Use of Teledermatology to Improve Dermatological Access in Rural Areas

Alberto Coustasse, DrPH, MD, MBA, MPH,¹
Raghav Sarkar, MBBS, MPH, MS,² Bukola Abodunde, MHA,¹
Brandon J. Metzger, MS,² and Chelsea M. Slater, MHA¹

¹Healthcare Administration Program, Lewis College of Business,
Marshall University, South Charleston, West Virginia.

²Health Informatics Program, Marshall University, Huntington,
West Virginia.

Abstract

Introduction: Dermatological access in rural regions has been impacted due to an acute, global dermatologist shortage coupled with a striking disparity in dermatologist density between urban and rural areas. As a result, the dermatological arena has been under notable pressure to amplify access. Teledermatology has entailed the use of technology to provide dermatological services to individuals located at a remote distance. The purpose of this literature review was to examine the effect of utilization of teledermatology to determine enhancement of dermatological access to residents of rural areas.

Materials and Methods: This review followed a systematic approach and utilized five electronic databases to obtain peer-reviewed journal articles. A PRISMA approach was used and a total of 86 references were employed.

Results: Teledermatology programs have been able to complement conventional dermatological care to enhance dermatological access to rural areas that have suffered from a shortage of dermatologists and could aid in supplementing traditional care as well. Within rural settings, the results of three studies in this review indicated the importance of improved quality for diagnostic precision, whereas one study reported that clinical images might not provide sufficient insight to deliver clear-cut diagnoses. In addition, enhancements in diagnostic precision could be obtained by upgrades in phone cameras to capture images. Finally, to most of the existing literature, in using teledermatology, physician satisfaction has been stronger than patient satisfaction.

Conclusions: Teledermatology has had a beneficial impact in improving dermatological access to rural areas. The success of this technology is contingent upon the commitment and willingness of the dermatologist in utilizing it.

Keywords: access, quality of images, diagnostic accuracy, specificity, rural areas, teledermatology, telemedicine, e-health

Introduction

Telemedicine has entailed the utilization of visual communication, data information, and interactive audio to effectuate the transfer of medical information, and to facilitate remote patient consultations, diagnosis, and treatment.¹ Teledermatology has comprised the utilization of telemedicine and imaging to deliver remote dermatological services (clinical and laboratory) to patients located at a distance.² It has been one of the most rapidly evolving branches of telemedicine³; in fact, dermatology has been one of the medical specialties where telemedicine has been most vigorously implemented.⁴ Lee and English reported that there are 229 dermatology-related mobile applications by 2013 and 98.3 out of 100 people had access to mobile cellular in 2015.⁵

The ever-increasing demand for specialized dermatological care coupled with the pressing need to boost patient access has placed considerable strain on dermatological services.⁶ Data about physician needs assessment have assessed that, for a maximum of 30,000 individuals, it should be at least one dermatologist available to provide necessary services. However, the current scenario has been far from ideal.⁷ The International Foundation for Dermatology has determined that ~3 billion individuals residing in 345 developing rural communities have suffered from inadequate dermatological care.⁷ Countries in the developing part of the world have been facing an alarming shortage in specialists like dermatologists.⁸

From a global perspective, about 38% of nations have integrated teledermatology programs, and only 30% have had entire government-funded agencies that have allocated financial support to develop further, adopt, and maintain this innovation. Teledermatology implementation in high-income nations has faced obstacles relating to restricted reimbursement for those specialists and issues related to patient privacy/confidentiality, whereas in low-income countries, a shortage of technical skills and resource limitations have been grass-roots hindrances to tele-establishment.⁹

The stark disproportion in physician density between urban and rural areas has been a concerning issue, with greater

physician concentration in urban areas.¹⁰ Even though 54% of the global population has been situated in urban areas with greater access to health resources than rural areas, a significant portion has still populated rural areas with little access.¹¹ In these rural areas, time-sensitive, quality care has often been deficient, which has invariably resulted in a decline in patient health state.¹² According to the U.S. Census Bureau's designation of urban and rural areas, urban areas denote densely developed territory and include residential, commercial, and other nonresidential urban lands (areas with more than 50,000 individual and groups with 2,500 to 50,000 people), whereas rural areas comprise all housing, population, and territory not included within an urban area.¹³ Urban regions in Canada and the United States have had a higher density of dermatologists than rural areas.¹⁴ In the United States, even though the number of dermatologists has increased from 1.9 to 3.2 for every 100,000 individuals from 1970 to 2010, there has been a shortage, with urban areas having a higher density (25 per 100,000 individuals) compared to numerous rural western and central counties that do not have access to any local dermatologist.⁹

