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Discussions With End Users to Inform the Vision for a Shared Care Record in Ontario: Qualitative Interview Study

Marta Chmielewski¹, BSCN, MPH; Matthew J Meyer²,³,⁴*, PhD

¹Public Health Program, Schulich School of Medicine & Dentistry, Western University, London, ON, Canada
²Middlesex London Ontario Health Team, London, ON, Canada
³Office of Health System Transformation, London Health Sciences Centre, London, ON, Canada
⁴Department of Epidemiology and Biostatistics and Interfaculty Program in Public Health at the Schulich School of Medicine and Dentistry, and the Ivey Business School, Western University, London, ON, Canada

* all authors contributed equally

Corresponding Author:
Marta Chmielewski, BSCN, MPH
Public Health Program
Schulich School of Medicine & Dentistry
Western University
1465 Richmond Street
London, ON, N6G 2M1
Canada
Phone: 1 519 685 8500 ext 56765
Email: mchmiel2@uw.ca

Abstract

Background: Improving the health outcomes of populations of individuals through population health management requires the use of electronic health records that can exchange real-time digital information using an accurate and complete shared care record that is accessible to health care providers, services, and patients.

Objective: The aims of this study were to understand end users’ (health care providers) experiences, attitudes, and insights using current electronic health records; their expectations of what is required to establish a shared care record; and how they anticipate adapting to the use of a shared care record in daily practice. This work is the result of a quality improvement initiative deemed not to require ethics approval according to the Western research ethics board checklist.

Methods: Clinicians were contacted using voluntary response sampling and interviewed via Zoom (Zoom Video Communications) between June 2022 and July 2022. The participants were from various health care sectors and at various stages of career development.

Results: Overall, adaptation to the use of a shared care record was viewed positively by health care providers, highlighting the benefits of a centralized, shared, and accessible location for real-time data, promoting patient continuity of care. The main concerns included the privacy, confidentiality, and security of the record along with patients’ ability to interpret their own medical information found in a patient portal. The resources requested by end users included multifaceted ongoing training on the use of a shared care record.

Conclusions: This study provides practical findings that will help emphasize factors that facilitate clinicians’ practical use and process of adaptation to the use of a shared care record.

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Keywords
population health management; shared care record; health information exchange
**Introduction**

**Population Health Management**

Defining population health management (PHM) requires taking a step back and thinking of the bigger picture. The Population Health Alliance PHM framework explains that “a population health management program strives to address health needs at all points along the continuum of health and wellbeing through the participation of, engagement with and targeted interventions for the population” [1]. Their definition specifies that the goal of PHM is to uphold or improve the “physical and psychosocial wellbeing of individuals through cost-effective and tailored health solutions.” Breaking it down, PHM involves the use of data to proactively manage the health and well-being of an identified population of individuals while considering the diversities within that population along with their social determinants of health [2]. PHM is a constantly progressing concept that is increasing in popularity worldwide. For example, in Ontario, PHM has been characterized as a fundamental element in Ontario’s health system transformation. In the Netherlands, several PHM initiatives are working to tackle the health-related social needs of residents by building partnerships among medical care, public health, social services, and community-based organizations [3]. Managing populations of patients based on their diagnosis while maintaining their health and keeping them out of dangerous circumstances has recently become popular as it affords the ability to deliver high-quality and efficient care that is satisfying to everyone involved [4]. Examples of leaders in PHM and integrated health care delivery include those in Denmark, Spain, and the United States, such as Geisinger, Memorial Hermann, the Department of Veterans Affairs, and Kaiser Permanente. Another important mention is Epic, a widely used software company among hospitals that allows for the exchange of medical records across organizations in the United States and beyond. They are all highly regarded for high-quality and efficient health care through integrated care delivery processes [5].

PHM can be viewed as improving the health outcomes of a population using appropriately coordinated care and proper patient engagement, which is sustained through adequate economic and care models [6]. The question then becomes how to best support the entire population clinically and financially. According to the Health IT Playbook [7], examples of PHM services involve efforts to proactively help people improve their health, guarantee they obtain preventive screenings, and help them effectively manage their chronic conditions. A vital feature of this approach to care delivery is that the population whose health is being managed is a complete group of people, not only those who are pursuing health care. This population can be defined in ways such as all the employees of an employer, members of a health insurance plan, or residents of a community, but the key feature in PHM is that the health of all members of this population is considered [7].

Another crucial aspect of PHM is coordinating a diverse and progressive group of stakeholders who work together to provide programs, services, and tools for interoperable care for patients in various health care settings [8]. This is also where the integration of services occurs, such as financing and delivery of health care working together [4]. According to Jones and Smith [4], an entirely integrated care system is defined as both horizontally and vertically integrated. Vertical integration combines provider and care delivery, financing, and support services such as IT. Horizontal integration combines provider services, home health services, hospitalization (tertiary and secondary), and ambulatory care, entailing continuous and seamless care [4].

**Health Data**

The growing burden of chronic diseases challenges health care system sustainability in countries worldwide. Working toward coordinating care to prevent unnecessary hospitalizations is a crucial solution to limiting increasing health care costs. According to Burnel [9], to reach this goal, clinicians and professionals must be able to exchange information using electronic health records (EHRs). An EHR is a real-time digital form of a patient’s health care record, allowing information to be available to providers authorized to access it across different health care organizations instantly and safely [10]. Beyond providing a patient’s collected medical data, an EHR offers a comprehensive view of a patient’s care. An EHR contains information from all providers involved in a patient’s care concerning admission documents, diagnostics, ongoing assessments, and health care plans and can be shared with other health care providers; caregivers; patients; and organizations, including laboratories, medical imaging facilities, specialists, pharmacies, and clinics [10]. EHRs make it possible to reduce medical errors, increase health care provider communication, and improve care coordination [11]. The broad implementation of EHR systems in primary care has permitted the compilation of enormous amounts of clinical data that have the potential for secondary use, such as improving clinical programs, system management, and population health research [12].

**Shared Care Record**

With EHRs in mind, the concept of the shared care record is introduced. A shared care record is an enabler that helps allow PHM to be possible. According to the Patient, Family, and Caregiver Declaration of Values for Ontario [13], to enable integrated care, each resident in Ontario ought to have access to their health-related information record, which is “accurate, complete, available and accessible across the provincial health system at [their] request.” The record should be accessible to health care team members and patients as required and in a manner that encourages appropriate care and positive experiences. A complete and accurate shared care record includes up-to-date information about the person and their demographic information, the administrative services they use, their medical or clinical information, and additional health-related information involving the social determinants of health.

Shared care records permit all primary and secondary care providers to view and use a single dependable source of documentation that is up to date and provides accurate clinical information in real time about a patient [14]. It is about giving everyone access to the information they need but does not require everyone to be on one common information system.
Patient records from a variety of care providers and sources can be linked through a health information exchange (HIE) system. The vision of the shared care record would give providers, in the home database system they work in daily, access to information captured about their patients from other care providers and other systems. For example, a provider (or patient) can view medications prescribed by provider A alongside those prescribed by provider B in the same place even if providers A and B use different EHR technologies. This information could come from their primary care records, home and community care records, community mental health and addiction records, or hospital systems. Systems worldwide are using this approach to link information on allergies, laboratory test results, procedures, appointments, and much more. The HIE simply enables information exchange between systems, for example, between hospitals and primary care [15]. Moving this information between the systems aims to help the care team locate and use the correct information to provide safe, efficient, and equitable patient-centered care. This means that a patient only needs to describe their health care history once instead of sharing it multiple times at each health care encounter. If done properly, information from this system can also provide information to public health teams to understand the health and health needs of the population [15].

The Need to Reform Service Integration in Ontario

The current health care system in Ontario is experiencing increasing strain from the aging demographic, overloaded hospitals and emergency departments, and a significant increase in chronic diseases, putting our care delivery model at risk [16,17]. Completely changing the Ontario model of health care delivery is not feasible; therefore, we must work with the existing structures. One example is health IT systems that can be better connected to improve workflows; centralize health data; and deliver information to health care providers, patients, and families where and when they need it. Ontario is not alone; fragmented care exists among health care systems worldwide involving a lack of communication between primary care physicians, other health care providers, specialists, patients, and families, leading to negative impacts on patients and gaps in continuity of care. Many systems have realized the benefits of interoperability, “defined as the ability of different health information systems to cooperatively access, integrate and exchange data to advance effective delivery of health care” [16].

Several obstacles must be kept in mind when it comes to the electronic exchange of health information, such as technical, financial, legal, and privacy barriers that can impede the implementation of interoperability. Nonetheless, as health care providers request continuous integration of information and patients stress the need for access to health data, health care organizations will be forced to share information appropriately. This may require funding for information management technology such as EHRs and IT to enable care across the continuum [4,17].

The concepts of integrated care, digital health, interoperability software, and centralized health data, exemplified by the shared care record, are crucial to exposing the benefits of a restructured and better coordinated health care system. Collectively working toward a shared care record can help reduce medical errors, health care costs, and redundant and unproductive work while improving communication among health care providers, quality of patient care, and seamless transitions of patients across health care providers and settings to create a resourceful system [17,18].

Aim of the Study

This qualitative study used semistructured interviews to improve the understanding of end users’ (health care providers) perspectives and insights regarding how they anticipate adapting to the use of a shared care record. Information gathered from the interviews will support the development of use case storyboards to inform various stakeholders across Ontario of considerations for developing a shared care record across the province. Talking with end users will help understand what a range of clinicians from different specialties believe is required to establish a shared care record and how they will adapt to its use over time.

Methods

Setting

Middlesex County is in Ontario’s Southwestern region, covering a geographical area of 2800 km² and home to >450,000 people. This region consists of a mix of urban and rural residents. London is the largest metropolitan area within Middlesex County and is home to >450,000 residents. The region also surrounds 3 sovereign First Nations: the Chippewas of the Thames, Oneida Nation of the Thames, and Munsee-Delaware Nation. For several years, legislators in Canada’s most populated province, Ontario, have endeavored to change the local health care system to create a more coordinated and financially united system [19]. This initiative resulted in the Government of Ontario Ministry of Health formation of 54 approved Ontario Health Teams (OHTs) within specific geographic areas across the province. OHTs modify how health care is financed and delivered and concentrate on collaborative partnerships in which providers and organizations such as primary care, mental health services, hospitals, and home and community care work as one synchronized team [20,21]. The Middlesex London OHT is specifically responsible for supporting the health of the population residing in the Southwestern Ontario region [22]. Using OHTs, the provincial government is assembling sustainable systems that will respond to local populations’ short- and long-term needs, support local services, and enable straightforward system navigation and transition among providers [19,23]. Another critical player providing guidance and regulation is Ontario Health, a government-formed agency working to coordinate and connect the province’s health care system [24]. This new visualization of Ontario’s health care system is aligned with the Quadruple Aim, a framework internationally understood to design and provide a system that improves patient and caregiver experiences, patient and population health outcomes, and provider experiences while reducing total costs [23].

Participants and Recruitment

Using voluntary response sampling, clinicians were contacted via email based on preexisting professional relationships. A
total of 14 health care providers were interviewed, comprising those who volunteered or agreed to participate upon request. These health care providers hold positions in various care sectors, including nursing, community care, primary care, emergency medicine, dietetics, practice specialties, occupational therapy, and physiotherapy. The list of health care provider interviewees who agreed to participate in the data collection, organized by occupation, is shown in Table 1. The providers also ranged widely across stages of career development and duration, from new graduates to experienced employees.

Table 1. Interviewees.

<table>
<thead>
<tr>
<th>Professional title</th>
<th>Care setting</th>
<th>Professionals (N=14), n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registered nurse</td>
<td>Inpatient acute care</td>
<td>3 (21)</td>
</tr>
<tr>
<td>Registered nurse</td>
<td>Cardiac outpatient clinic</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Registered nurse</td>
<td>NSWOC(^a)</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Clinical nurse specialist</td>
<td>Chronic diseases and clinical informatics</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Clinical dietician</td>
<td>Bariatric outpatient clinic</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Physician</td>
<td>Emergency medicine</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Physician</td>
<td>Primary care practitioner</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Registered physiotherapist</td>
<td>Outpatient clinic and inpatient acute care</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Registered practical nurse</td>
<td>Home and community care</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Clinical practice specialist</td>
<td>Occupational therapy</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Clinical practice specialist</td>
<td>Palliative care and oncology</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Occupational therapist</td>
<td>Home and community care</td>
<td>1 (7)</td>
</tr>
</tbody>
</table>

\(^a\)NSWOC: Nurse Specialized in Wound, Ostomy and Continence.

**Data Collection**

Participants in the study were first introduced to the concept of a shared care record verbally and through a video demonstrating its functionality. All participant questions about a shared care record were answered before the interviews. A semi-structured question guide ensured that each interview covered essential topics and allowed participants to disclose issues and stories as they saw relevant. The use of a prepared guide also worked to decrease interviewer bias by decreasing interviewer involvement. Confidentiality and anonymity were established at the beginning of the interviews. Verbal consent was obtained from each participant to potentially use quotes from the discussions in future publications or presentation materials that result from the initiative. The semi-structured interviews averaged 15 (SD 2.56) minutes and were web-based via Zoom (Zoom Video Communications) between June 2022 and July 2022.

