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Article

Effectiveness of Telemedicine Health for Patients with Diabetic Foot Ulcers Care : A Systematic Review

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A B S T R A C T

Introduction: *Diabetic foot ulcers one of the complications that often occur in patients with Diabetes Mellitus. Telemedicine is an established means of using evolving telecommunication technology to obtain and disseminate medical data and services. This systematic review aims to ensure the effectiveness of telemedicine for the management of diabetic foot ulcer care.* ***Method:*** *We used "telemedicine" to restrict our search to "healing" and "diabetic foot" and used "diabetic foot ulcers", keywords, and abstract connected by the Boolean operator "AND". Search articles using the PICOT framework in the international database; EBSCO, Science Direct, Scopus, ProQuest, limited to the last five years, 2017 to 2021, obtained 15 articles the inclusion criteria studies focused on telemedicine in a patient with diabetic foot ulcer care. The articles were included Randomized Control Trial, quasi-experiment. Other design studies were included in exclusion criteria. was performed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA) rules.* ***Results:*** *The outcome shows that telemedicine accessible a few innovations accessible that adequacy esteem in the observing, anticipation, and treat diabetic foot ulcers. Ends: Telemedicine skin thermography, photograph imaging, and mobile phone online innovation show comparative gives great outcomes in recuperating viability for patients with diabetic foot ulcers care*.

I. INTRODUCTION

Diabetic foot ulcers are a general and devastating complication of diabetes. The mostly devastating and costly outcome is lower leg amputation, which is nearly still preceded by an infected foot ulcer. The global of Diabetic Foot Ulcers (DFU) prevalence is 6.3%. In 2019, the International Diabetes Federation (IDF) estimated that diabetic foot ulcers expand

in 9.1-26.1 million people worldwide every year (Killeen *et al.*, 2020). Diabetic foot ulcers significantly negatively impact morbidity, mortality and increase the risk of lower extremity amputation. A foot ulcer is a frequently reported complication in patients with diabetes, with long-standing nerve damage and poor circulation being major causative factors (Gatt *et al.*, 2018). At the point when a foot ulcer is available, checking of the ulcer is essential to evaluate treatment adequacy, anticipate recuperating, and react quickly if a confusion, for example, a foot disease creates (Fraiwan *et al.*, 2017). Telemedicine technology may have esteem in self-observing of foot wellbeing status by diabetic patients, chiefly for analytic, restorative, and instructive aim to improve productivity and viability of care (Armstrong *et al.*, 2017). Some telemedicine has been produced for this reason and incorporates skin thermography, photograph imaging, mobile phone online innovation (Najafi *et al.*, 2017; Renero-C, 2018). While the benefits of telemedicine are evident in the care of diabetes in general, it is not known whether patients with the diabetic foot can get the same benefits (Jeffcoate *et al.*, 2018). The aim of this articles was to conduct a systematic review of the effectiveness of telemedicine for patients with diabetic foot ulcers care. The results of the systematic review are supposed to be applied to the medical service. This systematic review is included in an article that consists in abstract, introduction, method, result, discussion, conclusion, and references.

II. METHODS

1. Strategy for searching for studies

The systematic review search strategy resulted to focused on the limited to the last five years. The systematic review method was based on the preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA) approach. Search articles using the PICOT framework in the database EBSCO, Science Direct, Scopus, ProQuest. The keywords in English used are “telemedicine” restricted our search to “healing” and “diabetic foot” and used “diabetic foot ulcers”, keywords and abstract connected by the Boolean operator “AND”.

After some articles were obtained, the researcher then selected them again according to the specified inclusion and exclusion criteria. The search for articles used keywords determined by the researchers and provided limits as per the inclusion and exclusion criteria. The data obtained from EBSCO, Science Direct, Scopus, and ProQuest were then selected one by one by the researchers to determine their suitability. After obtaining articles that were in accordance with the researchers’ intentions, the articles were analyzed one by one and grouped to get the results. The next step was to discuss what had been found based on the points obtained from the results.