Given these multiple issues, teledermatologists have thought that delivering dermatological care through teledermatology could aid in improving access to inhabitants based in rural areas since its benefits could be extrapolated and mobilized to provide vital services remotely to individuals.¹⁵ Most of the teledermatology studies have been associated with diagnostic and treatment concordance and accuracy of this modality of treatment versus traditional care provided by a dermatologist in a face-to-face visit. The key metrics of concordance have included sensitivity and specificity, whereas accuracy has been determined by histopathological findings, as the gold standard.¹⁶ In addition, teledermatology could potentially ameliorate the national shortage and urban-rural disparity by cost-effective consultations and guidance for primary care physicians.¹⁷ As an example, teledermatological models have been explored as a possible means of alleviating the restricted access and reduced costs to dermatologists in Australia.¹⁸ Moreover, a practical aspect of teledermatology has been that it has had a profoundly visual facet intrinsic in its function,^{19,20} which has also been inherent within the overall context of telemedicine.²¹ This know-how has caused novel opportunities for employing teledermatology in resource-stricken areas.²²

The purpose of this literature review was to examine the effect of utilization of teledermatology to determine enhancement of dermatological access to residents of rural areas.

Methods

The methodology design for this study was a literature review based on the research framework adapted from Yao et al.²³ This research framework illustrates the process of utilizing teledermatology involves the needs of teledermatology in rural areas followed by the adoption and application; when the benefits and barriers were evaluated and settled out, the cycle continues (*Fig. 1*). This research framework was appropriate to this study as both the adopted and the original research frameworks used it for the adoption of technology. Its utilization in prior studies has supported the internal validity of this research framework.^{24–26}

The methodology used in this review was a systematic review approach, and it was performed in three different stages: (1) Literature Identification and data collection; (2) Establishment of Inclusion Criteria and Literature analysis; (3) and Literature Categorization.

STAGE 1: LITERATURE IDENTIFICATION AND COLLECTION

The electronic databases of PubMed, EBSCOhost, Academic Search Premier, ProQuest, and Google Scholar databases were employed to obtain peer-reviewed literature. The following keywords were utilized in conducting the literature search: “teledermatology” OR “eHealth” OR “mHealth” AND “biopsy,” OR “clinical images,” OR “diagnostic test accuracy,” OR “specificity” OR “patient/physician satisfaction” AND “rural consultation OR rural access” OR “real-time.”

Following a PRISMA approach, citations and abstracts identified by the search were assessed to identify relevant articles. The search identified 225 relevant citations and articles

FIG. 1. Conceptual framework for the adoption of teledermatology to enhance dermatological access to rural areas. Source: Adapted from Yao et al.²³

were excluded ($n = 115$) if they did not meet the inclusion criteria. In addition, articles were added ($n = 86$) if they identified teledermatological clinical outcomes (including diagnostic accuracy, patient satisfaction, and identification of skin malignancy) and/o teledermatological economic and/or access outcomes (including a reduction in travel time, waiting time, and consultation time). These 110 articles were subject to full-text review; of these, 24 were excluded because they did not meet focus specifically on Teledermatology and rural health. At the conclusion of the full-text review, a total of 86 articles were included in the data abstraction and analysis (Fig. 2).²⁷

STAGE 2: ESTABLISHMENT OF INCLUSION CRITERIA AND LITERATURE ANALYSIS

The literature examined was selected after a review of the abstracts was performed. Examined references were published in English, in rural settings and in between 2007 and 2018 to keep this review current. This evaluation scrutinized 86 references that were either conducted in rural settings (which could have also included remote environments distant from the nearest clinic, underserved areas, developing countries, or resource-stricken regions) or provided information concerning the viability of teledermatology in enhancing rural dermatological access.

STAGE 3: LITERATURE CATEGORIZATION

The results that emerged from the systematic literature were classified as follows: diagnostic acuity and quality of images; waiting period for initial consultations, duration of consultations, and travel reduction; biopsy, identification of skin malignancy, referrals, and follow-up; and patient/physician satisfaction with the above four categories.