The interview format was chosen, as opposed to focus groups, as it allowed for direct, individual engagement with each end user. Stokes and Bergin [25] discussed the opportunity for the interviewee to truly analyze their motivations for a particular action while being given a feeling of empowerment because of the anonymity in the individual interview setting without the pressures of a group setting that may lead to a consensus view. The interviews were designed to elicit the health care providers’ understanding of and experiences with the EHRs they currently use along with their attitudes, beliefs, and expectations regarding the future use of a shared care record in their daily practice. The sequence of interview questions used and additional instructions to guide the interview are shown in Table 2. The interviews were audio recorded with permission from the participants, transcribed using web-based software, checked for accuracy, and then analyzed to develop a report. The results present the participants’ initial reactions to the concept of a shared care record and then transition to their interpretation and reflections on the use of and adaptation to a shared care record.
Table 2. Interview guide.

<table>
<thead>
<tr>
<th>Interview portion</th>
<th>To do</th>
<th>Additional notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm-up</td>
<td>• Introduce and explain the purpose of the interview. Obtain consent to use quotes from the interview and to record the interview.</td>
<td>• Introduce the idea of the shared care record and how it works.</td>
</tr>
<tr>
<td>Interview questions</td>
<td>• Consider your electronic health record today (name the record), what additional health or social information regarding your patient would you like to have access to in this new shared care record or would make a difference for you, when providing care for that patient?</td>
<td>• Build each question off the previous one and rearrange the order as needed according to the flow of the conversation. Use the prompts to further stimulate conversation.</td>
</tr>
<tr>
<td></td>
<td>• Prompt: tell interviewee more about what a shared care record could offer them.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• So, for you, tell us how this information would impact or change the care you provide (or can) to your patients?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Prompt: what difference would it make if you had access to all of your patient’s information (the type of information you just listed) on the shared care record?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Prompt: would you look at it more or make use of that information?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• This would be a change and change is never easy, but what do you think you and your colleagues would need to do to adapt to using a shared care record in your day-to-day practice?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Prompt: what would help your colleagues benefit from this change?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Prompt: what support or resources would help you with the introduction to and adaptation to this system?</td>
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</tr>
<tr>
<td></td>
<td>• Do you have any concerns with the concept of a shared care record?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Prompt: Overall, what factors or conditions challenge or serve as barriers to your personal use of a shared care record? How might this change that?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• In closing, do you have any concluding thoughts or comments related to the shared care record that you would like to convey?</td>
<td></td>
</tr>
<tr>
<td>Closing</td>
<td>• Thank the interviewee for their time. Let them know not to hesitate to reach out if they have anything else they would like to discuss.</td>
<td>• Ask interviewee whether they give permission to be contacted in the future.</td>
</tr>
</tbody>
</table>

Data Analysis

The interviewer first read and interpreted the individual transcripts to become well acquainted with the data collected. After developing the initial semantic codes based on the data, the interviewer grouped the codes into categories and themes and then reviewed, named, and discovered various connections between the themes to write the analysis. The themes were modified using an iterative process, adjusted, and grouped, with categories and subcategories added as they arose from the data analysis. The interviewer used a qualitative interpretative approach, the framework method, to analyze the data by joining thematic analysis with comparison so that the data were surveyed for known literature themes and emerging themes. The interview findings are presented in the Results section of this paper; quotes are included from the interview transcripts to illustrate the generated themes. End users are identified by their health professions in each quote.

Ethical Considerations

This publication is the result of a quality improvement initiative deemed not to require ethics approval according to the Western research ethics board checklist.

Results

Participants’ Reflections on the Shared Care Record

Theme 1: Opportunities for Using a Shared Care Record

Lack of Communication Affecting Care Delivery

A lack of adequate communication among health care providers, services, and health care facilities across the care system was a common response among participants. Discussions with end users highlighted frustrations across the care continuum, such as entering care encounters with inadequate or lacking information, more difficult care management and planning, and delays in access to information causing delays in care. Registered nurse 4 stated the following:

Why are we doing the same assessments over and over again? Patients are forced to repeat tests because the results are not passed between the health care providers, which in the end only delays their [the patients’] treatment.

The introduction of a shared care record could drastically improve communication among health care providers, potentially decreasing the current workload, increasing confidence in decisions, and affecting patient safety and continuity of care:
...with a client that I’m seeing, he’s a cancer patient, so he’ll go to London, and then he’ll go to Stratford for example. The two hospitals they don’t communicate very well...the communication between the two kind of gets lost in between...it’s all of these extra steps between myself and this patient’s daughter. We are trying to figure out when was his last treatment? And was the medication provided? What was that medication? And how long was he supposed to take that? So, you have Stratford asking this and trying to get through to London to get those questions answered, the whole process becomes very difficult.

[Registered practical nurse]

End-user discussions touched on the impact of poor communication on patient satisfaction, trust, and their subsequent health care journeys. Occupational therapist 1 described how enhanced communication between providers could affect the patient care experience:

From a patient perspective, it might be one less time they have to answer the same questions. Not being asked the same questions over again seems trivial, but if you’re the patient who’s had to answer the same question twenty times you think people aren’t listening to you...we could just kind of summarize what we know, which I think also makes the patients feel like we’re all a team speaking with each other. So, we’re communicating what we know about the patient, as opposed to having to ask them the same information over and over again.

The retrieval of information to provide proper care was deemed exceptionally crucial among end users working in community settings, where some may not have any connections to EHRs:

I mean our nurses are walking in really with very minimal information. Again, relying on the family a lot of the time to tell us, even as far as medications that they’re on, you know, we’re going through all of their bottles and discharge lists, and lists they pull out of their wallet, and trying to reconcile it. So, it’s really pieces of information. [Clinical practice specialist]

Real-Time Information

End users collectively admired that one of the most critical advantages of the record would be the access to real-time information as it changes and becomes updated. A clinical nurse specialist described information access as “very much a game changer for clinicians,” with other participants agreeing, describing it as “taking the legwork” out of obtaining essential patient information. The shared care record real-time information feature “would not only help the patients but also the healthcare team be up to date, and they wouldn’t have to take so long to find the information they need” (registered nurse 3). Considering their daily practice allowed the end users to visualize clinical patient data being stored in one central location where the information could be accessed, analyzed, uploaded, and used, with one process going to everybody involved in the patient’s care:

I’m really intrigued by receiving information in real time, I find that especially in the community if there has been a medication that’s been added, I don’t always receive that information, unless I’m at the client’s home and I see the new bottle because they don’t typically tell me if they are on a new medication, and the doctors just prescribe it, they definitely don’t inform us. That would be information would be very helpful for me when trying to figure out why they’re having a change in their health status, or maybe a cognitive change or something along those lines. [Registered practical nurse]

Theme 2: Perceived Benefits of Using a Shared Care Record

Effective Use of Time

Access to clinical information through the shared care record was described as promoting the effective use of time and resources. End users felt that the record would provide “an accurate picture of what’s going on,” and it would be “a lot less doubling and tripling of assessments.” Registered nurse 1 recalled a common scenario occurring in their inpatient hospital unit:

...on my floor patients come up with a bag of medications or just a list of medication names and dosages that they have scribbled onto a piece of paper...the time we are spending on doing something very basic like manually inputting medication information that should be available through the pharmacy or from a physicians list would save so much time and then you would be able to spend more time doing a proper assessment on the patient, providing care or starting a treatment.

Within the complex and fast-paced acute care setting in which several of the interviewed end users worked, the ability to save time was the most significant determinant of efficiency. Effective care must be provided with often limited resources and high workloads. Occupational therapist 1 discussed the vision of the shared care record as a benefit to their work:

...we’re always looking in acute care for efficiencies. The length of stay is already very short, and the more information that we have access to when we are doing our initial triage or chart review, the earlier we can start to at least reflect on what the likely plan is.

Informed Circle of Care That Promotes Continuity of Care

The vision of the shared care record would allow the patients’ circle of care, everyone involved in the patients’ care, to be well informed, leading to better care, time savings, and less frustration. According to registered nurse 1, “it would promote continuity of care and keep everybody in the loop and informed, which is so important in healthcare in general.” End users discussed the benefit of being able to collaborate with other clinicians and share more information in general:

...even when our clients go into hospital, they [the hospital occupational therapists] have no idea what we have been working on at home. And then if they
go to discharge the client, sometimes they’ll put in new OT and PT services without realizing there’s already different things in place. There’s just poor communication, so I think this idea would make a huge difference. [Occupational therapist 2]

The consensus among the participants was that this vision becoming reality would change the way they practice, offering the ability to connect with everyone that the patients are in contact with:

...everything is just in silos right now, and I think anyone that’s had any contact with the healthcare system knows that. I think it’s very prominent in community...it is not practical how it is right now, so I think any move in that direction [access to a shared care record], would help immensely. [Registered nurse 4]

With regard to the patient-provider relationship, providers indicated that patients in the hospital setting can feel vulnerable and left out of conversations and might not know what is going on:

If we could retrieve those records...it would help the patients feel comfortable, they would be able to ask more questions during their stay and obtain answers from us as providers.

No one wants to be in the hospital as it is, so when they [the patient] come in, and they notice that their cardiologist has no idea that so and so [other healthcare providers] prescribed a certain medication, patients tend to become annoyed, and rightfully so...having that information prior to their visit would make their visit a lot easier, faster, and more efficient for them and for everyone involved. [Registered nurse 5]

Overview of Patient Health Status

The increased amount of health and health-related information accessible to health care providers would help them understand their patients’ medical requirements. A physiotherapist discussed how treatment of his patients would be enhanced “by helping me know and understand their timeline for recovery.” The record would “help understand other areas they [the patient] need help with because patients forget things and don’t always understand what other healthcare providers tell them when it comes to their injury.” Participants noted a lack of patient awareness regarding what providers are involved in their care, medication management, or even their diagnoses. Physicians discussed situations in which, unless their patients informed them, they were unaware of new allergies or changes to medication dosing made by other physicians. Registered nurse 2 discussed that, when noticing a new irregular sign or symptom, the shared care record would allow for “a quick reference, if that’s something they [the patient] have at baseline or if you need to look into it further, and just kind of base your actions on that information”:

...especially going into people’s homes, it would just make me more aware of things. People won’t always tell you the truth about things or they’ll leave out things they don’t feel are important but are impacting how they are managing at home...If you knew the information, walking into it, you kind of have a more holistic picture before moving forwards with them. [Occupational therapist 2]

Adaptation

Theme 3: Factors That Promote Use of the Record

Positive Outlook on Adaptation

Overall, the participants revealed an incredibly positive outlook when considering their own and their colleagues’ adjustment to the record. Participants made comments such as “it wouldn’t be a challenge for me and my colleague’s personally” (registered nurse 3) and “I don’t think there would be a large change-related level of concern or anxiety” (occupational therapist 1). End users acknowledged that technology is on the rise, with many individuals of all ages using digital solutions in their daily lives:

...even just logging in and seeing their bloodwork online, people are more comfortable doing that...even if they’re older or they haven’t done that they’re comfortable reaching out to their neighbor or their child to help them with that...I think it would be easier than you know even 5 years ago. [Registered nurse 4]

Health Care Provider Requests for Health Information Access

When end users were asked what other patient health or social information they would like access to when providing patient care, most made remarks regarding the difficulty of obtaining access to clinical data documented beyond the organization they worked within. The most common request among end users was access to a verified list of medications. Often, providers must rely on medication bottles, discharge lists, and family members to reconcile patient prescriptions:

...patients might know the name of the drug, or what the pill looks like, but they have no idea what it does, or why one of their physicians ordered it. For example, when they come into the clinic telling us that their nephrologist ordered something to bring their blood pressure down because their kidneys are failing, their cardiologist might just be finding out about the medication and realizing the medication could be affecting their heart. So being able to see what was ordered and when it was ordered would be such a big help. [Registered nurse 5]

The lack of integrated health IT was found to cause duplication of efforts and lack of comparison across documentation from the hospital versus the community or across organizations or different regions:

I cannot see pictures of x-rays that they [patients] get in the community. So, people get sent in with a break and I need a picture to see if I need to push on it, to put a cast on it and get it in the right place. We often repeat x-rays that probably wouldn’t need repeating if we could just see the original picture. [Physician 1]
Interoperability between organizations can reduce redundant tests, save time and costs, and result in better continuity of care. Participants regarded patient diagnostic imaging as the information they would like to access, including the actual pictures and not just the reports of x-rays, ultrasounds, computed tomography scans, echocardiograms, and other imaging modalities. Furthermore, patient exposure to radiation or contrast dye would decrease without the need to repeat tests and scans:

