FEASIBILITY OF STORE-AND-FORWARD TELEDERMATOLOGY IN OUTPATIENT CARE: A PROSPECTIVE STUDY FROM RURAL INDIA UTILISING SPECIALIST REFERRAL SERVICES THROUGH AN INSTANT MESSAGING PLATFORM - "WHATSAPP"

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Abstract

Objectives: The COVID-19 pandemic has placed unprecedented demands on the delivery of health care in rural areas of India. We examined the feasibility of store-and-forward mobile teledermatology for outpatient access to specialist dermatologic care in underserved areas in India. **Methods:** We conducted a prospective study using smartphone-based teledermatology, connecting six underserved clinics manned by primary care physicians (PCP) to three dermatologists, using the instant messaging platform WhatsApp. We assessed the concordance between PCPs and dermatologists (using prevalence adjusted bias adjusted kappa), consultation time, the spectrum of conditions, and the outcome. **Results:** Of the 730 dermatology patients screened in the clinics, 95 (13%) (36 males and 59 females) required teleconsultation, among which 61.1% were non-infective, 34.7% were infective, and the diagnosis could not be ascertained in 4.2 %. The mean time taken for the first response was 13.5±18.4 minutes. Twenty per cent (n=19) required referral, and 80% (n=76) of consultations could be resolved at the clinic, of whom 36.8 % were cured, 38.2% had moderate, 4% had minimal improvement, 13% were lost to follow-up, and 8% refused treatment. Cure was observed in viral infections and eczema. The diagnostic concordance ranged from low values [0.38 (95% CI: 0-0.68)] in infective to moderate [0.66 (95% CI: 0.42 -0.83), p=0.033] in non-infective disorders. **Conclusion:** Asynchronous mobile teledermatology, using specialist referral via instant messaging platforms, is a powerful modality for providing real-time dermatologic care, while offering a very promising alternative for decreasing healthcare disparities and continuity of services even in adverse situations like the Covid-19 pandemic.

Keywords: asynchronous teledermatology; mobile teledermatology; WhatsApp messenger; store and forward; India

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Introduction

The revolution in healthcare delivery using teledermatology (TD) was envisioned a decade ago when it was predicted that "the teledermatology train is coming: get on board, get out of the way, or get run over".[1] Smartphones, by overcoming many limitations, have opened a new field of telemedicine called "mobile teledermatology".[2,3] The obvious advantage of mobile teledermatology is the mobility factor, and with time, mobile teledermatology has become cost-effective with the decreasing cost of smartphones, increased capability of mobile phone cameras and mobile broadband services.[4]

Considering the high prevalence of skin diseases in rural areas coupled with the limited availability of trained dermatologists, there is a need to explore innovative avenues with TD using smartphone apps like WhatsApp.[5] Furthermore, since the onset of the COVID-19 pandemic TD has become critical for maintaining patient access to dermatologic services in many areas.[6]

WhatsApp, with end-to-end encryption, is currently one of the most popular applications worldwide and allows its users to communicate by maintaining privacy. Although sparse, there is growing literature exploring WhatsApp as a potential telecommunication tool in medicine.[7,8] The ease of use, portability, speed, cost-effectiveness and simplicity makes WhatsApp a good adjunctive telemedicine tool.[9] Familiarity with the application is the biggest advantage. WhatsApp can deliver both real-time-TD and store and forward (SAF) images and/or text, and the dermatologist can reply at a convenient time.

Many studies have shown that access to specialised care is improved by using store-and-forward teledermatology, which provides accurate diagnosis and reduces the time taken for treatment, with high patient satisfaction.[10] Although the application of teledermatology has increased worldwide over the years, there are unfortunately, still large countries with poor geographical distribution of physicians where teledermatology is underutilised.[2,9] India has a ratio of approximately one dermatologist per 130,000 population.[10] The dermatologist community in India is clustered in and around urban areas, limiting access to specialists for many patients in rural locations, which is further complicated owing to limited means of communication and transportation.[11]

Against the backdrop of the Covid-19 pandemic, the pre-existing dearth of specialists in rural areas in India opened opportunities to use mobile teledermatology to respond to these challenging times. Considering the significant improvement in smartphone camera resolution and the rapidly increasing number of physicians using them, we examined the feasibility of primary care physicians (PCPs) working at the grass root level using SAF teledermatology for the delivery of dermatologic care to outpatients in underserved areas.