Results

DIAGNOSTIC ACUITY OF TELEDERMATOLOGICAL MODELS ALONG WITH QUALITY OF CLINICAL IMAGES ANALYZED

A systematic review conducted within the context of Australia's native population reported the teledermatological diagnostic accuracy of 80%; it also revealed that accuracy rose from 66% with poor-quality images to 87% with images of adequate quality.²⁸ Concordance levels between primary care practitioners and teledermatologists have been between 41% and 89%,²⁹ while it was 48% in another study.³⁰ Thind et al. reported a study in which there was a 47% diagnostic

FIG. 2. Overview of literature evaluation following PRISMA Approach. Source: Moher et al.²⁷

agreement between the dermatologist and the general practitioner with the utilization of teledermatology in the remote training of general practitioners in Burkina Faso.³¹ A 75% diagnostic concordance level has been detailed in the study of Rubegni et al.³²

Based on the levels of specialist referral concordance, diagnostic concordance, and management concordance, a Chilean research team concluded that 40.8% of consultations would be unnecessary by store-and-forward technology.³³ Results from a randomized controlled trial conducted in a rural primary health care facility in Batangas, Philippines, did not find mobile teledermatology inferior to face-to-face consultations regarding clinical outcomes.³⁴ A study conducted in a remote area in Egypt revealed 81.3% complete concordance and 97% partial/complete concordance rates, indicating that the cost-effective teleservice could enable educational programs and monitoring of practitioners.³⁵ Within a nonrural context, a prospective study conducted in underserved, urban primary facilities in Philadelphia revealed that teledermatology could enhance outpatient care access and clinical results in these facilities by resolving diagnostic disagreements between primary care practitioners and dermatologists.³⁶

For the dermatologist, clinical images of good quality have enhanced diagnostic precision.³⁷ In addition to increased training of health care personnel, enhancements in diagnostic precision could be obtained by upgrades in phone cameras to capture images.³⁸ In one study, in addition to patient histories, teledermatologists accepted images with pixel ranging between 640 × 480 and 4,000 × 3,000 as sufficient image resolutions for diagnoses.³⁹ Analyzing clinical images has been a crucial component of diagnoses, and one study concluded that image quality was good enough to perform diagnoses using teledermatology, and it helped 75% patients in their treatment.⁴⁰

However, Tsang and Kovarik's study concluded that clinical images may not deliver adequate information to provide a definitive diagnosis and that microscopic examination of specimens was vital in providing accurate diagnoses, as well as in recommending appropriate treatment options.⁴¹ Moreover, a systematic review of 78 studies conducted that in a nonrural context, two-thirds of studies indicated enhanced diagnostic accuracy with clinic dermatology as opposed to teledermatology. Also, the authors concluded that teledermatology and teledermatoscopy were not as accurate as clinic dermatology in evaluating malignant lesions.⁴² A direct observational study in a nonrural setting inferred that the percentage of management and diagnostic concordance between in-person examination, live-interactive technology, and store-and-forward technology was high; however, the study posited that dermatologists relied more on in-person examinations than on the other two telemodalities of treatment.⁴³

The previous studies that were conducted within a rural context have been further detailed in *Table 1*, including a research that reported 28% and 36% concordance rates of treatment recommendations, while other studies described varying concordance rates between 58% and 97%. These studies concluded that teledermatology was viable in augmenting rural access (*Table 1*).

WAITING PERIOD, DURATION OF CONSULTATIONS, AND TRAVEL REDUCTION

A systematic review performed within a rural context reported that the waiting period for an initial teledermatological consultation extended anywhere between 4.6 to 71 h and 58 min—this has been in sharp contrast to the average 90-day waiting period in the United States for a face-to-face appointment.²⁷ A report that gathered information about the Veterans Integrated Services Network also revealed reduced waiting time with the technology.⁴⁴ In rural provinces of Nova Scotia, Canada, in 2009, it was reported that teledermatological videoconferencing appointments decreased the scheduled waiting time duration from 13.7 weeks for face-to-face appointments to 4.6 weeks.⁴⁵ However, regarding consultation durations, a Viber-based mobile teledermatological setup in rural Nepal reported that direct consultations took 5 min, whereas teleconsultations took 12 min.⁴⁶ A randomized cluster trial evaluated this technique using a mobile phone platform in rural Mongolian clinics and it has obtained promising results: a reduction of 19,892 km in travel distance and 269 h in travel time was noted, along with a \$76.36 per-patient decrease in expenses and a 75% reduction in referrals to tertiary centers.⁴⁷