...it would help me if I had access to imaging without having to rely on what the patient tells me or what they can even remember. Sometimes patients don’t even know what type of imaging they had done or even what that imaging was for. [Physiotherapist]

Participants listed patient medical-related appointments as the information they wanted to see on the record. Many patients have complicated cases and multiple teams following them in the community, which can be overwhelming to manage independently. Family physician records or membership in a family health team was another common request, along with up-to-date access to all referrals sent out and specialist information:

Knowing what doctor the patient was referred to...a lot of time people will come in and will say “well my doctor sent me to a cardiologist, but I haven’t heard anything in three months” So then I’m like “well I’ll send you to a cardiologist as well.” Am I sending them to a different cardiologist? I have no idea. [Physician 1]

Access to patient social history information was highly requested, including living arrangements, home care reports, and community support or professional services that patients were using as this information significantly affects patient care planning and discharge planning. According to physician 2, “it would be nice if the patient could update things like occupation, substances, family members, consent to family members”:

In many cases, we don’t have a true understanding, at least initially on chart review, without speaking with our team about the exact specifics of what type of services or equipment or programs they are [the patient] currently involved in, in the community. A true understanding of that social and community history allows us to initially strike off maybe some options that we may not have at our disposal, or start to plan out some of the gaps that we anticipate based on what we know that they already have. [Occupational therapist 1]

End users discussed situations requiring access to patients’ medical histories and complete health records. Requests for clinical data access included a complete list of diagnoses and when the patient was assessed for them; laboratory test results; previous rehabilitation journeys; surgeries; and conversations that had taken place, which could indicate the patient’s understanding of their illness or where they are at:

Almost every single clinician that I have spoken to would say, we wish we had more, or the information is just a very brief summary...especially with acute care, the length of stay is so short, we’re trying to piece together as much as we can...so the more the more understanding of the patient’s history and journey through the healthcare system, the more efficient we can be as occupational therapists. [Occupational therapist 1]

Ongoing Training

The most common suggestion among end users was the provision of proper education and training on the new system. As one of the primary objectives of an EHR is to improve collaboration among health care providers, it only makes sense that they are offered the chance to provide feedback on the system they use daily:

From a training perspective, it’s nice to first of all be part of the process of building the system, or having some input on that system, which helps with the engagement and integration when we’re actually putting the rubber to the road...it definitely would help with the connection to the implementation. [Clinical nurse specialist]

Most participants suggested that they would benefit from getting to know the new system through proper training on the layout of the information and how to find the information that they could use. End users visualized the benefits they could obtain from an introduction to and familiarization with the system before it becomes implemented in practice:

...obviously, there needs to be training, and along with that comes the resources. Not only do the training but pay for them [the end users] to attend, which is always an issue. And then I think even support along the way, for example IT support, do we need to build that internally in our IT department...up front, it’s just really the education and making sure it is ongoing...in healthcare in general, there is a lot of turnover, so how do we sustain the education moving forward. [Clinical practice specialist]

Many participants discussed “multi-pronged approaches” as the most effective method for introducing and adapting to the record. Resources mentioned by the participants included a chat or live support option for immediate questions, videos on how to use the system, a toolkit or tip sheet developed by the system creators, and in-person and web-based computer sessions. Occupational therapist 2 described the introduction to their current EHR system as they recalled:

Clinicians felt more comfortable using the system if they had some test patients to go through trial cases of what a daily patient intervention might look like prior to the go live.

Several participants mentioned the idea of “super users”:

...our nurse colleagues on the floor, who had additional training and were more familiar with the record so that we could reach out to them if we needed help or if we had questions. [Registered nurse 1]
These super users would function to support their colleagues in the transition while helping others learn to use the record to the fullest extent.

Another resource identified was the use of clinical educators who already work to support staff with clinical updates to rules, procedures, policies, and methods of accessing information.

Record Accessibility

Several questions from end users concerned how to physically access the clinical data on record and the timeliness of finding information. Questions included the following: “where do we need to click?” “Under what icon?” “How do I add things to the shared care record?” “Do I have to do it manually?” “Does it just happen automatically?”

The biggest adaptation would be how to access the information, like opening the charting system will look different, so getting used to the new layout and the new system and knowing where to find things. [Physiotherapist]

A key finding among participants included statements regarding the user interface or usability of the shared care record. Participants used terms such as “seamless,” “simple,” “accessed quickly,” “user friendly,” and “easy to follow” to describe how they envisioned the software to function:

But we need to really limit where they’re [frontline staff] finding their information, if they need to upload, that they are not having to do it to all of the people we need to report to. There are so many layers and rules, and we just need to make it as simple as possible. [Clinical practice specialist]

Participants considered the least amount of clicking and integration with their current systems to obtain data or add to their assessments as crucial features of the record. Information being uploaded automatically was considered foundational, with physician 1 commenting the following:

If we have to do an additional step at the end to get it uploaded, you’re going to get way less uptake...as long as in the back end of things, my EHR links it all up.

Regarding user-friendliness, the physicians explained that they would not appreciate retyping a password to access the charting or repeated verification of the designation upon entering the system:

I don’t want to have to log into something else, I’m already logging into so many things every day...and so there’s that information that sits somewhere but that it gets pushed to all the different places and then shared between the different places. [Physician 2]

Theme 4: System-Dependent Considerations and Concerns

Clinical Data Consistency, Accuracy, and Organization

Although participants recognized numerous potential benefits, they also discussed fundamental considerations of functional practicality, such as the consistency and accuracy of data across the record. To present clinical data across different EHR systems uniformly, health care providers must be consistent with the documentation methods and upload the documentation to the record:

I would be concerned about it being unorganized or messy, um if everyone has different styles and systems of taking notes or recording, maybe it would be difficult to find one particular piece of information that you are looking for. [Physiotherapist]

Understanding patient rostering or enrollment was discussed as a critical element of the record, understanding who is involved in a patient’s care, and participating providers can change or adjust that if needed:

I changed my practice maybe three years ago, but I am still on some people’s charts at the hospital. I have requested to have my name taken off, but unless the patient calls and changes that, nothing can happen. And so that becomes a privacy issue. I keep getting files for people who I am not actually taking care of. [Physician 2]

Beyond consistency, participants identified the importance of double-checking the information obtained from the record with the patients themselves. Updates may not be revised, data could be deleted, and mistakes can still occur:

If you have a medication record from two years ago, you would still have to do your due diligence to make sure the information you are using is accurate. [Registered nurse 1]

An auditing system of the record was suggested that could review charting to help ensure that health care providers input the required information to maximize the utility and reliability of the clinical data. According to registered nurse 5, “that way people have to take responsibility for what they’re changing or what they’re contributing towards this shared documentation.”

Change in Workflows

Uncertainty regarding daily practice workflows came up as a barrier to overcome when participants discussed adaptation to the use of the record. Visualizing the details of the change to their current EHR system interface was difficult for certain participants:

It’s hard to know what the change management strategy would be. [Clinical practice specialist]

My hope is that there would be very little that we would actually have to change...everything else I would expect to be kind of behind the scenes where I do my normal process, that it would just sort of happen in the background. [Physician 2]

Discussions held with professionals in the community setting revealed that there would be an adjustment to their current workflow, with the additional time spent reviewing history, reports, and other data accessible in the record before going in to see the patients:

Right now...I really only check [name of EHR] to look at when appointments are confirmed, phone numbers, names, and then I find out a lot more information from the patient once I get there [to their place of
residence...for home care, that’s just kind of how it’s been. If I am seeing four or five people every day and driving between these destinations, it would take time maybe at the beginning before getting used to it as part of the routine. [Occupational therapist 2]

Upon introducing the idea for the record, a statement from the Ontario Patient, Family, and Caregiver Declaration of Values [10] was presented to participants explaining the vision for transparency in patient access to their health records. Wondering how patients would interpret seeing physicians no longer in the patient’s circle of care re-entering their medical information and whether this would be concerning, physician 1 stated the following:

...Most of us [physicians] require understanding of, did the treatment I gave actually have a good effect? And what did the follow up doctor think? So, we will access records a few weeks later to see what happened so that we can learn...that’s how I learn and how I can change how I practice, which is super important...we are expected to do continuing professional development and take courses, but then it’s always read and learn around your cases. How am I supposed to learn around my cases when I can’t find out what the specialists thought of this unique situation that I can’t just open a textbook and read about.

Privacy, Confidentiality, and Security of the Record

The most common concern among participants regarded privacy and confidentiality. The extensive personal health information or personal information accessible in a central location, this being the record, increases the risk of a privacy breach:

I think about it, not only as a clinician, but as a user of healthcare as well. [Occupational therapist 1]

According to registered nurse 1, with “a lot more information that is available to you as the healthcare provider, it would have to be ensured that only people who are part of the patient’s circle of care are accessing this information and that you are only accessing records that are applicable to the care that you are providing.” Nevertheless, most providers, including the nurses, physiotherapist, and occupational therapist, agreed that the benefits of the shared care record would outweigh the risks, and everyone could work together to make it as secure as possible.

Patient Portal Access

The concept of a patient portal, as described in the video shown to the participants, raised many questions and some hesitation among them. According to physician 1, “if the patients can see accessing records that are applicable to the care that you are providing.” Regardless, health care providers considered the inclusion of these types of documentation to be vital to the patient’s record:

...there might be certain things...in the record that maybe patients themselves would not want to see...if the patient was confused after a surgery and there was an episode of violence that was documented. It may almost be triggering or upsetting to them [the patients]. [Registered nurse 2]

When considering patient access to records, participants emphasized the importance of patients being able to interpret the information correctly and objectively, especially regarding medical jargon. Participants suggested that clinicians may be inclined to use different terminology or a different writing style or reformulate the information in a meaningful way for patients:

...kind of helping socialize the clinicians to the new reality of the patients being able to read their notes more readily or easily. I think there would be value in having a discussion as a team about those types of changes. [Occupational therapist 1]

Discussion

Overview

Concepts such as PHM, data security, and privacy can be complex to explain to individuals; however, they will become progressively essential to the design and delivery of health care. PHM is founded on interoperability, data sharing, and integration with diverse health sectors and services. Although people tend to understand the role and significance of EHRs, they may neglect the value of inputting accurate and high-quality data into them. PHM and primary health care strive for many of the same features, including person-centeredness; continuity; accessibility; and consideration of physical, mental, cultural, and social aspects of health, among others [2]. Health care providers commonly have a good understanding of the population that they serve, often living within the community themselves, and appreciate the needs and some of the determinants of health of these populations. A PHM approach rooted in quality data quantifies this understanding and enables an even deeper level of understanding [2,17]. As the vision for a shared care record using HIE technology starts coming to life,
obtaining end users’ opinions and ideas will be imperative. End-user involvement in the record’s design; development; and, ultimately, operation will help simplify the adoption of changes and attain the goals of proactive and coordinated care that actively engages patients.

**Principal Findings**

This study provides practical findings that will help emphasize factors that facilitate clinicians’ process of adaptation to the use of a shared care record. Considering the fast pace of health care, clinicians highly commended and admired a central location for real-time information availability that could promote efficiency through the effective use of time. The benefits of accessible retrieval of information were especially highlighted among end users practicing in the community setting. Discussions with end users brought forth the importance of an informed circle of care, promoting patient continuity of care, and more effective provision of care. Health care providers requested access to additional information that would help them in their practice, from medication lists and diagnostic imaging to social community and home care support, laboratory test results, and referrals. Discussions also brought forth questions regarding the interoperability of the record, its functional usability, and changes in workflows.

Adaptation to a shared care record was viewed positively by health care providers. Several end users spoke about the benefits of getting to know the new system through proper ongoing training using multifaceted approaches. Some of the approaches considered included videos, in-person and web-based computer sessions, and live user support options. The idea termed “super users” was brought forth, whereby colleagues who would be more acquainted with the software would function as support for their coworkers in the transition and adaptation to use of the record. End users wanted to understand the functionality of the record, the impact of changes on their daily workflows, and the consistency and accuracy of data across the record to maximize the utility and reliability of the clinical data. The main concerns of participants were the privacy, confidentiality, and security of the record and patient information interpretation through the patient portal.

A growing body of literature on the topic of patient access to health care provider electronic visit notes suggests that the active involvement of patients at the point of care can foster stronger patient-provider therapeutic partnerships. A study by Wolff et al [26] suggested that most patients reported benefits of reading provider notes, such as more agreement concerning treatment care plans, increased ability to formulate questions to ask their care providers, and more productive care discussions. Walker et al [27] brought forth challenges such as patients not being registered on portals to allow for access to notes or patients being unaware of provider notes being available to access. Nevertheless, the benefits of expanded patient access to clinical notes have been established, holding the potential to better support and involve patients in care, increase communication, and provide feelings of control and preparation for health care visits [26-28].

