. Interestingly, one of our phlebotomists (P4) even mentioned receiving emotional support from their manager, who also arranged for another phlebotomist to visit in response to a difficult patient encounter. Therefore, in the absence of a formal grievance redressal mechanism, our phlebotomists trusted their reporting manager, and reported unpleasant patient encounters to them immediately.

They also mentioned seeking support and advice from their fellow phlebotomists. This informal support structure served as a valuable resource for our phlebotomists in navigating challenging patient encounters and strengthening their relationships with their managers and coworkers. In addition, we found that home phlebotomists' workflows provided them with opportunities to build and further strengthen these relationships. For instance, we observed P8 to chat, laugh, and have lunch with his reporting manager and other coworkers while waiting for the next set of orders.

Apart from that, phlebotomists mentioned receiving verbal instructions from their reporting manager on behalf of their organization to "*increase business*" by enrolling new patients, recommending new tests to the scheduled patient (if needed), and informing patients about test packages

and ongoing deals. While phlebotomists were not obligated to participate in these activities, occasionally, monetary rewards are associated with them to encourage phlebotomists. For instance, P3 shared: "*If we feel that we should recommend these tests, then we do recommend them. We are also advised by the company's end to add extra tests and increase the sales... We get a 20% commission on such test referrals*". Such revenue-boosting techniques not only help the organizations to increase their sales but also help the phlebotomist to earn more. Our phlebotomists reported selectively recommending test packages to patients based on their perceived potential health and/or monetary benefits. This personalized approach not only added value to the services provided but also fostered long-term trust with patients.

4.3.2 Personal and Professional Networks of Support. Most of our phlebotomists' choice to pursue phlebotomy as a career was highly influenced and conditioned by someone within their closed personal network (e.g., friends, family) who was already working as a lab technician or in related areas like nursing. People in their personal networks talked affirmatively about the future scope and career opportunities in this profession. For instance, P6 mentioned how the presence of 8 lab technicians within his family nurtured his interest since his early years:

> "From 10th standard, I was interested in (the profession of) Lab Technician only. There are 8 lab technicians in my house (family)... all my brothers, sisters and cousins. My brother guided all of them. He works in a hospital himself." (P6)

Besides influencing career choice, our phlebotomists reported continued utilization of these personal networks as they ventured into the job market. Seven phlebotomists mentioned that they were referred to their first job by a friend or relative already working in that organization.

Our phlebotomists established a strong professional network with other home phlebotomists across organizations and with other stakeholders in the phlebotomy ecosystem (like riders and managers). This resulted in the blurring of boundaries between personal and professional networks. Our phlebotomist participants continued to exploit these networks to seek support, negotiate and optimize their daily workflows. Whenever in need, we found our participants to delegate their assigned orders among their network of phlebotomists (within the organization), as P8 described,

> "Suppose if I have collections in my ID, but I can't go as I am not feeling well. I will just ask some other phlebotomist where you are... if he said *Moti Nagar* (name of a locality in Delhi), then I'll request him to do my *Moti Nagar* orders. Similarly, one of the phlebotomists today had to get his bike serviced, so he asked me if I can do his orders, and hence I am doing his collections as well." (P8)

Additionally, our phlebotomists also transferred orders within their closed networks to optimize their earnings. They either borrowed bookings from their friends or transferred their bookings to a friend phlebotomist when the incentive component was not lucrative enough provided the travel cost and time required for that sample collection. For instance, P8 described, "*... traveling that far for a single collection will be stupid... it will take a lot of time... that's why we ask someone else to do it.*" He further added that there there are occasions when the phlebotomists express reluctance to travel long distances due to challenging weather conditions (like heavy rainfall). Upon mutual agreement, our participants got the bookings transferred among themselves. To do so, they need to contact the phlebotomy care representative team, and request the transfer of the order ID from the originating phlebotomist's account to that of a different phlebotomist. When asked about the organization's stance on order transfers, P8 added, *"[phlebotomy care representative team] has no problem with the transfers of bookings, they just want the collection to happen on time... and that there should be no complaints... they don't care who is doing the collection and how they are doing it."* Interestingly, P8, who was assigned two bookings for the day, mentioned collecting 15

orders by borrowing orders from his friends. This indicates that despite the rigorous schedule and variable pay, phlebotomists used these strategies within their networks to maximize their income. Moreover, the act of transferring orders, built upon mutual trust and reliance, serves as a catalyst for promoting collaboration and teamwork among the home phlebotomist. Finally, one of our home phlebotomists who is now also an entrepreneur running his own diagnostic lab, discussed the importance of personal and professional networks built over the years. He leveraged his network of phlebotomists, friends running other diagnostic labs, and his trusted patients, in the day-to-day operations of his organization.