Comparable results were obtained in studies that were conducted within a nonrural context. It has reported waiting periods of 2 to 50 days with the teledermatology system, compared to 88 to 137 days with the conventional letter referral.⁴⁸ Another analytical study showed that teledermatology reduced the waiting times from 26.5 to 9 days compared to face-to-face diagnosis.⁴⁹ Wootton et al.'s systematic review also reported a dearth of studies concerning travel reduction. That study's analysis of 20 literature articles revealed that in 12 studies, an average value of 43% in travel reduction was possible with the utilization of teledermatology, and in the remaining eight studies, 70% of patients were not required to travel for care.⁵⁰

BIOPSY, IDENTIFICATION OF SKIN MALIGNANCY, REFERRALS, AND FOLLOW-UP OF TELEDERMATOLOGY PROJECT

Only one 2015 study about biopsies performed with teledermatological models was obtained. Within the Veterans

Table 1. Selected Studies About Diagnostic Acuity and Quality of Clinical Images in Rural (Including Remote, Indigent, and Developing Country) Settings

AUTHORS	SETTING OF STUDY	OUTCOME	CONCLUSION
Chen et al. ³⁰	A descriptive retrospective cohort study of the electronic medical records of 429 pediatric patients was performed to assess treatment regimen patterns; these patients were referred from rural primary facilities in California (utilizing store-and-forward technology) to a teledermatology practice based in the San Francisco Bay area.	28% of treatment recommendations were concordant, 36% were partially concordant, and 36% were not concordant; 1.4% and 6.0% of patients had to undergo additional teleconsultations and in-person consultations, respectively.	The study concluded that telemedicine improved diagnostic and treatment care for pediatric patients who had inadequate access to dermatologists.
Garcia-Romero et al. ⁴⁰	A pilot teledermatological study involved a public social networking website, in which the general practitioner at a rural clinic would transmit clinical images of dermatological conditions—through Facebook—to dermatologists at a reference hospital. One of the parameters evaluated was image quality in the website to formulate diagnoses.	75% of patients benefitted from diagnoses and appropriate treatment.	Teleservice through a website has been used for delivering care to individuals who lack access.
Muir et al. ³⁹	In this pilot study in Queensland, Australia, the feasibility of utilizing a store-and-forward Skin Emergency Telemedicine Service to quickly deliver specialist dermatological care for emergency department patients was evaluated for 60 participants.	The utilization of the technology revealed a 96% clinical management concordance rate between telediagnosis and the emergency department diagnosis (with 4% relative agreement).	The technology could deliver specialist care to rural areas.
Rubegni et al. ³²	The therapeutic agreement, diagnostic agreement, and degree of diagnostic confidence of the store-and-forward teledermatological system were compared with face-to-face consultations by examining 130 geriatric patients in this direct observational study in Siena, Italy.	The therapeutic agreement between both methods was 69.6% (Cohen's $K=0.640$), and the diagnostic agreement (yielding the same ICD-9 code) was 87.7% (Cohen's $K=0.863$); however, dermatologists displayed uncertainty on diagnoses provided by telemedicine.	The system could augment diagnostic and therapeutic care for geriatric patients who have suffered from a lack of access.
Tran et al. ³⁸	In this feasibility study in Cairo, Egypt, diagnostic concordance rates for 30 patients were evaluated by face-to-face consultations and by a 5-megapixel camera attached to a software-based mobile telephone.	An overall 75% mean diagnostic agreement rate between face-to-face consultations and teleconsultations was obtained.	Mobile teledermatology could be a reliable means of delivering care to impoverished areas.
Tsang and Kovarik ⁴¹	A retrospective case review about the African Teledermatology Project involved the submission of biopsy specimens to centers in the United States for definitive clinical diagnoses.	A 58% clinic-pathological concordance rate between the diagnosis of the submitting physician in remote areas of Africa and the definitive biopsy results in the United States was obtained.	Dermatopathology could aid in diagnosing and treating dermatological conditions in developing countries.
Thind et al. ³¹	In this feasibility study in Aberdeen, United Kingdom, a teledermatology system was implemented to boost supervision of rural general practitioner training in dermatology, and to examine concordance rates between consultant diagnoses and general practitioner with particular interest (GPwSI) diagnoses (with the aid of teledermatology) for 230 selected referrals.	Store-and-forward teledermatology demonstrated a 61% diagnostic concordance rate.	The study reported that teledermatology could complement inadequate dermatological care in remote areas.
Gatica et al. ³³	In this direct observational study, a teledermatology electronic platform of the Ministry of Health was evaluated for 125 patients to gauge the ability in eliciting dermatological diagnoses for primary care patients in rural health centers in Chile.	There was an 82.4% agreement percentage between diagnoses elicited by the onsite dermatologist and the teledermatologists. The treatment concordance and specialist referral concordance were 75.2% and 73.6%, respectively.	Teledermatology could enhance access to care in isolated areas.
Byrom et al. ³⁷	A retrospective case analysis evaluated Tele-Derm, a teledermatological initiative that has delivered dermatological advice to dermatologists who have provided clinical care to rural populations of Australia.	Among the 83% of cases that clinical images were provided for, 73% were determined to be of good quality.	The technology has delivered precise diagnoses and treatment resulting in patient outcomes comparable to face-to-face sessions.