**Limitations**

This study was limited in certain ways. The range of clinicians could have included various other providers within diverse health care settings to broaden the perspectives included. Furthermore, the application of voluntary response sampling in the recruitment of health care providers for this study is a limitation because of the possible sampling bias of respondents who volunteered, meaning that the study could have involved EHR advocates. Future research should involve a subsequent round of health care provider interviews once the record has a fully developed user interface design functioning across several systems involved with the HIE initial demonstration project. At this stage, health care provider interviews may offer further understanding of the functional usability of the shared care record once the providers can visualize and use it within the home database system they work in daily. These interviews could be geared toward comprehending how information design principles align with clinician workflows, patient information examinations, or decision-making in the medical environment. Building on this effort can help populations receive high-quality care while ensuring that it meets community needs.

**Conclusions**

This study provided insights into health care providers’ perceptions of a shared care record and presented their reflections on the practical use and adaptation to the use of a shared care record. It is essential to bring end-user perspectives into the shared care record’s development, introduction, and maintenance, along with the training necessary to permit the use of the system. There is an urgent demand for high-quality, integrated, and timely health data allowing individuals, health care providers, and communities to be involved and informed partners in the provision and attainment of health care [17].

**Acknowledgments**

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**Conflicts of Interest**

None declared.

**References**


Abbreviations

EHR: electronic health record
HIE: health information exchange
OHT: Ontario Health Team
PHM: population health management

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Patient Characteristics Associated With Phone and Video Visits at a Tele-Urgent Care Center During the Initial COVID-19 Response: Cross-Sectional Study

Saif Khairat1,2,3, PhD, MPH; Roshan John1, PSM; Malvika Pillai1, PhD; Philip McDaniel4, MA; Barbara Edson5, RN, MBA, MHA

1Carolina Health Informatics Program, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States
2Cecil G Sheps Center for Health Services Research, Chapel Hill, NC, United States
3School of Nursing, University North Carolina at Chapel Hill, Chapel Hill, NC, United States
4Digital Research Services Department, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States
5UNC Health, Morrisville, NC, United States

Corresponding Author:
Saif Khairat, PhD, MPH
Carolina Health Informatics Program
University of North Carolina at Chapel Hill
428 Carrington Hall
Chapel Hill, NC, 27514
United States
Phone: 1 9198435413
Email: Saif@unc.edu

Abstract

Background: Health systems rapidly adopted telemedicine as an alternative health care delivery modality in response to the COVID-19 pandemic. Demographic factors, such as age and gender, may play a role in patients’ choice of a phone or video visit. However, it is unknown whether there are differences in utilization between phone and video visits.

Objective: This study aimed to investigate patients’ characteristics, patient utilization, and service characteristics of a tele-urgent care clinic during the initial response to the pandemic.

Methods: We conducted a cross-sectional study of urgent care patients using a statewide, on-demand telemedicine clinic with board-certified physicians during the initial phases of the pandemic. The study data were collected from March 3, 2020, through May 3, 2020.

Results: Of 1803 telemedicine visits, 1278 (70.9%) patients were women, 730 (40.5%) were aged 18 to 34 years, and 1423 (78.9%) were uninsured. There were significant differences between telemedicine modalities and gender (P<.001), age (P<.001), insurance status (P<.001), prescriptions given (P<.001), and wait times (P<.001). Phone visits provided significantly more access to rural areas than video visits (P<.001).

Conclusions: Our findings suggest that offering patients a combination of phone and video options provided additional flexibility for various patient subgroups, particularly patients living in rural regions with limited internet bandwidth. Differences in utilization were significant based on patient gender, age, and insurance status. We also found differences in prescription administration between phone and video visits that require additional investigation.

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KEYWORDS
telehealth; telemedicine; tele-urgent care; virtual urgent care; nonemergency care; televisit; phone visit; video visit; urgent care; health services research; COVID-19; health disparities; insurance status; cross-sectional study
Introduction

Health systems rapidly adopted telemedicine as an alternative health care delivery modality in response to the COVID-19 pandemic. Demographic factors, such as age and gender, may play a role in patients’ choice of a phone or video visit [1-3]. However, it is unknown whether there are utilization differences between phone and video visits.

The pandemic led to a rise in phone and video consultations, providing an opportunity to study their usage across demographics and outcomes, such as medication prescriptions. Telemedicine can help improve health access and reduce disparities for vulnerable populations [4-7]. Although we know that medication prescription differs between in-person and video visits [8], there is a gap in the knowledge regarding differences in prescription administration, whether medication was prescribed or not, between telephone and video visits. Driven by prior differences in prescription administration among providers based on gender and specialty [7], we hypothesized that prescription administration, a service outcome of telemedicine, may differ between phone and video visits.

Phone-based treatment has been found feasible, acceptable, and effective compared to face-to-face visits. It is a promising alternative in telemedicine, offering tailored interventions [9]. Phone visits have taken less time and have been used more frequently, but there have not been significant differences in patient perceptions or other clinical outcomes [10].

Telemedicine’s growth during the pandemic has led to a need for understanding the limitations of telephone-based versus video-based consultations for clinical care [11,12]. Patients reported that video consultations were more favorable compared to phone consultations, claiming that video visits led to improved outcomes, better diagnostic accuracy, and patient satisfaction [13-18].

Previous studies have looked at the impact of phone or video visits on vulnerable patients [19-23], but there is a lack of research on the differences in patient characteristics between the 2 modes of telemedicine-based care. Understanding these differences can help health organizations and policy makers tailor telehealth options to better suit patients.

Telemedicine use during the pandemic has been examined in various clinical environments, such as primary care, geriatrics, and subspecialties [5,22,23]. It is unclear how phone and video health care delivery in urgent care clinics was affected during the initial phases of the COVID-19 pandemic, especially regarding wait times and visit duration. The demand for urgent care clinics increased due to emergency department overcrowding, cost increase, and long wait times [24,25]. Therefore, it is important to understand the changes in urgent care practices considering telemedicine deployment postpandemic.

In this exploratory study, we examined patient and service characteristics of on-demand telehealth utilization and whether they differed by modality during the initial phase of the pandemic when the health care system suspended all in-clinic visits. We used the Donabedian framework of structure-process-outcome to inform this study design [26].

Methods

Study Overview

We conducted a descriptive analysis on a cross-sectional study of patients using a statewide, on-demand tele-urgent care clinic in the southeastern United States region. The Virtual Urgent Clinic (VUC) is an on-demand clinic open for nonemergency concerns 24 hours a day and 7 days a week. Regardless of whether they are new or existing patients, any individuals can register and access the virtual clinic through the web-based portal. To use the telemedicine service, individuals must create an account, input their medical history, and request a virtual care visit. Individuals can choose their telemedicine modality—telephone or video—through a computer, tablet, or phone.

The cost of the visit was the same for phone and video visits. The clinic provides on-demand service such that individuals can log on to the web-based portal and choose to have a visit immediately or schedule a visit for a later date. Board-certified physicians are available 24 hours every day of the week to provide care for patients. If an individual is an existing patient, documentation of the virtual visit is integrated into the electronic medical record after the visit is completed.

Data Collection

VUC monthly data were collected from March 3, 2020, through May 3, 2020, using the institutional data warehouse. The data set included patient information, such as age, gender, insurance status, and residential address, and service characteristics, such as telemedicine modality, wait time, visit duration, and medication prescription outcomes. To avoid double counting of patients or visits, each patient and each visit received a unique identifier. Incomplete encounters were recorded in the data set as incomplete if the call was not completed for any reason. The rate of incomplete encounters was only 7.9% (142/1803) of the total visit volume in this study and was included to better understand the characteristics of patients who sought care via telehealth.

Outcomes

Our primary endpoints were the characterization of telemedicine modalities (phone vs video) on patient characteristics measured by demographics and insurance status, utilization measured by the volume of visits; and service characteristics measured by medication prescriptions and visit wait times. The secondary endpoint was utilization, which was measured by the number of visits from rural and urban neighborhoods.

Statistical Analysis

The study data included patient age, gender, health insurance status, address, number of medication prescriptions, number of visits, and choice of telemedicine modality. For each of these variables, we calculated descriptive statistics for each demographic category stratified by modality (phone or video) and the total of both groups. A χ² test was calculated to check for significant differences between telemedicine visits and these
variables. Additionally, we calculated the average wait time and visit duration for phone and video visits. A 2-sample t test assuming unequal variances (Welch t test) was also conducted to determine if there was a statistically significant difference in the average wait times and visit duration lengths between phone and video telemedicine visits.

To examine the predictors of prescription administration, we constructed a logistic regression model with a dichotomous dependent variable of prescription administration (0=no prescription=0 and 1=at least 1 prescription given) as a dependent outcome variable and patient age, gender, insurance status, location, and telemedicine modality as independent variables in the model predictors. We used a P value level of .05 to indicate statistical significance.

Geospatial Analysis
Geographical locations for patients with VUC visits over the phone or video were examined to assess the urban-rural spread of the patients in this data set. Using the US Census definition, cities with populations of 50,000 people or more were designated as urban, and those with less than 50,000 people were designated as rural. In the telemedicine data set, 198 places in North Carolina were found, of which 179 were classified as rural and 19 were classified as urban, which was used to develop the health access map. A χ² analysis was used to determine the significance between an encounter from an individual in an urban or rural area and the encounter modality.

To understand the association between telehealth modality and location, we used ArcGIS (Esri) to map zip code–level populations, as reported in the 2010 US Census Bureau data, with VUC visits based on Zip Code Tabulation Areas (ZCTAs). We used the 2016 American Community Service (ACS) to calculate the percentage of households with internet access by ZCTA. We then mapped the ACS data and visit counts from the VUC by modality on the North Carolina (NC) map to better understand the preference of patients for modalities based on internet availability.

We used natural breakdowns to quantify the percentage of households with internet in each NC zip code to determine the threshold for low, medium, and high categories based on the 2016 ACS data set. The colors along the bottom row (gray to light blue to teal) represent ZCTAs with a low percentage (0%-71%) of households with internet access and an increasing number of phone (or video) visits. The colors in the middle row (light pink to light purple to blue) represent ZCTAs with a medium percentage (72%-82%) of households with internet access and an increasing number of phone (or video) visits. The colors along the top row (pink to purple to dark purple) represent ZCTAs with a high percentage (83%-100%) of households with internet access and an increasing number of phone (or video) visits. The colors along the diagonal (gray to light purple to dark purple) represent ZCTAs with low internet access and low telemedicine visits, medium internet access and medium telemedicine visits, and high internet access and high telemedicine visits. For phone visits, the breaks were 1-2 (low), 3-6 (medium), and 7-37 (high). For video visits, the breaks were 1 (low), 2-3 (medium), and 4-15 (high). We used quantiles to determine the threshold for low, medium, and high categories based on the ACS 5-year estimates from 2015-2019.

Ethical Considerations
University of North Carolina at Chapel Hill institutional review board approval was obtained prior to conducting this study (18-1628).

Results
Telemedicine Visit Overview
Table 1 shows a series of visit counts of the patients who used the telemedicine service during the observed period categorized by the patient characteristics captured in this study. It also indicates the χ² and P values for significance tests for the differences between these observed characteristics.
### Table 1. Percentage statistics and $\chi^2$ values for phone and video telemedicine visits.

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Phone visits (n=1414)</th>
<th>Video visits (n=389)</th>
<th>Total visits (N=1803)</th>
<th>Chi-square (df)</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visits per day, mean (SD)</strong></td>
<td>22.8 (9)</td>
<td>6.3 (3.1)</td>
<td>29.1 (10.7)</td>
<td>N/A$^a$</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Gender, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td>16.79 (2)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Women</td>
<td>1033 (73)</td>
<td>245 (63)</td>
<td>1278 (70.9)</td>
<td>6.3 (3.1)</td>
<td>22.8 (9)</td>
</tr>
<tr>
<td>Men</td>
<td>377 (26.7)</td>
<td>144 (37)</td>
<td>521 (28.9)</td>
<td>4 (0.3)</td>
<td>4 (0.2)</td>
</tr>
<tr>
<td>Nonbinary</td>
<td>4 (0.3)</td>
<td>0 (0)</td>
<td>4 (0.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age (years), n (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td>24.99 (4)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&lt;18</td>
<td>96 (6.8)</td>
<td>57 (14.7)</td>
<td>153 (8.5)</td>
<td>4.8 (13.1)</td>
<td>82 (4.5)</td>
</tr>
<tr>
<td>18-34</td>
<td>579 (40.9)</td>
<td>151 (38.8)</td>
<td>730 (40.5)</td>
<td>31.6 (123)</td>
<td>609 (33.8)</td>
</tr>
<tr>
<td>35-50</td>
<td>486 (34.4)</td>
<td>123 (31.6)</td>
<td>609 (33.8)</td>
<td>11.3 (44)</td>
<td>229 (12.7)</td>
</tr>
<tr>
<td>51-64</td>
<td>185 (13.1)</td>
<td>44 (11.3)</td>
<td>229 (12.7)</td>
<td>3.6 (14)</td>
<td>82 (4.5)</td>
</tr>
<tr>
<td>≥65</td>
<td>68 (4.8)</td>
<td>14 (3.6)</td>
<td>82 (4.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Health insurance status, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td>18.91 (1)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Insured</td>
<td>329 (23.3)</td>
<td>51 (13.1)</td>
<td>380 (21.1)</td>
<td>13.8 (151)</td>
<td>1423 (78.9)</td>
</tr>
<tr>
<td>Uninsured</td>
<td>1085 (76.7)</td>
<td>338 (86.9)</td>
<td>1423 (78.9)</td>
<td>7.1 (1085)</td>
<td>1423 (78.9)</td>
</tr>
<tr>
<td><strong>Residence, n/N (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td>6.74 (1)</td>
<td>.009</td>
</tr>
<tr>
<td>Rural</td>
<td>782/1370 (57.1)</td>
<td>189/381 (49.6)</td>
<td>971/1751 (55.5)</td>
<td>12.9 (486)</td>
<td>780/1751 (44.5)</td>
</tr>
<tr>
<td>Urban</td>
<td>588/1370 (42.9)</td>
<td>192/381 (50.4)</td>
<td>780/1751 (44.5)</td>
<td>12.9 (486)</td>
<td>780/1751 (44.5)</td>
</tr>
<tr>
<td><strong>Prescriptions per visit, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td>24.07 (1)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Received</td>
<td>980 (69.3)</td>
<td>218 (56)</td>
<td>1198 (66.4)</td>
<td>1.0 (980)</td>
<td>1198 (66.4)</td>
</tr>
<tr>
<td>Did not receive</td>
<td>434 (30.7)</td>
<td>171 (44)</td>
<td>605 (33.6)</td>
<td>1.0 (434)</td>
<td>605 (33.6)</td>
</tr>
</tbody>
</table>

$^a$N/A: not applicable.