Overall, we found that phlebotomists are a part of a close-knit network that is utilized in different stages of their professional careers for optimizing workflows and career advancement.

4.3.3 Multi-faceted Support for Female Phlebotomists. Our phlebotomist participants pool comprised of 4 female phlebotomists, who were primarily recruited for clinic-based phlebotomy work but were also involved in home sample collections. Home phlebotomy service has a male-dominated workforce [49] perhaps due to the travel-intensive nature of work and safety concerns associated with home visits, which also resonates with other similar on-demand mobile professions like cab drivers and food delivery workers [4, 26, 52]. Despite that, our 4 female phlebotomists reported having access to multi-faceted support that extends across both the professional and personal fronts.

Three of our female phlebotomists did not have access to a vehicle for commute, which is often a prerequisite for a home phlebotomist. However, they all received commute support from their personal or professional network. One of them was provided a car with a driver by her reporting manager, showcasing relationship-building due to the phlebotomists' workflow. Another participant talked about the immense support from her husband. She said,

> "If he's at home, he'll only take me for sample collections. If I do not know the place where I have to go for collection, or do not get an auto(-rickshaw), or if it is raining, he takes me to that place and waits outside (the house)." (P15)

Besides commute, we observed female phlebotomists receiving additional support from their employers to ensure their comfort and safety. For instance, P5 shared: "*If there are only males* (in the patient's home), *then I will not go. If there are female family members, then only I will go. Otherwise, my senior will send someone else.*" Access to such support to female phlebotomists would help bring more female workers to this otherwise male-dominated workforce.

To minimize privacy risks, two of our female phlebotomists were advised not to use their personal phones to communicate with patients and only rely on the official smartphone for such communication. Our female participants mentioned receiving strong peer support at the workplace, which helped them in learning and upskilling, as well as in maintaining a work-life balance. (Note: None of our 12 male phlebotomist participants mentioned peer training.) For example, P15 described how her senior colleague taught her the procedure to draw multiple blood samples quickly:

> "She is senior to me... she has vast experience. I learnt from her how to work with huge volume of patients... I have even collected 500 blood samples at one go, in camps." (P15)

Additionally, the unsaid understanding and support among peers benefited in the division of responsibilities in a mutually convenient manner and also helped them take out time for personal chores. For example, P14 said, "*We go home during lunch. If a patient calls, then we travel back immediately. In case of a busy schedule, we take half an hour break, one person will go and come, the other person will go and come—that's how we manage it.*"

5 DISCUSSION

Our findings detailed phlebotomists' workflow, the role of human infrastructures throughout their phlebotomy career, their labor relations and interactions with other stakeholders in the ecosystem, and the crucial role of technology. We observed that while the increased digitization and platformization facilitated home phlebotomists in conducting their workflows more efficiently, it also served as a tool for organizations to constantly surveil their work and movements. We now reflect on what our findings suggest for the future of health and healthcare workers. In particular, we first offer insights to design more equitable futures of platform gig-workers, then outline the future of platformized health, and finally discuss design implications for telehealth platforms offering home diagnostic test services.

5.1 Towards a *Hybrid Model* of Platform Work

Several comparisons and contrasts can be made between the workflows of home phlebotomists with (traditional) platform workers employed in other professions. We believe that learnings from the home phlebotomy context might extend and help envision more equitable futures for other platformized workers, also called gig workers. Prior research has highlighted several challenges faced by gig-workers [44, 51].

First, the absence of worker networks lead to atomization and isolation among gig-workers [55, 67]. In contrast, the role of home phlebotomists required them to frequently interact with other stakeholders of the healthcare ecosystem—during sample collection and submission, while delegating orders, and even for grievance redressal. This, in turn, resulted in network visibility and enabled them to socialize, collaborate, and build strong peer networks. An interesting utilization of these peer networks emerged as our home phlebotomists leveraged these to optimize workflows and maximize earnings by transferring and borrowing sample collection orders among themselves. We believe that situating similar human infrastructures within the traditional platform ecosystem could foster collaboration and support low- and mid-skilled workers better. Furthermore, our home phlebotomists found these infrastructures particularly beneficial during challenging patient encounters. Prior studies on gig workers has discussed customer interaction as a major challenge [26]. Despite being medically-trained professionals, our phlebotomists sometimes did not receive the respect and dignity they expected from patients due to biases against their work as 'door-to-door' professionals. Though disrespected by a few, they held an overall better professional standing compared to other platform workers, attributed to their 'evident' medical training. Going forward, we encourage technologists to think of ways to reinstate dignity and respect towards low- and mid-skilled workers through digital platforms. One potential approach is to highlight their experience in the given profession and incorporate that into the rating system, thereby mitigating the negative perceptions associated with mobile workers.