continued →

Table 1. *continued*

AUTHORS	SETTING OF STUDY	OUTCOME	CONCLUSION
Carpio et al. ³⁴	A randomized controlled trial was conducted in a rural health center in Batangas, Philippines. The study compared clinical efficacies of mobile phone teledermatology (mdermatology) utilized by a general practitioner (GP) with that of face-to-face visits with a dermatologist.	The level of diagnostic concordance differed between general practitioners and dermatologists; however, concordance in management was comparable.	The utilization of the mdermatology application has potential in a rural primary health care facility, free clinic setup.
Cutler et al. ²⁹	A feasibility study was conducted in rural Haiti.	A concordance rate of 75.09% in diagnostic acuity was achieved between primary care practitioners and teledermatologists.	Teledermatology has been a means of delivering care to rural residents.
Saleh et al. ³⁵	An analytical study was conducted in a remote area of Egypt to assess the telesystem by determining diagnostic concordance rates between face-to-face dermatologists and teledermatologists.	The rates between one face-to-face dermatologist and two teledermatologists were 86.7% and 87%, respectively.	The study could facilitate teleutilization in remote areas.
Finnane et al. ⁴⁹	An analytical study was conducted on the accuracy of skin cancer diagnosis compared between face-to-face diagnosis and teledermatology.	The diagnostic accuracy rate for face-to-face is 67–85%, which is higher than teledermatology with a rate of 51–85%.	The time saving was a significant benefit when utilizing teledermatology, especially in rural areas.

Affairs Corporate Data Warehouse, Vedire et al.'s retrospective chart review compared teledermatology-directed surgical complication rates delivered by primary care providers at rural clinics with rates performed by specialists by conventional surgery.⁵¹ The study reported a 2.0% biopsy and a 7.7% wide-local excision complication at rural clinics, and a 2.5% biopsy complication rate and a 13.5% wide-local excision complication rate in severely dysplastic nevi by specialist conventional surgery.⁵¹

Only one 2014 study about the identification of skin malignancies with teledermatological models in rural areas of the United States was obtained. Karavan et al.'s retrospective chart review involved the Veterans Integrated Service Network 20 (in the Pacific Northwest region of the United States) that delivered teleservices to 27 rural community-based outreach clinics.⁵² The researcher found that 180 (40%) melanoma cases (identified by face-to-face consultations) resided in regions where the teleservice was offered, suggesting that the higher incidence of melanoma in the face-to-face group was primarily due to inadequate use of the technology. Moreover, the study posited that in regions where the teleservice was employed, it identified a more significant number of advanced melanoma cases that had a severe, initial prognosis.⁵¹

Literature about referrals and general follow-up in rural settings have been limited. A 2008 chart review study, performed in three remote primary care clinics in the United States, revealed that when compared to conventional referrals, teledermatology referrals reduced the average duration for the initial consultation, biopsy, and surgery by 44, 19, and

21 days, respectively.⁵³ In addition, Kahn et al. compared the time duration to biopsy utilizing teledermatology referrals with the time duration to biopsy using conventional dermatology referrals to dermatological clinics. It was revealed that the average time to biopsy of skin cancer was 9.7 days with teledermatology referrals and 13.8 days with traditional referrals, suggesting that with enhanced triaging measures, the utilization of teledermatology in remote areas shortened the time to biopsy.⁵⁴

After implementing a follow-up protocol and tracking system that evaluated an established teledermatology project in rural areas of the U.S. Pacific Northwest, 93 conditions (out of 1,454 conditions requiring clinic pathological correlation consultations) were met with revisions in final diagnoses. The importance of the protocol was illustrated by the fact that the follow-up of the teledermatology project was vital in assuring enhancement of patient health outcomes.⁵⁵