### Patient Characteristics

Phone visits constituted most of the 1803 total visits (n=1414, 78.4%), with an average of 22.8 (SD 9) daily visits, while video visits accounted for the remaining visits (n=389), with a daily average of 6.3 (SD 3.1) visits. Most of the patients were women across both phone and video modalities (phone visits: n=1033, 73%; video visits: n=245, 63%). Among age groups, patients aged 18 to 34 years had the most visits (phone visits: n=579, 40.9%; video visits: n=151, 38.8%), with patients aged 35 to 50 years being the next most represented age group (phone visits: n=486, 34.4%; video visits: n=123, 31.6%). Across both modalities, the least present age group included patients older than 65 years being the next most represented age group (phone visits: n=486, 34.4%; video visits: n=123, 31.6%). Most patients across both modalities were uninsured (phone visits: n=1085, 76.7%; video visits: n=338, 86.9%).

Significant differences between telemedicine modalities and gender ($P<.001$), age ($P<.001$), insurance status ($P<.001$), health access ($P=.009$), and prescriptions given ($P<.001$), This suggests that men, patients younger than 18 years, uninsured patients, and patients residing in urban areas preferred the video modality for telemedicine visits, and video visits were more associated with not getting prescriptions.

### Telemedicine Service Characteristics

#### Prescription Administration

More patients received at least 1 prescription (phone visits: n=980, 69.3%; video visits: n=218, 56%) from a telemedicine visit rather than no prescription. Video visits were more associated with no prescriptions than phone visits ($P<.001$). Significant differences were found in medication prescription administration between phone and video visits ($P<.001$; Table 1).

For phone visits, of a total of 1414 phone visits, 980 (69.3%) resulted in at least 1 prescription given, while the other 434 did not receive any prescriptions. On average (SD), patients received 1 (1.02) prescription per encounter. Of all phone visits, 434 (30.7%) patients did not receive a prescription, 944 (66.8%) patients received 1-3 prescriptions in an encounter, and 36 (2.5%) patients received 4-7 prescriptions in an encounter.

For video visits, from a total of 389 video visits, 218 (56%) resulted in at least 1 prescription given, while the other 171 did not receive any. The average (SD) number of prescriptions per encounter was 0.84 (1.00). Of all video visits, 171 (43.9%) patients did not receive a prescription, 210 (54%) patients received 1-3 prescriptions in an encounter, and 8 (2.1%) patients received 4-7 prescriptions in an encounter.

We found that 5 patient characteristics were strong predictors of telemedicine prescription administration (Table 2). Predictors...
that were positively associated with prescription administration were patients aged 18 to 34 years ($\beta$=.62, $P$<.001), 35 to 50 years ($\beta$=.81, $P$<.001), and older than 65 years ($\beta$=.94, $P$=.002). Predictors that were negatively associated with prescription administrations were video visits ($\beta$=-.47, $P$<.001) and male patients ($\beta$=-.38, $P$<.001). There was no significant relationship between patients’ insurance status and prescription rates.

Table 2. Logistic regression model showing patient demographic associations with telemedicine prescription administration. The independent variables were modality, age, gender, and insurance status. The depended variable was prescriptions given.

|                        | Estimate | SE   | z score | Pr(>|z|) | $R^2$  |
|------------------------|----------|------|---------|----------|--------|
| Model intercept        | 0.2711   | 0.1853 | 1.463  | .14      | 0.027269 |
| **Modality**           |          |       |         |          | N/A    |
| Video                  | -0.4724  | 0.1204 | -3.922 | <.001    |        |
| **Gender**             |          |       |         |          | N/A    |
| Men                    | -0.3878  | 0.1108 | -3.5   | <.001    |        |
| Nonbinary              | 0.4606   | 1.1715 | 0.393  | .69      | N/A    |
| **Health insurance status** |         |       |         |          | N/A    |
| Insured                | 0.1629   | 0.1308 | 1.245  | .21      |        |
| **Age (years)**        |          |       |         |          | N/A    |
| 18-34                  | 0.6227   | 0.1858 | 3.351  | <.001    | N/A    |
| 35-50                  | 0.8057   | 0.19  | 4.241  | <.001    | N/A    |
| 51-64                  | 0.3573   | 0.2173 | 1.644  | 0.10     | N/A    |
| ≥65                    | 0.9421   | 0.3045 | 3.094  | 0.002    | N/A    |

$^a$Pr(>|z|): $P$ value associated with the value in the z score column.

$^b$N/A: not applicable.

**Wait Times and Visit Duration**

The average wait time for patients to start their phone visits was 64.1 (SD 129.9) minutes, while the average wait time for patients with video visits was 24.6 (SD 45.6) minutes. The average visit duration for phone visits was 7.3 (SD 4.4) minutes, while the average visit duration for patients in video visits was 9.0 (SD 5.9) minutes. Significant differences existed between the average wait times and durations for phone and video visits (Welch $t$ test $P$<.001 for both wait times and duration). For phone and video visits in this data set, the daily wait times for patients to see a physician across each modality are indicated in Figures 1A and 1B, respectively. The number of physicians working daily shown in these figures peaked at a maximum of 33 physicians on March 21 and 22. The number of phone sessions facilitated was also at its peak on these days at 47 phone visits. Phone users experienced the longest wait times in the second half of March, but both phone and video users experienced extended wait times in this same period compared to April.
Figure 1. Comparison of (A) phone visit and (B) video visit wait times with a count of daily visits and physicians working.

Telemedicine Utilization in Rural and Urban Areas

Of the 1080 NC zip codes, 262 (24.3%) had a low percentage of households with internet access, 277 (25.6%) had a medium percentage of households with internet access, and 269 (24.9%) had a high percentage of households with internet access. There were 272 (25.3%) zip codes with no internet access.

The overall utilization of video visits was higher in areas with high percentages of households having internet access (Figure 2). Among the individuals from zip codes with low internet access there were 127 (83.5%) phone visits and 25 (16.5%) video visits. Zip codes with medium internet access had 367 (80.8%) phone visits and 87 (19.2%) video visits, and those with high internet access were 879 (76.2%) phone visits and 274 (23.8%) video visits.
Figure 2. Comparison of (A) phone and (B) video telemedicine visits and the percentage of households in North Carolina with internet access based on American Community Service data.

Visits to the telemedicine-based clinic came from 431 (40%) unique NC zip codes. Of these, 251 (58.2%) were rural zip codes and 180 (41.8%) were urban zip codes (Figure 2). The density of the visits, shown in larger icons in Figure 2, originated mostly from major metropolitan areas like the state capitol or the Research Triangle Park. Phone visits provided further reach into areas with low internet access, while video visits mainly occurred in urban settings with high access to internet services.

Phone visits provided significantly more access to rural areas than video visits ($P < 0.001$). There were 1363 phone visits from patients in NC, with 780 (56.8%) being from rural areas and 583 (42.5%) from urban settings. There were 383 video visits from patients in NC, with 190 (49.2%) being from rural areas and 193 (50%) from urban settings.

Phone visits originated from 290 (26.9%) unique NC zip codes, of which 170 (58.6%) were from rural areas, 80 (27.6%) were from urban areas, and 40 (13.8%) were from out of state. Video visits occurred in 141 (32.4%) unique NC zip codes, of which 80 (56.7%) were from rural areas, 56 (39.7%) were from urban areas, and 5 (3.6%) were from out of state. Phone visits provided better reach into rural areas; however, video visits had widespread coverage, demonstrating the potential to complement phone visits in rural areas. Both phone and video visits within urban areas provided comparable coverage as expected.

Discussion

Principal Findings

We conducted a cross-sectional study of telemedicine urgent care visits completed through phone or video using a statewide,
on-demand urgent care telemedicine clinic, focusing on demographics, utilization, and service characteristics. We observed significant differences in service characteristics between phone and video visits. The rate of medication prescription was much higher among phone visits compared to video visits. Patients had a higher probability of receiving a prescription during a phone visit, while the probability of receiving a prescription was lower during a video visit. Differences in gender, age, and telemedicine modality were associated with significant variations in prescription administration.

Similarly, significant differences in wait time and visit duration were observed between phone and video visits, where phone visits had higher wait times and longer visit durations. The high volume of requests for phone visits can justify the long wait. It was unclear if providers compensated for the long wait times by providing more visit time or if patients who waited longer had more questions based on the differences in visit durations.

Utilization of phone and video visits differed significantly. Women, insured patients, and those residing in rural areas preferred phone visits, while men, uninsured patients, and those residing in urban areas preferred video visits. Patients older than 65 years were equally split. The increase in video visits was due to pandemic-related cancellations of in-person appointments. Video visits were more common for children due to the need for clinical examination. Phone visits were more common in rural areas with no internet access for video visits. Rural patients preferred phone visits while urban patients preferred video visits. The reason for this preference is unclear. We suspect that a combination of privacy concerns, lack of confidence in their internet connection, and a lack of awareness may drive patients’ decisions; however, more investigation is needed [27,28].

Tying our findings to similar studies in the literature was a challenge because of a gap in studying the differences between telephone and video visits on the same outcomes [29]. Comparative studies have indicated that there has not been a meaningful difference between these modalities, having similar consultation session lengths, content, and perceived quality [30-32]. One study reported that older, rural, and ethnic minority patients were associated with lower utilization rates of video visits compared to phone visits [23]. A previous study reported that patients who had telephone visits had longer visit durations than those who had video visits [32], which contradicts our finding where video visits were longer in duration. A few studies have indicated increased utilization of telemedicine to trend toward women, with women being more likely to attend telephone-based interventions and to benefit from such interventions in the context of addiction treatment [33,34]. Moreover, another study showed that no major differences in utilization were found between video and telephone visits [31], which contradicts our findings demonstrating higher utilization of telephone visits compared to video visits.

Other studies explored telemedicine modalities separately demonstrating limitations due to selection bias in patient populations, such as including patients from a single hospital or clinic setting [13,14,16]. There is also concern that these studies often cater to specialized medical concerns or treatment options, which limits the demographic diversity of the patients recruited regarding factors such as age or gender, making the findings less generalizable [17,30]. Little was known regarding the patient characteristics of telephone or video telemedicine modalities across the rural-urban divide, patient insurance statuses, and prescriptions provided to the patients.

The COVID-19 policy waivers by the Center of Medicaid and Medicare and private insurers to include phone and video visits appear to be an effective decision that increased access and reduced disparities [35,36]. Additionally, this study shows that internet access is still limited in rural areas, which may limit the ability to conduct patient video visits, resulting in more phone visits. We recommend policymakers to continue to support video and phone visits equally, and we highlight the importance of building internet capacity within rural and vulnerable communities to expand the effective use of telemedicine.