Second, traditional on-demand platform workers are generally paid per task [44], leading to precarity in payment conditions [13, 44, 50, 65]. Despite the "gig" nature of our home phlebotomists' work, their salary consisted of a fixed component accompanied by an incentive per sample collection, which helped ensure a minimum salary. However, we found our home phlebotomists pursuing additional jobs (similar to prior findings in gig-worker literature [39]), to generate extra income. In contrast, for other platform workers, it was the precarious conditions that motivated them to pursue additional jobs [39]. Recently, on-demand platforms such as *Zomato* started experimenting with a compensation model that ensures food delivery workers a minimum fixed income along with an incentive per delivery [29]. Such an incentive model might help reduce the uncertainty around the compensation structure of platform work. Third, past studies in ride-hailing literature have reported drivers regularly engaging in 'emotional labor' in exchange for higher ratings [51], as ratings are

directly linked with the rewards and penalties. Apart from compensation, customer ratings are sometimes used to classify drivers into categories like gold and platinum [14]. Our findings also described the use of digital ratings provided by the patient to surveil the phlebotomist's performance. However, only one organization regulated phlebotomists' monetary compensation based on their digital ratings. Since digitization in home phlebotomy is still nascent, rating mechanisms and their impacts were mostly opaque to the phlebotomists. Like other gig-work, we found home phlebotomists to engage in emotional labor with their patients, but primarily due to their medical responsibility of comforting the patient. While there are immense opportunities for the phlebotomy ecosystem to learn from the merits and failures of the rating system in typical on-demand platforms, it might be of value to understand how algorithmic ratings in telehealth services impact the trust between patients and healthcare providers. More specifically, *what will be the patient's perception towards a low-rated phlebotomist or a non-'premium' phlebotomist?*

Lastly, prior studies in on-demand platform literature have highlighted the lack of trust among workers in the platform [44, 53]. Specifically, the key reasons behind distrust are unfair compensation practices and unnecessary surveillance [53]. While a similar sentiment echoed among our phlebotomists concerning the submission of digital evidence and the need to constantly justify their work, interestingly, we observed that our phlebotomists trusted their organizations. The reason for such trust could be linked to the presence of human infrastructures consisting of reporting managers, route managers, and peers to share, discuss, and resolve complex problems (related to compensation, surveillance, or customer complaints). In a typical gig work, due to the absence of a human face, the worker can only rely on their on-call care representative, who lacks agency and training to provide support and address their grievances.

The learnings from our study could help envision a *hybrid model* of platform work, where both human infrastructures and digital platform augments each other and not every workflow needs to be algorithmically mediated, where the compensation is a combination of fixed payment and per task incentive, where the impact of ratings is transparent to both workers and customers, and where there is visible human middle management to support the workers.

5.2 Future of Health Platformization

Insights from the home phlebotomy ecosystem can guide the design of future healthcare platforms. We now discuss concrete design recommendations for digital health platforms that could facilitate secure and transparent workflows for phlebotomists, foster trustworthy phlebotomist-patient relationships, and expand the role of phlebotomists.

Designing Transparent Incentive Mechanisms. Despite the increasing adoption of rating mechanisms by organizations to monitor the performance of phlebotomists, most of our phlebotomist participants lacked an understanding of its impact on their compensation. Moreover, even our patient participants were not educated about the role ratings play in defining the compensation of the phlebotomist and, at times, give (random) ratings without much thinking. Therefore, there is a need to design transparent rating mechanisms that clearly explain the impact of rating on their compensation to both parties—patient and phlebotomist. Moreover, it is important to clarify the impact of these ratings on other attributes of phlebotomists' work, if any (e.g., number, type, location of assigned orders, career growth). For example, *Tata 1mg* introduced a "premium phlebotomist" feature (now taken down) which allowed patients to request expert phlebotomists by paying an additional amount of INR 99 [2]. It is, however, unclear on what basis (platform rating, education, or work experience) they categorize phlebotomists as experts. Future research could investigate the consequences of such categorizations on healthcare delivery experiences.

Designing to Elevate Phlebotomist-Patient Trust Relationship. A common misconception among our patient participants was that home phlebotomists were less experienced than clinic phlebotomists. To promote trust within home phlebotomists, the patient app could display parameters such as the phlebotomists' qualification, years of experience, and some (positive) reviews from previous patients. From the phlebotomist's perspective, we observed that existing platforms had limitations in verifying patient-entered information, particularly in the case of pediatric phlebotomy. It becomes crucial to design technology for governing patients' actions and boost phlebotomists' trust in their customers. For instance, strict verification checks through proof of identification could be introduced during patient registration to avoid incorrect patient bookings. In addition, our phlebotomists reported collecting digital evidence, such as screenshots of call logs, to justify cancellation requests. These manual self-logging measures for collecting digital evidence are additional workflows for phlebotomists. Future research could develop techniques to auto-track phlebotomist-to-patient call logs and automatically share them with the reporting manager, thus minimizing the additional workflows undertaken by phlebotomists. For instance, the reporting manager could receive an automated message notifying that *"Mr. A phlebotomist tried calling Mr. B patient thrice..."*