Methods

An Institutional Ethics Committee approved, smartphone based teledermatology consultation service was established to serve six rural secondary level hospitals belonging to Emmanuel Hospital Association (EHA), a non-governmental healthcare organisation, located in Central Northern India, from November 2020 to April 2021. (Table 1) The six hospitals were situated in remote areas of four states, which have been designated as "BIMARU" states[12] (translated as unhealthy) in India, according to the state health index with a very low human developmental index.[13] (Figure 1)

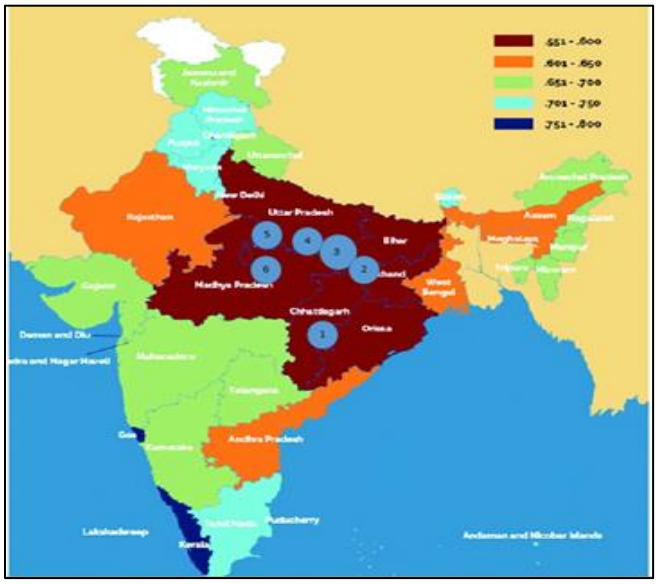

Figure 1: The six teleconsultation rural hospitals in India. are located in areas of very low Human Development Index. [Source-https://www.researchgate.net/figure/The-Human-Development-Index-of-Indian-states_fig1_332510872].

Table 1: Characteristics of the six teleconsultation rural hospitals.

Hospital location / State	Number of beds	Primary care physician qualification	Phone / Camera specifications /network	Teleconsults / Dermatology OPD patients (6 m) n = 95/730	Derma-tologist in the locality (Yes/No)	Nearest Dermatology Referral Centre
Jagdheeshpur/ Chattisgarh	50	MBBS	Xiaomi –Poco F1 / 12MP /4G	5/17	No	150km (Raipur)
Kachhwa / UP	20	MBBS	MotoG7 / 12MP /4G	6/272	No	35km (Benaras)
Robertsganj / UP	75	Diploma in Child Health	Moto G 5 plus/ 12MP/ 4G	42/120	No	120 Km (Benaras
Lalitpur / UP	10	MD Anaesthesia	Redmi note 5 Pro/ 12MP/ 4G	20/144	Yes (1)	100km (Jhansi)
Chattarpur / MP	120	MD Medicine	Samsung Galaxy M30s/ 48 MP/4G	13/120	No	130 km (Jhansi)
Satbarwa / Jharkhand	75	MBBS	Samsung J7/13MP//4G	9/57	No	140 km (Ranchi)

In this prospective study, the teleconsultations were provided by non-dermatologists, who function as primary care physicians (PCPs) in the rural hospitals. A virtual meeting was arranged to familiarise the PCPs with dermatological examination protocols, study design and photography requirements. The teledermatology consultations were submitted using store and forward (SAF) method through the instant messaging 'WhatsApp messenger' application. A chat group comprised of three dermatology specialists (DS) (RG, MT and MJC) and the six PCPs was formed.

All dermatological patients presenting with a condition that the PCP had difficulty in diagnosing or managing were eligible for inclusion. Any patient who was unwilling to provide their details for sharing with a distant specialist was excluded. After obtaining written informed consent, the PCP completed a 27 question proforma document covering the subject's demographics, clinical history, dermatological examination, and the PCPs diagnosis and management plan. The proforma was scanned and sent via WhatsApp with at least two relevant photographs of the patient. All consultations were shared within the chat group, and the DS alternatively took turns to respond by providing a diagnosis, plan for management and advised referral if required. The WhatsApp consultation was supplemented with a voice call if required. Relevant investigations necessary for diagnosis and management were advised wherever appropriate, and any further information or clarification needed was obtained simultaneously (Figure 2). All data were securely transmitted to a computer maintained at the site of the principal investigator (M T). A copy of the proforma was kept in the patient's file and the copy and photographs submitted to the WhatsApp group were downloaded to the departmental computer. All messages, scans and photos of a case were deleted from the senders' and recipients' phones on completion of the case.