Limitations
This study had several limitations. We conducted a cross-sectional study as we could not randomize patients to a telemedicine modality due to the complexity of the process and given the sensitivity of COVID-19. In addition, the study was conducted over 2 months (March 3, 2020, to May 3, 2020) at the height of the pandemic with a limited amount of data; however, this reflected the initial response to the pandemic when telemedicine was the primary option for care. A large proportion of patients in this study were uninsured. Uninsured patients preferred telehealth during the initial phase of the pandemic due to the suspension of in-person visits and the shutdown of health care systems and primary care clinics, which are more expensive for uninsured patients compared to emergency departments [37]. This study did not include a comparison to in-person consultations because the health care system suspended all nonessential visits during the observed study period, starting on March 20, 2020. There were no data collected on race, ethnicity, or type of insurance used or covered, which could have added value to the findings of this study. The diagnosis type may confound the difference in prescription administration of phone and video visits. We could not merge the telemedicine data with the electronic health record data to assess the difference in documentation quality between phone and video visits. No information was available to determine if the visit wait times in the data set included those seeking a telemedicine visit immediately as opposed to at a later date. Wait times could be separated for those seeking immediate appointments to improve our findings. Physician-level data was not accessible, limiting our assessment of factors such as clinician preparedness. Finally, the study findings were limited to 1 site, and so the generalizability to other settings is limited.

Conclusion
Our study analyzed the use of phone and video visits at a telemedicine clinic during the COVID-19 pandemic. We discovered that providing patients with a variety of phone and video options was beneficial for many patient groups, especially those in rural or low-bandwidth areas. Gender, age, and insurance status were also factors affecting usage. Moreover,
we observed differences in prescription administration between the 2 modalities that require further investigation. Our findings indicate that phone visits were more prevalent in rural regions compared to urban areas. To promote telemedicine adoption and quality, we must work toward improving internet infrastructure in rural areas, educating patients on selecting the appropriate modality, and establishing equitable service policies for phone and video visits.

Acknowledgments
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Authors’ Contributions
SK contributed to the data collection, study design, analysis, and manuscript writing. RJ contributed to the data analysis and manuscript writing. MP contributed to data analysis and manuscript writing. PM contributed to map creation and manuscript revision. BE contributed to the study design and data collection. All authors have reviewed and agreed to submitting the manuscript.

Conflicts of Interest
None declared.

References


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Abbreviations

ACS: American Community Service
NC: North Carolina
VUC: Virtual Urgent Clinic
ZCTA: Zip Code Tabulation Area
Original Paper

Trends in the Ophthalmic Workforce and Eye Care Infrastructure in South India: Cross-Sectional Questionnaire Study

Srinivasa R Pallerla1, MBBS, MD, MCEH; Madhurima R Pallerla2, BOptom, MHA; Sannapaneni Krishnaiah3, MSc, PhD

1Andhra Pradesh Right to Sight Society, Hyderabad, India
2Sri Jyothi Eye Clinic, Hyderabad, India
3LV Prasad Eye Institute, Hyderabad, India

Corresponding Author:
Srinivasa R Pallerla, MBBS, MD, MCEH
Andhra Pradesh Right to Sight Society
Plot No 12 BN Reddy Colony Road
No 14 Banjara Hills
Hyderabad, 500034
India
Phone: 91 9849078882
Email: srinivasar107@hotmail.com

Abstract

Background: This study is part of broad-based research to determine the impact of blindness control activities in general and with special reference to the Andhra Pradesh Right to Sight Society (APRTSS) activities in the southern Indian states of Andhra Pradesh and Telangana. As part of the global “VISION 2020: The Right to Sight” initiative, the APRTSS was established in the undivided state of Andhra Pradesh in 2002. Since then, the APRTSS has been actively implementing the strategies of VISION 2020 to reduce visual impairment and blindness in the state.

Objective: The availability and distribution of the eye care workforce are essential to reach the goals of VISION 2020: The Right to Sight, the global initiative to eliminate avoidable blindness. This study assessed the trends in the availability and distribution of eye health professionals and eye care infrastructure in 2 southern Indian states: Andhra Pradesh and Telangana.

Methods: This cross-sectional study used a pretested questionnaire to gather data for the year from 2012 to 2013. Data for 2002 to 2003 were collected from available historical records. The questionnaires were pretested in a pilot study conducted before the main survey. Pretested questionnaires were administered to all eye care professionals—ophthalmologists (n=1712) and midlevel ophthalmic personnel (MLOP; n=1250)—eye care facilities with ≥10 inpatient beds or performing ≥100 cataract surgeries per annum (n=640), local nongovernmental eye care organizations (n=182), and international eye care organizations (n=10). Data were collected for 2 different time periods: the baseline year of 2002 to 2003 and the target year of 2012 to 2013. Data analysis was conducted using SPSS version 19.0.

Results: The response rates were 81.1% (519/640) for eye care facilities, 96.1% (1645/1712) for ophthalmologists, and 67.6% (845/1250) for MLOP. From 2002-2003 to 2012-2013, there has been an increase in eye care facilities, from 234 to 519 (121.8%); ophthalmologists, from 935 to 1712 (83.1%); and MLOP, from 767 to 1250 (63%). The ophthalmologist:population ratio improved from 1:88,260 in 2002-2003 to 1:51,468 in 2012-2013. The MLOP:population ratio improved from 1:168,283 in 2002-2003 to 1:138,117 in 2012-2013 but still falls short of the ideal number.

Conclusions: Both southern Indian states are able to meet the requirements for ophthalmologists and eyecare infrastructure as per the goals of VISION 2020. However, the number of MLOP falls short of the ideal ratio for the population. This study has some limitations. For example, most of the data collected through questionnaires were based on self-report, which might introduce bias due to memory recall or over or under-reporting of certain information. However, this was addressed by cross-checking the collected data with information from supplementary sources.

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KEYWORDS

Trends; human resources; infrastructure; eye care; South India
Introduction

Blindness and visual impairment represent a major public health problem in India [1-4]. The major causes of blindness and visual impairment in Andhra Pradesh and Telangana include cataract, refractive errors, retinal diseases, glaucoma, and corneal opacities, as reported in the Andhra Pradesh Eye Diseases study [5]. To tackle the problem of blindness and visual impairment, we need adequate human resources and sufficient infrastructure in eye care. Since the global “VISION 2020: the Right to Sight” initiative was launched in 1999, there has been a lot of progress in not only lessening the burden of blindness and visual impairment but also increasing the number of skilled eye care professionals and eye care infrastructure [6,7].

In line with the global Vision 2020 initiative, the undivided Andhra Pradesh state (the state was divided into Andhra Pradesh and Telangana in 2014) established the Andhra Pradesh Right to Sight Society (APRTSS) in 2002 to work toward the VISION 2020 goals. Since its formation, the APRTSS has coordinated closely with major stakeholders in eye care such as those in the government, nongovernmental organization (NGO), and private sectors. Its activities include human resource development, infrastructural strengthening, disease control, and advocacy. To determine the impact of APRTSS VISION 2020 activities, we carried out a research project collecting information about the APRTSS activities from the baseline year of 2002 to 2003—the year in which the APRTSS was established—and the target year of 2012 to 2013—after a period of 10 years.

As part of the aforementioned research project, we carried out a survey on the ophthalmic workforce and infrastructure to identify the trends over a period of 10 years. An evidence base is essential to understand trends in human resources for health [8]. However, no regular mechanism exists in India to collect data on human resource trends in the provision of eye care services [9]. This study fills that gap by identifying trends in eye care. The results of the survey will be helpful to identify gaps, strengthen the eye care facilities, and overcome the maldistribution of human resources and infrastructure, in order to achieve the goals of VISION 2020. This study assessed trends in the availability and distribution of eye health professionals and eye care infrastructure in 2 southern Indian states: Andhra Pradesh and Telangana.

Methods

Study Design

This cross-sectional study used a pretested questionnaire for the year 2012 to 2013. The data for the 2002-2003 period were collected from available historical records.

We used questionnaires in both electronic and hard copy formats to collect the data. The questionnaires were developed based on the 6 building blocks of the universal health care system [10].

Questionnaire

The questionnaire had 4 sections. Each section was distributed to concerned eye care professionals both in electronic form and hard copy to obtain the data.

Section 1: Questionnaire for Eye Care Facilities

The questionnaire for eye care facilities (Multimedia Appendix 1) was distributed to the director, superintendent, administrator, or manager in charge of the care facility. It was completed to obtain information for both the baseline and target years. It contained questions ranging from the services available, human resources, infrastructure, training facilities for eye care professionals, and any other relevant data.

Section 2: Questionnaire for Ophthalmologists

The questionnaire for ophthalmologists (Multimedia Appendix 2) was sent to all ophthalmologists working in government, NGO, and private eye care facilities. It was intended to be completed both by email and in hard copies by surface mail. It contained questions about demographic details; whether the ophthalmologist performs surgeries; whether the ophthalmologist practices in any subspecialties such as anterior segment surgeries, glaucoma, or retina; the average number of cataract surgeries per month; the principal method followed during cataract surgeries; professional experience; academic activity; and any training undergone.

Ethical Considerations

This study was conducted as part of the research project on the “Impact of implementation of blindness control activities in the state of Andhra Pradesh,” which was approved by the ethics committee of the LV Prasad Eye Institute (reference number: LEC 09-13-097) and conducted in accordance with the tenets of the Declaration of Helsinki.

Definitions

For the purpose of this study, an eye care facility was defined as any health care facility where ophthalmologist services are available. The eye care facilities were identified as secondary or tertiary eye care facilities. For the purpose of this study, secondary eye care was defined as any eye care facility having an ophthalmologist conducting cataract and basic minor surgical procedures. Tertiary eye care was defined as any eye care facility with secondary eye care services as well as at least one subspecialty such as cornea, glaucoma, retina, or oculoplasty.

Eye care facilities were categorized as government eye care facilities if they were established and funded by the government or other public sources such as universities and public sector organizations. NGO eye care facilities functioned on a no-profit, no-loss basis. Eye care facilities with a profit motive, irrespective of whether owned by an individual or a group of people or agencies, were categorized as private eye care facilities.

Inclusion Criteria

All eye care facilities with ≥10 inpatient beds or performing ≥100 cataract surgeries per annum were eligible.
Section 3: Questionnaire for MLOP
The questionnaire for MLOP (Multimedia Appendix 3) was distributed to all optometrists, ophthalmic assistants, and nurses working in all government, NGO, and private eye care facilities. It contained questions to elicit information on knowledge, skills, experience, and special training undergone such as in contact lens practice, refresher training in refraction methods, and biomedical training for equipment maintenance. We also collected information on how many refractions were conducted per month, how many pairs of spectacles were prescribed per month, any administrative work, and any research activities.

Section 4: Questionnaire for District Blindness Control Societies and NGOs in Eye Care
The questionnaire for district blindness control societies (DBCSs) and NGOs in eye care (Multimedia Appendix 4) was distributed to program managers to obtain information on the impact of the implementation of blindness control activities in the district. It contained 3 subsections: section A for program managers of DBCS, section B for NGOs in eye care, and section C for international NGOs in eye care who were active in the state.

Follow-Up
Follow-up mechanisms were instituted every 2 weeks after mailing the questionnaire to the various stakeholders, and reminders were sent at the 3rd month and again at the 6th month.

Table 1. Response rates for eye care facilities, eye care professionals, and eye care organizations.

<table>
<thead>
<tr>
<th>Questionnaire recipient</th>
<th>Questionnaires distributed, n</th>
<th>Response rate, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye care facilities</td>
<td>640</td>
<td>519 (81.1)</td>
</tr>
<tr>
<td>Ophthalmologists</td>
<td>1712</td>
<td>1645 (96.1)</td>
</tr>
<tr>
<td>Midlevel ophthalmic personnel</td>
<td>1250</td>
<td>845 (67.6)</td>
</tr>
<tr>
<td>Local NGOs(^a)</td>
<td>182</td>
<td>165 (90.7)</td>
</tr>
<tr>
<td>International NGOs</td>
<td>10</td>
<td>9 (90)</td>
</tr>
<tr>
<td>DBCSs(^b)</td>
<td>23</td>
<td>23 (100)</td>
</tr>
</tbody>
</table>

\(^a\) NGOs: nongovernmental organizations.
\(^b\) DBCSs: district blindness control societies.

Eye Care Facilities and Service Delivery
The number of eye care facilities in the undivided state increased from 234 in 2002-2003 to 519 in 2012-2013 (121.8% increase). From 2002-2003 to 2012-2013, there was a marginal increase in the number of eye care facilities in the government sector (44 to 58, 31.8%), there was a substantial increase in the NGO sector (105 to 165, 57.1%), and the highest increase was seen in the private sector (85 to 296, 248.2%; Table 2).

Table 2. Number of eye care facilities in the combined state of Andhra Pradesh in 2002-2003 and 2012-2013.

<table>
<thead>
<tr>
<th>Type of facility</th>
<th>Facilities in 2002-2003, n</th>
<th>Facilities in 2012-2013, n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government</td>
<td>44</td>
<td>58</td>
</tr>
<tr>
<td>NGO(^a)</td>
<td>105</td>
<td>165</td>
</tr>
<tr>
<td>Private</td>
<td>85</td>
<td>296</td>
</tr>
</tbody>
</table>

\(^a\) NGO: nongovernmental organization.