2. Inclusion and Exclusion

The inclusion criteria desired articles were articles published between 2017 to 2021 and articles written in English focusing on the keywords in the search for relevant articles. This study focused on telemedicine in patients with diabetic foot ulcer care. Applications telemedicine has been included skin thermography, photograph imaging, and mobile phone online innovation. Research design articles were RCT (randomize control trial), articles based on a systematic review, narrative review, thesis, books, or chapters, were not used in this study (Figure 1).

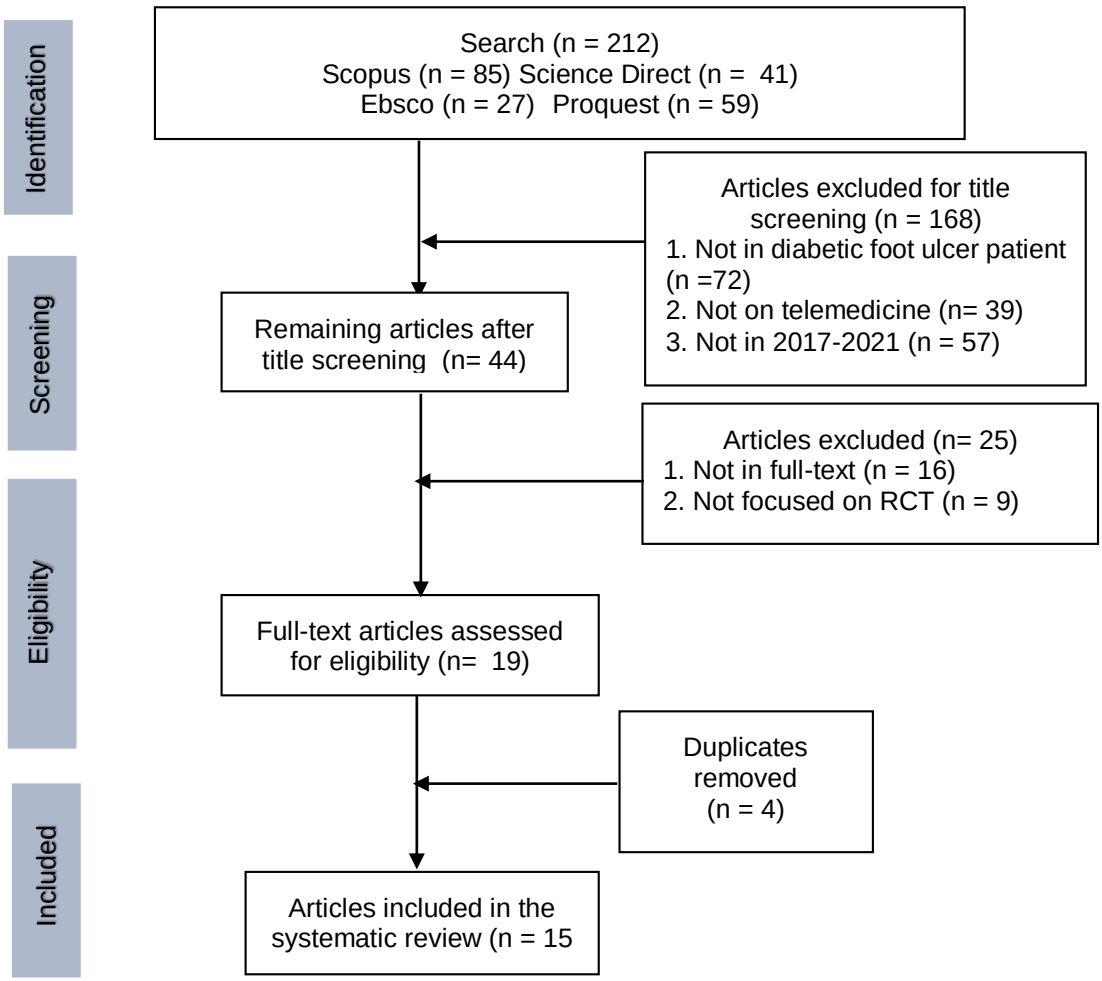

Figure 1 Study selection

III. RESULT

1. Study Selection

A total of 212 articles were retrieved from the initial search. This article reviewed 15 selected articles from various countries. After the title screening process, 168 were excluded because they had unrelated titles. Of the 72 articles not on diabetic foot ulcer patients, 39 not focused on telemedicine, and 57 articles not in 2017-2021. Of the 25 excluded studies, 16 articles not a full text, nine articles not RCT, and four articles duplicates removed. At the end of the process, 15 studies were included in this systematic review (Fig. 1).