We assessed the mean time for consultation, the spectrum of conditions managed, concordance between PCPs and DSs (using Cohen's kappa coefficient), and the outcome at two weeks. During the review, the status of the patient was recorded by the PCP using an outcome score (0 - no improvement, 1-4 mild improvement, 5-9 moderate improvement, 10 -complete resolution).

Statistical Analysis

Descriptive statistics were used to summarise the data. Mean andstand ard deviation (SD) or median and interquartile range (IQR) were used for continuous variables as appropriate, and for categorical variables, numbers and proportions were used. The diagnostic agreement between the DS and the PCP were analysed using prevalence adjusted bias adjusted kappa (PABAK), which corrects for the proportion of agreement expected by chance. PABAK <0.40 indicates fair agreement, PABAK between 0.41–0.60 indicates moderate agreement, 0.61–0.80 indicates good agreement and a PABAK >0.81 indicates almost perfect agreement.[14] Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 21.0 (Armonk, NY: IBM Corp) and Dx Test Software (Developed by Biostatistics Resource and Training Center, Christian Medical College, Vellore, India) was used for the reliability analysis.

Results

Patient characteristics

During the study period, 730 dermatology patients were eval-

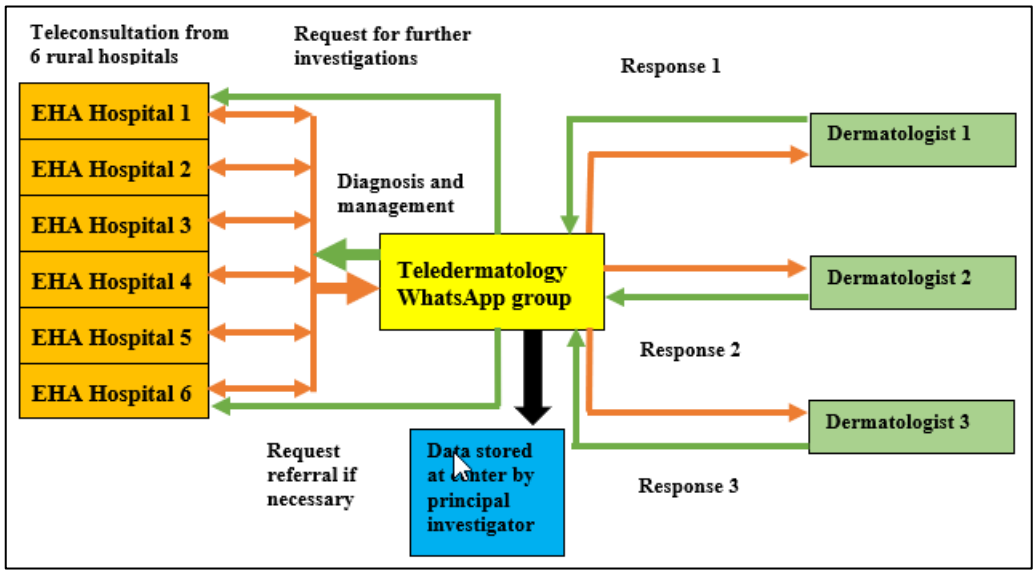

Figure 2: Flowchart of the study design for teleconsultation between the six rural hospitals and dermatologists.

uated in the six rural hospitals, of whom 13% (95) required a TD consultation. The male: female ratio was 36:59 and the mean age of patients was 30.1±17.85 years.