PATIENT/PHYSICIAN SATISFACTION OF TELEDERMATOLOGICAL MODELS

Studies describing physician and patient satisfaction along with physician education in rural areas were also obtained. A systematic review implemented within a rural context reported that, according to most of the existing literature, in using teledermatology, physician satisfaction has been stronger than patient satisfaction.²⁶ Unexpectedly, there has been a deficiency of studies regarding physician satisfaction, with even fewer investigations regarding imaging technician satisfaction.⁵⁶

Table 2. Studies About Patient and Physician Satisfaction in Rural/Remote Settings

AUTHORS	SETTING OF STUDY	OUTCOME	CONCLUSION
Vallejos et al. ⁵⁷	An exploratory study was conducted in eastern North Carolina rural clinics, in which dermatologists provided 79 consultations to farmworkers utilizing store-and-forward teledermatology.	12% of consultations were rated as "somewhat helpful," and the rest were rated as "helpful" or "very helpful."	The study indicated that teleconsultations could be a valuable tool for farmworkers.
Hsueh et al. ⁶²	A Veterans Integrated Service Network 20 Rural Teledermatology Quality Improvement Project was conducted in the Pacific Northwest (Idaho, Alaska, Washington, and Oregon) to assess patient satisfaction with both the teleservice and with face-to-face consultations in rural clinics.	66% of patients favored teledermatology over face-to-face appointments, and 83% of patients would have recommended the teleservice to other veterans.	Most rural patients had favorable views toward the technology.
McFarland et al. ⁵⁶	A store-and-forward teledermatology project was conducted in underserved, rural regions of the Pacific Northwest (Idaho, Alaska, Washington, and Oregon) to deliver care to veterans; moreover, continuing education sessions for rural primary care providers were established and assessed by 20 multiple-choice questions on the "Basic-20" quiz.	Providers amplified their knowledge of skin conditions on the quiz from 63% correct at baseline to 74% accurate at the end of 1 year; moreover, 83% of providers and 92% of imaging technicians indicated that these sessions were useful.	The educational aspect of the teleproject provided enhanced skills to providers and imaging technicians, thereby augmenting access to underserved areas.
Assis et al. ⁶⁰	A retrospective study was conducted in Minas Gerais, Brazil, to evaluate teleconsultations performed with the Telehealth Network of Minas Gerais (TNMG), which has been a service that has assisted primary care physicians.	97% of primary care practitioners were satisfied with the TNMG.	The TNMG has been a practical tool to provide dermatological care to remote and isolated areas.
Biscak et al. ⁵⁹	A pilot study employing a clinical questionnaire was conducted in remote areas of Queensland, Australia.	100% of clinicians found the state-wide store-and-forward teledermatology service to be beneficial, and 97% of clinicians reported that they would utilize it again, with one clinician stating "possibly" on the questionnaire.	Teledermatology could have a significant role in delivering health care to remote areas in Australia.
McFarland et al. ⁵⁸	A Veterans Integrated Service Network 20 Rural Teledermatology Quality Improvement Project was executed in rural veteran's administration clinics in the Pacific Northwest (Idaho, Alaska, Washington, and Oregon) to determine provider and imaging technician satisfaction rates.	71% of primary care providers and 94% of imaging technicians were satisfied or very satisfied with the project; moreover, 95% of providers also believed that tele-education programs on diagnosis and treatment were beneficial.	The Veterans Health Administration's program could spur similar teledermatology programs in rural areas.
Al Quran et al. ⁶⁰	A direct observational study that involved two rural hospitals in Jordan utilized patient questionnaires to determine patient satisfaction rates, among other types of information.	The average patient satisfaction score was 90.5 (SD 8.5), which suggested a high degree of satisfaction with the technology.	The availability of a teleservice in the remote regions of Jordan could be highly advantageous.

In another analysis, results have indicated that 86% of providers rated the consultations as helpful or very helpful with the technology and had perceived teleconsultations as an educational tool.⁵⁷ After participating in educational sessions, providers could conduct dermatological procedures and formulate diagnoses.⁵⁸ One study reported an overwhelmingly positive response from clinicians.⁵⁹ High physician satisfaction rates of 97% have reinforced the utility of teledermatology in providing care to isolated cities and remote areas that have encountered acute dermatologist shortages.⁶⁰

In addition, a direct observational study revealed favorable patient views in the ability of teledermatology to limit expenses, decrease travel time, and facilitate shorter waiting

periods.⁶¹ According to Hsueh et al., perceptions of adequate care and follow-up and obtaining educational information were associated with a higher patient satisfaction rate of 78%.⁶² All the above six studies conducted in rural settings have illustrated high patient and/or physician satisfaction, and have been further detailed in *Table 2*.