Despite having an official digital platform, our phlebotomists used a multitude of applications. This not only resulted in redundant workflows [62] but also led to the scattering of patients' private data (e.g., address) across applications such as WhatsApp and Google Maps. Their digitally stored data will persist and be accessible to the phlebotomist in their personal (unofficial) applications even after the house visit, which could negatively affect the patient's privacy. This is in contrast to the official phlebotomy application, which revokes access to the patient's private data immediately after the house visit. We envision two opportunities for the design of future health platforms to mitigate these issues. First, the phlebotomist application could be designed to integrate end-to-end workflows so that the phlebotomists do not require switching applications. It could entail additional workflows like directional navigation, text messaging, provision to update the reporting manager with their location, etc. Second, organizations could exploit existing popular platforms to support phlebotomists' workflows instead of introducing a new application. Prior research has highlighted that users often appropriate existing platforms than using custom-built ones for conducting their workflows [25, 34, 63]. For instance, existing chat applications (like WhatsApp) could power phlebotomist workflows, as communication and location sharing are key components of their work. An official WhatsApp-based chatbot could be designed where the phlebotomist could receive patients' details, provide updates of their location, send pictures of the collected sample, collect payment, etc., and any private patient data could be automatically erased after the sample collection process.

Designing for Role Expansion. Besides home phlebotomy, digital telehealth platforms offer a suite of patient-centric services. Teleconsultation, in particular, received a major uptake as a consequence of the COVID-19 pandemic. Despite the success, previous work has identified that the key cause for its relegation to the peripheries of healthcare infrastructures is its inability to perform physical examinations [7]. Mid-skilled healthcare workers, such as home phlebotomists, can supplement remote teleconsultation services by acting as intermediaries between the doctor and the patient [9], thus substituting for the doctor's physical presence. For instance, Bhat et al. [7] highlighted the challenges a patient faces in maneuvering the phone camera to capture themselves during a dermatology teleconsultation session. The health platform should enable booking home phlebotomists to provide such assistance in the future. They could also assist the patient in better understanding the doctor's instructions about the treatment, adding a physical human touch to the otherwise remote teleconsultation service. Such added work opportunities could serve as a means for phlebotomists to overcome the monotonous nature of blood sample collection tasks. Moreover, with adequate

training, there is a possibility to even further expand the role of home phlebotomists to upskill and perform more precise tasks such as recording chest and lung sound using a digital stethoscope [35], capturing a video of their ear using a digital otoscope [9], if needed by the doctor prior or during a teleconsultation session. Such technology-aided human intermediaries could support doctors in teleconsultations through remote, recorded physical examinations and has the potential to increase the role of mid-skilled health workers as well as the scope of health platforms in the future.

5.3 Limitations

We acknowledge several limitations of this work. First, as all our participants were from 2 urban cities in India, our findings may not generalize across the country given its rich socioeconomic diversity. However, given the increasing digitization in healthcare, findings in the context of urban cities might be valuable as platformized health services gradually seep into semi-urban and remote areas of India. Second, although we tried to interview different stakeholders in the home phlebotomy ecosystem, we could not interview route managers and reporting managers due to their packed schedules as they monitored the workflows of phlebotomists and riders (~20). Finally, we acknowledge reporting limited findings from the patient and rider interviews. This might be attributed to the respective small sample sizes. Moreover, we found most of the insights from our patient and rider interviews to be either not directly connected with the phlebotomist's workflow (which is the focus of our paper) or already covered in the phlebotomist interviews.

6 CONCLUSION

To understand the home phlebotomy ecosystem in India, we conducted 26 semi-structured interviews with key stakeholders, including phlebotomists, patients, and riders, along with observational studies of 3 phlebotomists. In spite of the close resemblance between home phlebotomy work and typical gig work, we found key differences with respect to the social support system and compensation structure, thus envisioning a hybrid model of gig work. The strong support network was leveraged by our phlebotomists to delegate orders, optimize earnings, and share grievances. In addition, we uncovered the role of platformization as an inhibitor by location-based surveillance and redundant workflows, as well as a facilitator with the digital evidence of work safeguarding them in difficult situations. Based on our findings, we propose a future of health platformization, with home phlebotomists intermediating teleconsultation, serving the low-income community, and relying on a single platform to minimize patient data leakage risk. We also propose design recommendations to improve the transparency, trustworthiness, and confidentiality, within the phlebotomy ecosystem.

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Received January 2023; revised July 2023; accepted November 2023