2. Characteristic of the study

Population characteristics in all studies only included telemedicine, just on skin thermography, photograph imaging, and mobile phone or online technology. The identified methods application telemedicine include for skin thermography (n = 7), photograph imaging (n = 5) and mobile phone online innovation (n = 3). The studies were conducted on 1863 diabetic foot ulcer patients with a mean age of 41 – 86. Most participants were male (n=74%).

3. Skin Thermography

There were seven examinations recognized on the utilization of skin

thermography to forestall foot ulcer repeat. Patients randomized to the intercession bunch estimated their skin foot temperatures at home every day at six areas for each foot. On the off chance that a temperature distinction >4 F (2.2 C) between relating areas on the left and right leg happened for two continuous days, members were told to contact the examination nurture and lessen their wandering movement until temperatures standardized. The consequences of the examinations showed a positive effect for skin thermography on checking, anticipation, and treatment of patients with diabetic foot ulcers.

In Armstrong *et al.,* (2017), evaluating 225 patients, 18-month ulcer repeat rates were 4.7% and 12.2% for the mediation and control bunch, individually (P = 0.038). Netten *et al.*, (2017) exhibited that diabetic foot complexities could be recognized utilizing infrared temperature profiles, with feet without entanglements showing left-to-right temperature contrasts <1.5 C, those with neighborhood confusions (e.g., neuropathic ulcer) >2 C, and those with diffuse intricacies (e.g., tainted ulcer) >3 C. The most ideal remove temperature distinction (2.2 C) to recognize diabetes-related intricacies to be 76% touchy and 40% explicit.

Gatt *et al.*, (2018) tracked down that the mean temperatures of the legs and forefoot were altogether higher in patients with foot complexities (neuropathy, neuro-ischemia, fringe blood vessel illness, and neuroischemic toe ulceration) contrasted with patients with no foot confusions and solid people. Wijlens *et al.*, (2017) tracked down that in 20 patients who estimated their plantar foot temperature at six areas four times each day more than six days-follow-up discovered single-day temperature contrasts >2.2 C in 8.5% of all cases. This diminished to 0.3% with affirmation of a temperature distinction >2.2 C the ensuing day, and with independently adjusted temperature edges, this decreased further to 0.2%. Gatt *et al.*, (2018) announced in 33 patients a 6-month ulceration rate after 2% in the mediation bunch versus 20% in the benchmark group (P = 0.01).

Frykberg *et al.*, (2017) utilized a remote thermograpy foot mat with temperature sensors dependent on a thermistor to survey plantar temperature profiles and imbalances in 132 patients. In 34 weeks, an aggregate of 53 nontraumatic diabetic foot ulcers created in 37 (28.7%) patients, and utilizing a temperature lopsidedness limit of 2.22 C, the framework accurately recognized 97% of these ulcers with a normal lead season of 37 days. A bogus positive pace of 57% was accounted for (affectability 97 %, explicitness 43%). Renero-C, (2018) shows that an essentially higher temperature was estimated in the foot with a ulcer than in the contralateral foot.

4. Photograph Imaging

Evaluation of diabetic foot ulcers utilizing a cell phone contrasted with live appraisal (as reference) gave solid help for the choice for per-wound debridement, however low interobserver unwavering quality [kappa (k) = 0.09-0.49] and moderate intraobserver dependability (k = 0.47-0.64) for surveying the presence of ischemia, contamination, granulation, swamp, following or burrowing, sodden or an oozing injury, cellulitis, or erythema (Smith-Strøm *et al.*, 2016; Yap *et al.*, 2018). Wang *et al.*, (2016) tracked down a critical contrast between PC based injury region assurance and to manual comment. Utilizing support vector machines, they could decide the injury limits considerably more precisely.