Discussion

The purpose of this research project was to examine the effect of utilization of teledermatology to determine enhancement of dermatological access to residents of rural areas. Results of the literature review have suggested that teledermatology could increase dermatological access to underserved, rural areas.

Teledermatology programs have been able to complement conventional dermatological care to enhance dermatological access to rural areas that have suffered from a shortage of dermatologists,⁶³ and could aid in supplementing traditional care as well.⁶⁴ Also, this technology could assist if incorporated into a regional dermatological service.⁶⁵ The technology could permit rural patients to capture images as a complimentary evaluation tool to augment clinical care,⁶⁶ while urban-based dermatologists could refine or enhance rural general practitioner diagnoses.⁶⁷ Other studies have revealed that the technology could substitute for conventional care; moreover, pilot studies have indicated that diagnostic sensitivity and specificity could be within satisfactory ranges of traditional care.⁶⁸ This review posits that it could be highly improbable for teledermatology to mitigate the necessity for conventional care, while still ensuring equivalent patient safety and quality of care levels.

It has generally been accepted that the diagnostic accuracy of teledermatology has been lower compared with face-to-face consultations.^{69,70} Concerning diagnostic acuity in rural settings, this review has reported varying fluctuations in diagnostic concordance rates. This review stated that all images utilized in formulating diagnoses for rural patients could be relayed to an urban center for confirmation; even though this would inevitably prolong the consultation process and involve additional fees for the rural patient, the likelihood of a precise diagnosis could be enhanced.

Greater diagnostic precision has depended on the enhanced quality of clinical images observed.^{71,72} Within rural settings, results of three studies in this review indicated the importance of improved quality for diagnostic precision, whereas one study reported that clinical images might not provide sufficient insight to deliver clear-cut diagnoses. The central tenet of teledermatology has revolved around image clarity, and higher degrees of accuracy would undoubtedly assist in identifying the correct diagnosis. However, this review suggested that sole reliance on even high-quality images as a confirmatory diagnostic tool could be risky, especially since the remote evaluation of a picture for a rural patient could easily be misinterpreted. Depending on the gravity of the lesion, microscopy and biopsy could be employed to support diagnoses formulated by merely image observation.

Within a rural setting, this review revealed two studies that reported a reduction in the initial waiting period, one study that described an increased duration of rural teleconsultations, and one investigation that stated mitigation in travel distance and time. Telemedicine (within the context of teledermatology) has the potential to both significantly limit the need for rural patients to travel and deliver equitable treatment.⁷³ Limited traveling and waiting periods have appeared to be practical

features that could amplify appeal for the technology among patients. More importantly, it could be deduced that restricting travel for rural patients could maintain rural economic productivity since rural workers would not have to miss a day's work—mainly to have a minor dermatological lesion examined.

Within rural settings, one study reported limited biopsy complication rates and another one indicated a reliable identification of dermatological malignancies, two investigations revealed the ability of telereferrals to limit the time duration to biopsy, and one study demonstrated the importance of a follow-up protocol in refining diagnoses. This review could not find additional, similar studies conducted in this field. It was suggested that if there was a decreased time to biopsy with the telesystem (as noted in one study), this benefit could be attributed to the triaging technique embedded within that system. It could also be inferred that the follow-up of a telemodel has been vital in maintaining and ensuring the quality of care and patient safety. The drawbacks of a follow-up protocol could entail the extensive time necessary to do the follow-up, along with extra personnel to conduct the protocol.

Concerning patient and physician satisfaction in a rural setting, results of this review have such a clear and practical view of patients and physicians toward teledermatology. This positive perception could foster the expansion of existing teleservices and educational programs to improve access. Moreover, it could be assumed that patient satisfaction has been indicative of an enhanced health-related quality of life, thereby empowering informed patients to play an active role in consultation visits. By extension, the technology could facilitate patient socialization functioning, which could further augment positive patient health state. Patient satisfaction could be related to receiving timely information, personalized, holistic care, and decreased waiting periods. From the results of this review, it could be inferred that physicians have also viewed teleservices as an educational tool, in addition to merely a practical clinical tool.