Dermatology Conditions

Among the teleconsultations, 62.1% (59/95) were non-infective, 33.7% (32/95) were infective, and in 4.2% (4/95) the diagnosis could not be ascertained. Infections were the highest category, followed by eczemas. (Table 2)

Teleconsultation characteristics

The primary diagnoses given by the DS were compared with the diagnoses given by the PCP. The diagnostic concordance ranged from low values [0.38 (95% CI: 0-0.68)] in infective (Figure 3) to moderate [0.66 (95% CI: 0.42 -0.83), p=0.034] in non-infective disorders. Infective conditions showed lower concordance value in our study. The mean time taken for DS to respond was 13.5±18.38 minutes. While 53.6% (51/95)

Table 2: Distribution of various dermatological disorders diagnosed and their outcome score range.

Diagnosis	Frequency n (%)	*Outcome score range
Infections and infestations	33 (34.7)	
Fungal (dermatophytosis, pityriasis folliculitis, chronic paronychia)	15 (15.7)	5-10, R
Bacterial (impetigo)	2 (2.1)	8, R
Viral (herpes zoster, herpes genitalis, genital warts)	12 (12.6)	5-10, R
Infestations (Scabies)	3 (3.16)	10, LTF
Mycobacterial (HD)	1 (1.04)	R
Eczema	15 (15. 8)	
Contact dermatitis	4 (4.2)	10, LTF
Others (asteatotic eczema, allergic contact dermatitis)	11(11.57)	4-10
Adnexal diseases	4 (4.2)	
Acne	2 (2.1)	7, LTF
Others	2 (2.1)	5,8
Hypersensitivity	7 (7.3)	
Drug reactions (FDE, Covid arm, exanthematous rash)	4 (4.2)	8-10
Erythema multiforme	2 (2.1)	9
Polymorphic light eruption (PMLE)	1 (1.1)	LTF
Papulosquamous disorders	10 (10.5)	
Psoriasis	3 (3.2)	6-10
Lichen planus and lichenoid eruptions	7 (7.3)	7-9, R
Neoplasms	3 (3.2)	
Benign (Syringoma, Haemangioma)	3 (3.2)	R, LTF
Malignant	0	
Diseases of hair and nail	3 (3.2)	
Alopecia (alopecia areata)	2 (2.1)	2,5
Nail (brittle nails)	1 (1.1)	5,9
Pigmentary disorders	6 (6.3)	
Melasma	3 (3.2)	8, LTF
Vitiligo	2 (2.1)	5, R
Others (Hori's naevus)	1 (1.1)	LTF
Vesiculobullous disorders	2 (2.1)	
Pemphigus	1 (1.1)	R
Pemphigoid	1 (1.1)	R
Others	8 (8.4)	
Nutritional (pellagra)	1 (1.1)	10
Genodermatoses (ichthyosis, PPK)	2 (2.1)	R
Keloid	1 (1.1)	4
Chilblains	1 (1.1)	10
Skin tag	1 (1.1)	R
Palmoplantar hyperhidrosis	1 (1.1)	10
Erythroderma	1 (1.1)	R
Diagnosis not confirmed	4 (4.2)	
Lupus vulgaris/chromomycosis	2 (2.1)	R
Lichen sclerosis/morphea	1 (1.1)	LTF
Langerhans cell histiocytosis/sarcoid	1 (1.1)	R

*[Outcome score- 0- no improvement, 1-4 – mild improvement, 5-9 – moderate improvement, 10-cure] R-Referred; LTF- lost to follow up.

Figure 3: Herpes Zoster of right T1 dermatome in a pregnant lady promptly, managed through teleconsultation.

consultations required assistance for diagnosis, 46.3% (44/95) required help with only treatment of the skin disease. Overall, 80% of the consultations could be managed at the peripheral hospitals through TD, while 20% (19/95) required referral. More information could be obtained through the exchange of messages through the WhatsApp application, which enabled reaching a final diagnosis with the minimum delay.

Review at 2 weeks

Among the 80% (76/95) of patients managed through TD, 36.8% (28/76) were cured, 38.2% (29/76) and 4% (3/76) had moderate and minimal improvement respectively, 13% (10/76) were lost to follow-up, and 8% (6/76) refused treatment. cures were observed in viral infections and eczema.

Referred cases (n=19)

Out of the 19 patients referred for face-to-face consultation, ten were referred for treatment at a higher centre, eight for further investigations and one for lack of response to therapy. Patients referred for treatment included vesiculobullous disorders like bullous pemphigoid, pemphigus, ichthyosis, acral vitiligo and drug reactions like erythema multiforme. Patients referred for investigations primarily required skin biopsy to confirm the diagnosis in suspected cases of lupus vulgaris, chromoblastomycosis, sarcoidosis, and erythroderma.