Additional Data Sources
In addition to the data collected through questionnaires, we gathered information from the following sources: (1) member directory for the All India Ophthalmological Society and its website, (2) directory of the Andhra Pradesh Ophthalmological Society and its website, (3) directory of the Telangana Ophthalmological Society and its website, (4) directory of the Andhra Pradesh Paramedical Board, and (5) websites of leading eye care institutions.

The information obtained from these sources helped us cross-check the data received through the questionnaires from eye care facilities, ophthalmologists, MLOP, and DBCSs. The data collected were entered in Excel sheets by 2 different data operators and cross-checked for any typographical errors. The data were analyzed using SPSS version 19.0 (IBM Corp) for Windows.

Results

Participants
As per the inclusion criteria, a total of 640 eye care facilities were identified, and a questionnaire was sent to the directors or those in charge of the facilities. Of the 640 facilities, responses were received from 519. Table 1 shows the number of questionnaires distributed to the various participants and the response rates. All the DBCSs responded to the questionnaire, whereas the lowest response rate was from MLOP.
to 79 in 2012-2013 (119.4% increase). The secondary and tertiary eye care facilities experienced a large jump in number from 2002-2003 to 2012-2013, whereas there was no increase in the number of tertiary eye care facilities in the government sector for the same period (Table 3).

Of 519 eye care facilities, 455 facilities (87.7%) were offering patient care services exclusively. Only 17% (88/519) of eye care facilities offered training facilities for eye care professionals and eye bank services in addition to patient care.

Regarding the eye care workforce, there was a substantial increase in the number of ophthalmologists in both southern Indian states. There was an insufficient increase in MLOP to meet the need. There was a large jump in the number of eye care managers, mostly in NGO and private eye care facilities (Table 4).

Table 3. Increase in secondary and tertiary eye care facilities from 2002 to 2012 by sector.

<table>
<thead>
<tr>
<th>Eye care facility sector</th>
<th>Facilities in 2002-2003, n</th>
<th>Facilities in 2012-2013, n</th>
<th>Increase, %</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Secondary</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>34</td>
<td>48</td>
<td>41</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>NGO^a</td>
<td>88</td>
<td>139</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>76</td>
<td>253</td>
<td>233</td>
<td></td>
</tr>
<tr>
<td>All secondary</td>
<td>198</td>
<td>440</td>
<td>122</td>
<td></td>
</tr>
<tr>
<td><strong>Tertiary</strong></td>
<td></td>
<td></td>
<td></td>
<td>.009</td>
</tr>
<tr>
<td>Government</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>NGO</td>
<td>17</td>
<td>26</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>9</td>
<td>43</td>
<td>378</td>
<td></td>
</tr>
<tr>
<td>All tertiary</td>
<td>36</td>
<td>79</td>
<td>119</td>
<td></td>
</tr>
</tbody>
</table>

^aNGO: nongovernmental organization.

Table 4. Eye care workforce in the 2002-2012 period.

<table>
<thead>
<tr>
<th>Job role</th>
<th>Andhra Pradesh, n</th>
<th>Telangana, n</th>
<th>Both states, n</th>
<th>Increase, %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ophthalmologists</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professor or senior consultant^a</td>
<td>132</td>
<td>288</td>
<td>146</td>
<td>338</td>
</tr>
<tr>
<td>Assistant professor or junior consultant^b</td>
<td>257</td>
<td>364</td>
<td>248</td>
<td>467</td>
</tr>
<tr>
<td>Ophthalmologists acting as superintendents or directors</td>
<td>69</td>
<td>148</td>
<td>83</td>
<td>107</td>
</tr>
<tr>
<td>All ophthalmologists</td>
<td>458</td>
<td>800</td>
<td>477</td>
<td>912</td>
</tr>
<tr>
<td><strong>Midlevel ophthalmic personnel (MLOP)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optometrists, refractionists, ophthalmic assistants, vision technicians</td>
<td>272</td>
<td>410</td>
<td>238</td>
<td>472</td>
</tr>
<tr>
<td>Ophthalmic nurses and general nurses working in eye care facilities</td>
<td>58</td>
<td>111</td>
<td>72</td>
<td>130</td>
</tr>
<tr>
<td>All MLOP</td>
<td>330</td>
<td>521</td>
<td>310</td>
<td>602</td>
</tr>
<tr>
<td>Eye care managers</td>
<td>69</td>
<td>163</td>
<td>83</td>
<td>244</td>
</tr>
</tbody>
</table>

^aOphthalmologists with ≥10 years of experience.
^bOphthalmologists with ≤10 years of experience.

The ophthalmologist:population ratio ranged from 1:6309 in Hyderabad district, which is the capital area, to 1:193,822 in Nalgonda district (Table 5). This shows there was a maldistribution of ophthalmologists among the districts in the state. The ratio of optometrists and allied personnel to the population ranged from 1:66,209 in Ranga Reddy district to 1:221,173 in Guntur district. Overall, the ophthalmologist:population ratio in the state was 1:49,404, which appears to be optimal as per the VISION 2020 guidelines. We looked at the number of eye care beds available for the population, and this improved from an average of 1:17,457 in 2002-2003 to an average of 1:13,877 in 2012-2013 (Table 6). There was also a lot of variation in the availability of eye care beds among the districts; for example, in Hyderabad district, 1 eye care bed was available for 3805 persons, compared with 1 eye care bed for 30,014 persons in Karimnagar. The total number of eye care beds increased from 4339 in 2002-2003 to 6103 in 2012-2013 (40.6% increase). On average, 1
ophthalmologist was available per 100,000 people/6 eye care beds in 2002-2003, which increased to an average of 2 ophthalmologists per 100,000 people/7 eye care beds in 2012-2013. A greater number of ophthalmologists per 100,000 population will improve the accessibility and availability of ophthalmologists to the public.

Table 5. Human resources in eye care in the districts of undivided Andhra Pradesh.

<table>
<thead>
<tr>
<th>District name</th>
<th>Population, n</th>
<th>2012-2013 a</th>
<th>Population, n</th>
<th>2012-2013 a</th>
<th>Ophthalmologists, n</th>
<th>2012-2013 b</th>
<th>Ophthalmologist:population ratio</th>
<th>MLOP c, n</th>
<th>MLOP:population ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adilabad</td>
<td>2,479,347</td>
<td>2,741,239</td>
<td>N/A d</td>
<td>22</td>
<td>N/A</td>
<td>1:124,601</td>
<td>N/A</td>
<td>24</td>
<td>N/A</td>
</tr>
<tr>
<td>Hyderabad</td>
<td>3,686,460</td>
<td>3,943,323</td>
<td>N/A</td>
<td>625</td>
<td>N/A</td>
<td>1:630,9</td>
<td>N/A</td>
<td>12</td>
<td>N/A</td>
</tr>
<tr>
<td>Karim Nagar</td>
<td>3,477,079</td>
<td>3,776,269</td>
<td>N/A</td>
<td>42</td>
<td>N/A</td>
<td>1:89,911</td>
<td>N/A</td>
<td>31</td>
<td>N/A</td>
</tr>
<tr>
<td>Khammam</td>
<td>2,565,412</td>
<td>2,797,370</td>
<td>N/A</td>
<td>30</td>
<td>N/A</td>
<td>1:93,245</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
</tr>
<tr>
<td>Mahbub Nagar</td>
<td>3,506,876</td>
<td>4,053,028</td>
<td>N/A</td>
<td>18</td>
<td>N/A</td>
<td>1:225,168</td>
<td>N/A</td>
<td>28</td>
<td>N/A</td>
</tr>
<tr>
<td>Medak</td>
<td>2,662,296</td>
<td>3,033,288</td>
<td>N/A</td>
<td>14</td>
<td>N/A</td>
<td>1:216,663</td>
<td>N/A</td>
<td>20</td>
<td>N/A</td>
</tr>
<tr>
<td>Nalgonda</td>
<td>3,238,449</td>
<td>3,488,809</td>
<td>N/A</td>
<td>18</td>
<td>N/A</td>
<td>1:193,822</td>
<td>N/A</td>
<td>27</td>
<td>N/A</td>
</tr>
<tr>
<td>Nizamabad</td>
<td>2,342,803</td>
<td>2,551,335</td>
<td>N/A</td>
<td>29</td>
<td>N/A</td>
<td>1:87,977</td>
<td>N/A</td>
<td>19</td>
<td>N/A</td>
</tr>
<tr>
<td>Ranga Reddy</td>
<td>3,506,670</td>
<td>5,296,741</td>
<td>N/A</td>
<td>99</td>
<td>N/A</td>
<td>1:53,502</td>
<td>N/A</td>
<td>80</td>
<td>N/A</td>
</tr>
<tr>
<td>Warangal</td>
<td>3,231,174</td>
<td>3,512,576</td>
<td>N/A</td>
<td>55</td>
<td>N/A</td>
<td>1:63,865</td>
<td>N/A</td>
<td>39</td>
<td>N/A</td>
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<tr>
<td>Anantapur</td>
<td>3,639,304</td>
<td>4,081,148</td>
<td>N/A</td>
<td>45</td>
<td>N/A</td>
<td>1:90,692</td>
<td>N/A</td>
<td>24</td>
<td>N/A</td>
</tr>
<tr>
<td>Chittoor</td>
<td>3,735,202</td>
<td>4,174,064</td>
<td>N/A</td>
<td>44</td>
<td>N/A</td>
<td>1:94,865</td>
<td>N/A</td>
<td>23</td>
<td>N/A</td>
</tr>
<tr>
<td>East Godavari</td>
<td>4,872,622</td>
<td>5,154,296</td>
<td>N/A</td>
<td>93</td>
<td>N/A</td>
<td>1:55,422</td>
<td>N/A</td>
<td>37</td>
<td>N/A</td>
</tr>
<tr>
<td>Guntur</td>
<td>4,405,521</td>
<td>4,887,813</td>
<td>N/A</td>
<td>41</td>
<td>N/A</td>
<td>1:119,214</td>
<td>N/A</td>
<td>22</td>
<td>N/A</td>
</tr>
<tr>
<td>Kadapa</td>
<td>2,573,481</td>
<td>2,882,469</td>
<td>N/A</td>
<td>23</td>
<td>N/A</td>
<td>1:125,324</td>
<td>N/A</td>
<td>20</td>
<td>N/A</td>
</tr>
<tr>
<td>Krishna</td>
<td>4,218,416</td>
<td>4,517,398</td>
<td>N/A</td>
<td>108</td>
<td>N/A</td>
<td>1:41,827</td>
<td>N/A</td>
<td>22</td>
<td>N/A</td>
</tr>
<tr>
<td>Kurnool</td>
<td>3,512,266</td>
<td>4,053,463</td>
<td>N/A</td>
<td>57</td>
<td>N/A</td>
<td>1:71,113</td>
<td>N/A</td>
<td>30</td>
<td>N/A</td>
</tr>
<tr>
<td>Nellore</td>
<td>2,659,661</td>
<td>2,963,557</td>
<td>N/A</td>
<td>58</td>
<td>N/A</td>
<td>1:51,095</td>
<td>N/A</td>
<td>22</td>
<td>N/A</td>
</tr>
<tr>
<td>Prakasam</td>
<td>3,054,941</td>
<td>3,397,448</td>
<td>N/A</td>
<td>47</td>
<td>N/A</td>
<td>1:72,286</td>
<td>N/A</td>
<td>34</td>
<td>N/A</td>
</tr>
<tr>
<td>Srikakulam</td>
<td>2,528,491</td>
<td>2,703,114</td>
<td>N/A</td>
<td>11</td>
<td>N/A</td>
<td>1:245,737</td>
<td>N/A</td>
<td>20</td>
<td>N/A</td>
</tr>
<tr>
<td>Visakhapatnam</td>
<td>3,789,823</td>
<td>4,290,589</td>
<td>N/A</td>
<td>171</td>
<td>N/A</td>
<td>1:25,091</td>
<td>N/A</td>
<td>23</td>
<td>N/A</td>
</tr>
<tr>
<td>Vizianagaram</td>
<td>3,789,823</td>
<td>2,344,474</td>
<td>N/A</td>
<td>15</td>
<td>N/A</td>
<td>1:156,298</td>
<td>N/A</td>
<td>23</td>
<td>N/A</td>
</tr>
<tr>
<td>West Godavari</td>
<td>3,796,144</td>
<td>3,936,966</td>
<td>N/A</td>
<td>47</td>
<td>N/A</td>
<td>1:83,765</td>
<td>N/A</td>
<td>23</td>
<td>N/A</td>
</tr>
<tr>
<td>All districts</td>
<td>7,572,7541</td>
<td>8,458,077</td>
<td>858 e</td>
<td>1712</td>
<td>1:88,260</td>
<td>1:49,404</td>
<td>450 e</td>
<td>613</td>
<td>1:123,535</td>
</tr>
</tbody>
</table>