In this review, two studies conducted in rural settings demonstrated cost-effectiveness. This cost-saving feature could be an economic incentive for patients and the health care system. It could be suggested that as the price of the tele-equipment decreases with advances in technology, teledermatology could prove to be economically feasible. This review posits that the incentive to employ the technology could be enhanced if equivalent efficacy was obtained with the teleservice (at lower costs) as with conventional care.

There have been several advantages of teledermatology. It has permitted for the second opinion by worldwide dermatological experts on challenging cases.⁷⁴ Virtual follow-up of chronic dermatological cases has been useful, and the transmission of images and clinical data through a mobile network

could be conducted in areas of fluctuating internet availability; moreover, technological services have provided online atlases, databases, and continuing medical education through the internet, thereby providing a user-friendly platform.⁷⁵ Given the nationwide dermatologist shortage, the technology could be beneficial in improving access to individuals who could increasingly obtain health insurance under the Affordable Care Act mandate.⁷⁶ Teledermatology has been helpful in triaging patients with dermatological lesions,⁷⁷ especially in rural settings,⁷⁸ and in triaging inpatient dermatological consultations as well.⁷⁹ Moreover, mobile teledermatology has also been equally useful as a triaging tool.⁸⁰ An overall benefit has been that teledermatology could enable clinical collaborations between dermatologists and primary care providers, thereby also allowing professionals from several clinical specialties to consult one another.⁸¹

There have also been several ensuing drawbacks of teledermatology, which included the following: clinical inadequacies (e.g., erroneous diagnoses, learning curve, and absence of face-to-face examinations); ethical quandaries (e.g., technological-oriented care as opposed to patient-oriented care and reduced personal doctor-patient relationships); reimbursement schemes; legal issues (e.g., legal framework that has lagged behind scientific advancements and physician responsibility for accurate diagnoses when employing such technology); and integration hurdles with electronic medical records have all continued to hamper the full potential of teledermatology.⁸² Photographic images could miss dermatopathological lesions, and these images alone have not been able to comprehensively address patient reservations and concerns.⁸³ Issues with mobile teledermatology have included lack of image details (because of JPEG compression to enhance transmission) and the closeness of the flash device to the camera lens on the mobile device, which has not allowed for clarification of surface details.⁸⁴ Some teleprograms have curbed expenses for patients, but not for the health care system, whereas other programs have enhanced quality, but not cost-efficiency.⁸⁵ Physicians have utilized personal smartphones to exchange clinical data and images; since these devices have been subject to security breaches, the fear of violating patient confidentiality and the ensuing legal ramifications for physicians have been a concern.⁸⁶

Limitations of this analysis could be ascribed to several restrictions employed in the literature search strategy. Also, it was not conducted funnel and/or forest plot to assess bias as it was out of the scope of this review. Finally, publication and researcher bias could not be ruled out.

There are some practical implications of teledermatology. Opponents have argued that a gradual deterioration in empa-

thetic physician-patient relationships is a grave issue, since the technology can “dehumanize” this relationship; however, the technology can educate patients to ask focused questions about their problems, thereby maintaining and even solidifying the relationship. The successful utilization of the teleservice ultimately depends on the attitude of the physician; moreover, physician workload, and the payment system (capitated system vs. fee-for-service) play significant roles in adopting the service.

Moreover, investments in this form of technology in undeveloped and developing nations must be encouraged, so that practitioners can be persuaded to conduct research to seek for alternative technological modalities in the aim to reduce expenses for patients. Endeavors to amplify dermatological services to rural areas in developing nations will significantly depend upon collaborations between rural dermatological clinics and urban-based academic centers, along with an allocation of resources that depends upon population density. It is also imperative for policymakers to acknowledge the capability of the technology in enhancing access, and to formulate regulations through which the service can prudently assist routine dermatological care. Further research is needed, in particular, a formal meta-analysis study to have a more precise measurement of the effects of the teledermatological intervention in rural areas as well as appropriate metrics of variability.

Conclusion

Teledermatology has had a beneficial impact in improving dermatological access to rural areas. The success of this technology is contingent upon the commitment and willingness of the dermatologist in utilizing it.

Disclosure Statement

No competing financial interests exist.

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Address correspondence to:

Alberto Coustasse, DrPH, MD, MBA, MPH
Healthcare Administration Program
Lewis College of Business
Marshall University
South Charleston, WV 25303

E-mail: coustassehen@marshall.edu

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