Ming *et al.*, (2019) that the conclusion of foot disease is legitimate and dependable utilizing photographic imaging in mix with infrared thermography, accepting clinical determination as reference (affectability >60%, explicitness >79%), and better than with utilizing every methodology all alone. Iversen *et al.*, (2020) evaluated the attainability of at-home utilization of the DiaFo framework for ulcer observing and included: complete number of surveyed ulcer pictures, the length of the checking time frame, and change in ulcer region following four and 12 weeks follow-up.

5. Mobile Phone Online Innovation

Surveyed the attainability of utilizing a cell phone to interface the doctor and home visiting attendant to help ulcer treatment. Analyzed the adequacy on ulcer mending of either two phone or online meetings notwithstanding one outpatient center visit or three outpatient facility visits and tracked down no critical contrast in the danger proportion for recuperating or removal between these two intercessions (Kavitha *et al.*, 2020). Patients were happy with the treatment support since it was timesaving, medical attendants were fit for taking care of the specialized abilities, and doctors discovered the gear simple to utilize and doable for distance therapy (Iversen *et al.*, 2020). Besides, patients were fulfilled and had a sense of security with this distant treatment support, the meeting medical attendant felt upheld, and doctors felt a decent reason for utilizing the apparatus. Announced that the normal ulcer treatment cost per patient for the telemonitoring costs was discovered to be €2039 less per patient contrasted with standard checking, which was not a measurably critical distinction (Fasterholdt *et al.*, 2018). Infrared that telemedicine's elaborate medical caretakers are enabled by telemedicine and that a vital factor for carrying out telemedicine was preparing these attendants. In any case, concerns were raised in regards to the absence of multidisciplinary wound consideration groups, patient obligation, and patient collaboration with the doctor (Wijesinghe *et al.*, 2019).

IV. DISCUSSION

This systematic review was conducted to determine the effect of telemedicine for patients with diabetic foot ulcer care. A review of the literature found 15 relevant studies conducted on 1863 diabetic foot ulcer patients.

1. Skin Thermography

Seven examinations assessed showed that home observing of foot temperatures utilizing infrared thermography is exceptionally successful in decreasing diabetic foot ulcer repeat occurrence. Netten *et al.*, (2017) propose that the home checking of foot temperature is a compelling method to anticipate and forestall diabetic foot ulcer repeat. Impact sizes found were enormous, among the biggest of any intercession that intends to forestall foot ulcer repeat in diabetes. Mechanical headways in observing foot temperatures, like canny handheld infrared thermometers, temperature checking using extraordinary socks, other Smart Sox gadgets, or a thermometric foot mat may diminish this weight.

These gadgets have shown achievability in estimating plantar foot temperature, and on account of the foot-mat have demonstrated evaluations to be prescient of foot ulceration. Be that as it may, the adequacy and long haul ease of use of these gadgets in forestalling foot ulceration isn't known, restricting execution. Aan De Stegge *et al.*, (2018) show operational mistakes within the sight of bountiful callus or dry skin. Another issue is the weight on patients playing out these estimations every day,

at numerous, occasionally difficult to reach, areas by walking, and including the account and computation of temperatures and contrasts between the left and right foot.

2. Photograph Imaging

All examinations assessed showed that photograph imaging is a plausible and relevant apparatus for carefully estimating ulcer regions. Photograph imaging devises the DiaFo framework, show to be plausible for use in the home climate. The plausibility examination with the DiaFo framework was done in a little gathering of moderately youthful patients, and patient qualities were not announced (Iversen *et al.*, 2020). The possibility investigation on the photographic foot imaging gadget incorporated a bigger patient example, yet the 4-month follow-up was excessively short for an adequate number of foot entanglements to create and, consequently, heartily study plausibility. A limit of the two frameworks is that solitary the plantar foot surface can be evaluated (Wang *et al.*, 2017). Ming *et al.*, (2019) showed that the mix of photograph imaging and skin thermography improves precision over a solitary methodology alone in the analysis of diabetic foot disease. This is the first occasion when that home-checking approaches for the early determination of foot contamination have been introduced.