Discussion

Telemedicine has expanded dermatology services in many resource-limited settings.[15-19] This study highlights the advantages of involving PCPs, and the benefits of using an instant messaging app like WhatsApp. Although significant emphasis has been placed on synchronous telemedicine, such as video or telephone visits, current experience shows that store and forward or asynchronous telemedicine in the form of provider-to-provider or provider–to-patient e-consult has the potential to facilitate routine dermatology care.[20] In this context, the ubiquitous adoption of the smartphone has had a profound effect on the delivery of SAF TD, allowing dermatologists to provide services to remote centres. The widespread expansion of high-speed wireless networks and 4G telecommunications services imply that SAF TD consultations can be performed with minimal communication costs almost immediately after taking a photograph with a smartphone, a cost- and time-efficient option that negates the need to locate an available computer.[3]

Unlike many studies using the multimedia messaging service (MMS),[21,22] we used the instant messaging platform WhatsApp, which has the advantage of end-to-end encryption for maintaining data security as well as the ability to operate with both cellular networks and Wifi.[23] It is free and user-friendly (having a simple app interface), with ease of access across multiple operating systems,[24] which was very useful in this study for collaborating with PCPs in different locations. The WhatsApp platform has been designated as one of the most suitable tools for telemedicine in the Indian context in the recent 'Telemedicine practice guidelines' issued by the Indian Ministry of Health and Family Welfare.[25]

Furthermore, Opperman et al., in a recent appraisal on the ethical considerations related to WhatsApp, informs that, WhatsApp uses end to end encryption as a method to protect data, which even prevents the parent company from accessing the information, as well as double password protection, which includes phone and WhatsApp lock.[26] This double security feature of WhatsApp alleviates concerns regarding security of sensitive data containing identifiable patient information transmitted using this platform. However, it must be noted that use of WhatsApp to share medical information holds a risk of legal consequences, in the absence of informed consent by a patient.[26] If the above safeguards are in place, then the inability to comply with the elaborate requirements for privacy and data security required by HIPAA (Health Insurance Portability and Accountability Act) or other Western standards, cannot diminish or disqualify WhatsApp as an acceptable tool in clinical and

research setting.

In a recent scoping review on WhatsApp application in clinical practice, Morris et al., raised concerns over the need to safeguard protected health information (PHI) by stringent record keeping and data storage,[27] which was also strictly adhered to in our study. The PHI was accessible only to a restricted group in our study and the patient data were deleted once the consultation process was over. The consolidated data was stored only at one site i.e., at the centre of the principal investigator. According to our experience, this practice can be an additional safeguard to WhatsApp usage in telemedicine and will help to overcome much of the scepticism and apprehension related to confidentiality, patient privacy and data security. In a major advancement to support its case on the ease of use and reliability, WhatsApp announced that it can promote the adoption of a unified payment interface (UPI) with users across society, thereby extending its reach to the grass-root level.[28] WhatsApp is hence a very promising tool in mobile TD, extending its reach to all areas having internet connectivity.

Regarding the MMS text messages used, Shin et al. state that misdiagnoses may have been caused by the lack of information provided as the MMS messages could not facilitate a conversation.[21] The MMS text messages only contained very brief information about the patients, and the teledermatologists were unable to ask for more information about their medical histories or other symptoms they might have been experiencing.[21] The median delay in providing the first specialist response was 10.2 hrs in the Medicine Sans Frontiers experience using a web-based messaging system.[15] Insufficient quality of clinical details and information supplied by the referrers and lack of feedback about patient follow-up were two main issues which were raised in this study.[15] WhatsApp, in contrast, being an instant messaging platform, alerts the teledermatologist instantly and enables a quick response and is also able to facilitate an immediate dialogue between the teledermatologist and the provider so that any additional information required can be obtained simultaneously and any discrepancies in the images can be modified by sending another instantly to enable an accurate diagnosis. The mean time to respond was 14 minutes in our study, which is a significant advantage in terms of longer waiting time observed in the Afghan study (48 hr) as well as in other SAF studies done in USA (37 hr) and Brazil (1.5 months).[29-31]