aMLOP: midlevel ophthalmic personnel.
cCensus 2011 [12].
dN/A: not available.
eApproximate number from supplementary records.
### Table 6. Population and number of eye care beds by district.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adilabad</td>
<td>2,479,347</td>
<td>2,737,738</td>
<td>207</td>
<td>265</td>
<td>1:11,978</td>
<td>1:10,331</td>
</tr>
<tr>
<td>Hyderabad</td>
<td>3,686,460</td>
<td>4,010,238</td>
<td>855</td>
<td>1054</td>
<td>1:4312</td>
<td>1:3805</td>
</tr>
<tr>
<td>Karimnagar</td>
<td>3,477,079</td>
<td>3,811,738</td>
<td>102</td>
<td>127</td>
<td>1:34,089</td>
<td>1:30,014</td>
</tr>
<tr>
<td>Khammam</td>
<td>2,565,412</td>
<td>2,798,214</td>
<td>97</td>
<td>187</td>
<td>1:26,448</td>
<td>1:14,964</td>
</tr>
<tr>
<td>Mahbub Nagar</td>
<td>3,506,876</td>
<td>4,042,191</td>
<td>144</td>
<td>184</td>
<td>1:24,353</td>
<td>1:21,968</td>
</tr>
<tr>
<td>Medak</td>
<td>2,662,296</td>
<td>3,031,877</td>
<td>87</td>
<td>87</td>
<td>1:30,601</td>
<td>1:34,849</td>
</tr>
<tr>
<td>Nalgonda</td>
<td>3,238,449</td>
<td>3,483,648</td>
<td>198</td>
<td>228</td>
<td>1:16,356</td>
<td>1:15,279</td>
</tr>
<tr>
<td>Nizamabad</td>
<td>2,342,803</td>
<td>2,552,073</td>
<td>142</td>
<td>197</td>
<td>1:16,499</td>
<td>1:12,955</td>
</tr>
<tr>
<td>Ranga Reddy</td>
<td>3,506,670</td>
<td>5,296,396</td>
<td>127</td>
<td>242</td>
<td>1:27,612</td>
<td>1:21,886</td>
</tr>
<tr>
<td>Warangal</td>
<td>3,231,174</td>
<td>3,934,842</td>
<td>242</td>
<td>367</td>
<td>1:13,352</td>
<td>1:10,722</td>
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<tr>
<td>Anantapur</td>
<td>3,639,304</td>
<td>4,083,315</td>
<td>182</td>
<td>262</td>
<td>1:19,996</td>
<td>1:15,585</td>
</tr>
<tr>
<td>Chittoor</td>
<td>3,735,202</td>
<td>4,170,468</td>
<td>123</td>
<td>144</td>
<td>1:13,352</td>
<td>1:10,722</td>
</tr>
<tr>
<td>East Godavari</td>
<td>4,872,622</td>
<td>5,151,549</td>
<td>192</td>
<td>372</td>
<td>1:25,378</td>
<td>1:13,848</td>
</tr>
<tr>
<td>Guntur</td>
<td>4,405,521</td>
<td>4,889,320</td>
<td>207</td>
<td>277</td>
<td>1:21,283</td>
<td>1:17,651</td>
</tr>
<tr>
<td>Kadapa</td>
<td>2,573,481</td>
<td>2,884,524</td>
<td>152</td>
<td>297</td>
<td>1:16,931</td>
<td>1:9712</td>
</tr>
<tr>
<td>Krishna</td>
<td>4,218,416</td>
<td>4,529,009</td>
<td>102</td>
<td>170</td>
<td>1:41,357</td>
<td>1:26,641</td>
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<tr>
<td>Kurnool</td>
<td>3,512,266</td>
<td>4,046,601</td>
<td>107</td>
<td>162</td>
<td>1:32,825</td>
<td>1:24,979</td>
</tr>
<tr>
<td>Nellore</td>
<td>2,659,661</td>
<td>2,966,082</td>
<td>93</td>
<td>112</td>
<td>1:28,599</td>
<td>1:26,483</td>
</tr>
<tr>
<td>Prakasam</td>
<td>3,054,941</td>
<td>3,392,764</td>
<td>220</td>
<td>223</td>
<td>1:13,886</td>
<td>1:15,214</td>
</tr>
<tr>
<td>Srikakulam</td>
<td>2,528,491</td>
<td>2,699,471</td>
<td>147</td>
<td>267</td>
<td>1:17,201</td>
<td>1:10,110</td>
</tr>
<tr>
<td>Visakhapatnam</td>
<td>3,789,823</td>
<td>4,288,113</td>
<td>205</td>
<td>330</td>
<td>1:18,487</td>
<td>1:12,994</td>
</tr>
<tr>
<td>Vizianagaram</td>
<td>3,789,823</td>
<td>2,342,868</td>
<td>132</td>
<td>217</td>
<td>1:28,711</td>
<td>1:10,797</td>
</tr>
<tr>
<td>West Godavari</td>
<td>3,796,144</td>
<td>3,934,782</td>
<td>276</td>
<td>331</td>
<td>1:13,754</td>
<td>1:11,888</td>
</tr>
<tr>
<td>All districts</td>
<td>75,727,541</td>
<td>84,665,533</td>
<td>4339</td>
<td>6103</td>
<td>1:17,457</td>
<td>1:13,877</td>
</tr>
</tbody>
</table>

### Discussion

#### Principal Findings

Estimates indicate there are 4.95 million people who are blind (0.36% of the total population), 35 million people who are visually impaired (2.55%), and 0.24 million children who are blind in India [13]. Cataract and refractive errors remain the major causes of blindness and visual impairment, respectively, in India [13-16]. Cataract is responsible for nearly two-thirds of the blindness load in the older population in India [1-4], and one-fifth of blindness is due to uncorrected refractive errors [1-3]. There have been significant improvements in the field of blindness prevention, management, and control since the “VISION 2020: The Right to Sight” initiative [17]. In view of this background, India needs a pool of well-qualified, skilled, and optimal eye care professionals and sufficient infrastructure to eliminate avoidable and needless blindness and visual impairment.

The global advisory committee for VISION 2020 recommended a set of criteria for human resources and infrastructure based on expert consensus of the number of cataract procedures that could be performed by a surgeon per year under optimal conditions and the number of beds required for the same per 1 million population [9]. It was assumed that at least 50 procedures per bed per year could be optimally performed. Based on these assumptions, the following norms were recommended: 1 ophthalmologist per 50,000 population, 1 MLOP per 50,000 population, and 1 eye care bed per 20,000 population.

In this study, the ophthalmologist:population ratio in 2002-2003 was 1:88,822, and in 2012-2013, it reached 1:51,416. The state had almost reached the optimal ophthalmologist:population ratio. Previous data show that the national average ophthalmologist:population ratio is 1:107,000, ranging from 1:9000 in some regions to 1:608,000 in some areas [9].
per our study definition, these ophthalmologists who were providing their services part-time for the NGO eye care facilities were treated as working in the private sector only. Hence, the number of ophthalmologists working in the NGO sector appears to be under-reported when compared with that of other sectors.

As per VISION 2020, there should be 20 ophthalmologists and 50 beds per 1 million population [18]. The importance of the ophthalmologist:population ratio is that it can serve as a guide to forecast ophthalmic manpower requirements [19]. As per the norm, the number of available eye care beds is sufficient, and there is no need to increase the number of eye care beds; in addition, there is a shift toward day surgeries for cataract [8].

The distribution of ophthalmologists was skewed toward urban areas. Due to the lack of educational facilities for their children and other lifestyle-related infrastructure in underdeveloped areas, ophthalmologists and private eye care facilities tend to be established in developed urban areas. In the Telangana region, the majority of the ophthalmologists were practicing in Hyderabad City, whereas in coastal Andhra, many of the ophthalmologists were practicing in the urban areas of Visakhapatnam and Vijayawada. Compared with the coastal Andhra region, this phenomenon of ophthalmologists working in urban areas was more pronounced in the Telangana region. As urban areas became more crowded with ophthalmologists, there was a trend that some ophthalmologists started their practices in smaller towns in 2012-2013. In 2002-2003, ophthalmologists were mainly present in the district headquarters and major population areas. This trend changed in 2012-2013 when more eye care facilities were opened in less populated areas.

Murthy et al [20] reported that 69% of ophthalmologists worked in the private and NGO sectors, while 31% were working in the government sector. In this study, 88% of ophthalmologists were working in the private and NGO sectors, and the remaining 12% were working in the government sector. In this study, the majority of the ophthalmologists in the government sector were working in teaching institutions rather than in district and subdistrict hospitals similar to that reported by Murthy et al [20]. In this study, we found the average number of surgeries performed by surgeons in the NGO sector was significantly higher than that in other sectors in both the baseline and target years. After the ophthalmologists in the NGO sector, ophthalmologists in the government sector were performing more surgeries than those in the private sector.

Ophthalmologists with less than 10 years of experience were performing more cataract surgeries than those with more than 10 years of experience ($P=.001$). This may be because some of the senior ophthalmologists were involved in teaching and research. This finding corroborates the fact that nonteaching ophthalmologists were performing more cataract surgeries than their teaching counterparts.

The state should ideally have 1693 MLOP for its population of 84.6 million. The state needs 1080 more MLOP to reach this number. The majority of the MLOP either were not trained in streak retinoscopy or did not have access to streak retinoscopes. There is a need for a strategy to ensure that all MLOP can perform streak retinoscopy.

There were many reasons for the increase in the number of both secondary and tertiary eye care facilities in all 3 sectors—government, NGO, and private—from 2002-2003 to 2012-2013. The number of eye care facilities as well as the number of eye care professionals increased during this period. The highest increase in eye care facilities (248%) was seen in the private sector due to the establishment of many institutions for eye care professionals in both government and NGO sectors. People trained at these institutes either were absorbed into the private sector or started their own practice, because there was no recruitment in the government sector or minimal opportunities in the NGO sector. This is the reason why the number of secondary eye care facilities increased more than tertiary eye care facilities. Another reason was, compared with other fields in medical practice, it is easier to start a solo practice in eye care, as it does not depend on cooperation from other medical streams. For example, to start a general surgery or orthopedics practice, one requires the services of an anesthetist. To start a pediatric practice, good laboratory services are required. Of the 519 eye care facilities functioning in 2012-2013, 253 (48.7%) were from the private sector. This was similar to the findings reported by Murthy et al [1], in which more than one-half of the eye care facilities belonged to the private sector.

**Limitations**

This study has some limitations. Most of the data collected through questionnaires were based on self-report, which might introduce bias due to memory recall or over or under-reporting of certain information. However, this was addressed by cross-checking the collected data with information from the supplementary sources mentioned in the Methods section.

**Conclusion**

Regarding human resources, there was a substantial increase in the number of ophthalmologists, particularly in the private sector. In fact, the percentage of ophthalmologists in the government sector decreased from the baseline year to the target year, whereas in the NGO sector, it remained the same.

Though all 3 sectors—government, NGO, and private—showed an increase in the number of eye care facilities from the baseline year to the target year, substantial increases were seen in the private sector and, to some extent, in the NGO sector. Most of the eye care facilities offered patient care services only. The outpatient services and inpatient services were also higher in 2012-2013 in all 3 sectors, but the NGO sector contributed a major share, followed by the private sector. Regarding outreach activities, the NGO sector dominated the services, to the extent of 80%-97%. One NGO facility collected the majority of eyes for corneal transplantation, and the remaining eye care facilities in the government, NGO, or private sector showed very little improvement in their collection of eyes.

Regarding eye care infrastructure, there was a 41% increase in the number of beds available for eye care, and this increase was mainly due to the NGO sector, followed by the private sector. The average number of surgeries per surgeon per annum was highest in the NGO sector, followed by the government sector. There was a major shortage of MLOP in the state to attain the ideal ratio of 1 MLOP per 50,000 population. To attain the ideal...
number of MLOP, there is an urgent need to increase the number of training facilities for MLOP. Overall, the functioning of the DBCSs for planning and supervising district eye care programs was satisfactory.

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Conflicts of Interest

None declared.

Multimedia Appendix 1
Questionnaire for eye care facilities.
[XLSX File (Microsoft Excel File), 658 KB - ojphi_v16i1e50921_app1.xlsx]

Multimedia Appendix 2
Questionnaire for ophthalmologists.
[XLSX File (Microsoft Excel File), 485 KB - ojphi_v16i1e50921_app2.xlsx]

Multimedia Appendix 3
Questionnaire for midlevel ophthalmic personnel.
[XLSX File (Microsoft Excel File), 494 KB - ojphi_v16i1e50921_app3.xlsx]

Multimedia Appendix 4
Questionnaire for district blindness control societies (DBCSs) and nongovernmental organizations (NGOs) in eye care.
[XLSX File (Microsoft Excel File), 463 KB - ojphi_v16i1e50921_app4.xlsx]

References


Abbreviations

APRTSS: Andhra Pradesh Right to Sight Society
DBCS: district blindness control society
MLOP: midlevel ophthalmic personnel
NGO: nongovernmental organization