3. Mobile Phone Online Innovation

Cell phone and online correspondence as telemedicine support device has gotten very some new consideration in the logical writing. Three all around planned RCTs show that this type of telemedicine is attainable and as powerful as ordinary outpatient facility visits in ulcer the board. Cost-adequacy dependent on the RCT information demonstrated to be comparable between the telemedicine and common consideration bunch. In any case, the preliminary was not controlled to recognize contrasts in expenses, and cost-examination depended on just the initial a half year of follow-up. Future examinations ought to additionally investigate the expense viability of this methodology (Smith-Strøm *et al.*, 2018). Cost-adequacy is a basic viewpoint that will impact acknowledgment and execution in diabetic foot care. Some observing apparatuses like infrared skin thermometers, photograph imaging, and mobile phone online innovation are low in cost, while other costly modalities (Fasterholdt *et al.*, 2018).

V. CONCLUSION

The aftereffects of the surveyed examines showed that the beneficial effect of telemedicine instruments can possibly be financially savvy in the event that they lead to a huge decrease in hazard of foot ulceration, facilitated recuperating of ulcers, or less outpatient center visits. Telemedicine has demonstrated to be compelling or doable in evaluating, observing, prevent, or treating diabetic foot infection and requires affirmation in investigations to have more broad use in diabetic foot care, especially for patients living in distant regions. Effective execution of these telemedicine approaches can generously diminish the patient and medical services weight of diabetic foot infection.

APPENDICES

Author	Place	Design	Intervention	Time and sample size	Result
(Smith-Strøm *et al.*, 2018)	Norway	RCT	TelePhoto Imaging by Mobile Phone	4 years, 182 respondents	Telemedicine a relevant alternative and supplement to usual care
(Renero-C, 2018)	Mexico	RCT	Thermogram plantar skin	1 year, 186 respondents	Thermogram plantar skin has a positive effect on medical screening
(Fasterholdt *et al.*, 2018)	Denmark	RCT	Online telemonitoring	6 months, 374 respondents	Telemonitoring online service had same effects and costs standard monitoring
(Gatt *et al.*, 2018)	United Kingdom	RCT	Skin thermography	6 months, 57 respondents	Skin thermography there were no distinction in temperature of nonulcerated and ulcerated toes
(Armstrong *et al*., 2017)	USA	RCT	Smart Socks Skin thermography	1 week, 33 respondents	Smart socks effective to prevent diabetic foot at risk of foot ulcers
(Yap *et al.*, 2018)	United Kingdom	RCT	FootSnap Mobile Photo	6 months, 60 respondents	FootSnap significant to monitoring pathology
(Killeen *et al.*, 2020)	USA	RCT	Dermal Temperature	5 years, 4 respondents	Remote temperature monitoring significant to treatment
(Frykberg *et al.*, 2017)	New England	RCT	Smart Mat Foot Temperature	34 weeks, 129 respondents	Plantar temperature asymmetry was significant highly predictive of impending DFU
(Iversen *et al.*, 2020)	Norway	RCT	DiaFoto Imaging Telemedicine	4 years, 182 respondents	TM is effective more accurately improved ulcer healing
(Wijlens *et al.*, 2017)	Netherlands	RCT	Foot temperature	1 week, 20 respondents	Foot temperature monitoring significant to prevent foot ulceration.
(Kavitha *et al.*, 2020)	India	RCT	Online telemedicine	6 months, 3 respondents	Telemedicine is a good screening tool for diagnosing
(Wijesinghe *et al.*, 2019)	SriLanka	RCT	Photo Imaging	4 weeks, 9 respondents	Significant to cost-effective medical system diabetic-care assessment
(Aan De Stegge *et al.*, 2018)	Netherlands	RCT	DIATEMP	18 months, 304 respondents	Significant effect monitoring to reduce the incidence of foot ulcer recurrence

(Ming *et al.*, 2019)	Germany	RCT	Telemedicine	24 months, 300 respondents	Significant to preventive effects of diabetic foot ulceration
(Netten *et al.*, 2017)	Australia	RCT	Photo Images	2 months, 50 respondents	It should not be used as a diagnostic instrument for monitoring

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