In a retrospective study on SAF TD for primary care providers in Afghanistan, consults came from 38 providers based in 11 cities.[29] Similar to our study the consults came from varied specialities (family medicine, internal medicine, paediatrician, surgeon, etc) and in addition from nurses and occupational therapists as well. Female preponderance was common to both studies and the diagnosis was rendered by the teleconsultant in 94% cases as opposed to 80% in our study. In the diagnostic category, infections topped the list in both studies (23% and 33.7%) among which fungal infections was the most common in both. eczematous conditions came next in the list in both studies (16% and 13.7% respectively). This could be a reflection of the prevalent skin conditions in rural areas in India.[5]

Studies analysing the concordance in teledermatology have most often been between dermatologists by using the gold standard of face-to-face consultation.[32,33] In one such study, the concordance between the face-to-face and the store-and-forward diagnosis was 91.05% (Cohen κ coefficient = 0.906), validating the SAF model.[33] In another SAF study in a resource poor primary care setting, there was full diagnostic and management concordance between primary care providers and dermatologists for 22% and 23% of dermatologic conditions, respectively.[34] The concordance in our study ranged from low values [0.38 (95% CI: 0-0.68)] in infective to moderate [0.66 (95% CI: 0.42 -0.83), p=0.033] in non-infective disorders, emphasising the importance of specialist input in managing infective conditions.

The pandemic has widened the pre-existing socio-economic disparities and healthcare inequalities across the globe.[35] The pandemic has also led to innovations in teledermatology that will most certainly set new precedents in how it is practised for years to come. Not only has teledermatology served as a patch to help patients in a difficult time, but these disruptive changes pushed telemedicine into the forefront of conversations for reshaping best practices for dermatology care overall as well.[36] A key to the expansion in the utilisation of TD is to connect primary care physicians to specialist referral services through TD.[29] While our study had 20% referral, only 8% were recommended face-to-face evaluation in the Afghan study.[29] The reasons for referral in our study was chiefly for diagnosis and management of critical conditions. The higher referral could be attributed to the severe category of illness like vesiculo-bullous disorders and drug reactions, requiring specialist treatment and lack of diagnostic facilities in the peripheral centres. A still higher referral rate was seen in two other SAF studies in the US (35%)[30] and in Brazil (47%),[31] in comparison to our study. This could be due to the higher occurrence of pigmented lesions and neoplastic conditions requiring specialist evaluation in these studies.

Our study involving dermatologists and primary care physicians supports the viability of direct partnerships between primary care providers and dermatologists in teledermatology. Telemedicine may overcome the barriers of distance and time, but it may also paradoxically worsen access for some people in unanticipated ways.[37] The elderly, illiterate, and marginalised sections, for instance, may require assistance using digital devices. This well-described digital divide may be an important contributing factor in disparities.[37] Addressing the digital divide to ensure telemedicine does not worsen disparities will require a concerted effort from physicians, regulatory bodies, and public health services. Involving the PCP instead of a direct patient-dermatologist teleconsultation, as we have done,

ensures dermatology care to the technologically challenged, an inescapable feature of most rural communities, in addition to adherence to treatment, cognisance of coexisting medical conditions and prevention of abuse of teleconsultation. This also provides simultaneous educational opportunities for PCPs and mitigates suboptimal treatment. It was also observed that PCPs who regularly participated in teledermatology referrals consequently learned how to manage common skin conditions themselves and in turn required fewer referrals.[38] Even as demand may push the market toward more provider-to-patient models, direct partnerships between primary care providers and dermatologists may prove valuable in many ways in underserved areas.[38] Eighty per cent of patients could be managed without referral in our study, emphasising the vital role that specialist referral provides through teledermatology. It is imperative hence to consider how different telemedicine models like specialist referral by primary care physician, a model which we have employed, can mitigate the health disparities in resource-poor communities.

Conclusions

Smartphones have overcome many of the limitations seen in older devices and web-based systems to catapult SAF teledermatology to greater heights and wider reach. Our study supports the increasing evidence that asynchronous mobile teledermatology, using specialist referral via instant messaging platforms, expands access to specialists' input in the delivery of real-time dermatologic care to disadvantaged communities while also offering a very promising alternative for decreasing disparities in health care and continuity of services in situations restricting access to health care, like the Covid-19 pandemic.

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