SYSTEMATIC REVIEW

Effectiveness of remote patient monitoring for wound care: A systematic review

Fateema Tanveer[1], Khadeejah Sajwani[2], Mohammad Shah Hussain[3], Maliha Yunus[4], Um ul Baneen Zehra[5]

Abstract

Objective: To evaluate the role of remote patient monitoring with respect to wound care in terms of improving patient outcomes and facilitating the overall care process.

Method: The systematic review was conducted from July 2 to October 15, 2023, and comprised literature search on PubMed using key words, including "tele-monitoring", "remote patient monitoring", "telehealth", "telemedicine", "wound care", "home health monitoring", and "self-monitoring". To ensure thorough and robust findings, unpublished studies and solitary abstracts were excluded. To include current research and insights from the modern era, only human studies published from year 2008 to 2023 were included.

Results: Of the 51 studies identified, 48(94.11%) were reviewed. After excluding 32(66.66%) irrelevant studies, 16(33.33%) were included for analysis, with 15(93.75%) highlighting favourable results of remote patient monitoring and its efficacy in wound care.

Conclusion: Tele-monitoring systems have proven effective with respect to wound care, improving healthcare quality and reducing unnecessary hospital visits through online physician-patient communication. Future research should explore strategies for optimising remote patient monitoring to sustain advancements in wound care practices in Pakistan.

Keywords: Tele-monitoring, Remote patient monitoring, Telehealth, Telemedicine, Wound care, Self-monitoring.

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Introduction

In the continuously evolving field of healthcare, the integration of technology has introduced a new era of patient-centric approaches. Remote patient monitoring (RPM) has emerged as a ground-breaking strategy, presenting extraordinary opportunities to enhance the quality and efficiency of healthcare services.[1]

The American Telemedicine Association (ATA) defines telemedicine as the utilisation of electronically transferred medical data from one location to another with the goal of improving patient's health.[2] Studies indicate that telemedicine has the potential to lower expenses and economic burden without compromising the therapeutic efficacy of wound healing.[3]

With the growing global reliance on smartphones featuring high-resolution cameras and fast internet, patients with wounds and healthcare providers are increasingly engaged in remote wound management. Wound healing is a complex process that depends on coordinated cellular activities for effective tissue repair. Disruptions in these cellular functions, particularly in individuals with diabetes or those who are aging, can lead to delayed healing and chronic wounds.[4,5]

Following trauma — whether surgical or accidental — the physiological process of wound healing is crucial to preserving the integrity of the skin.[6]

In the final stage of wound healing, the remodelling phase requires a delicate balance between apoptosis of existing cells and new cell production. This phase involves the gradual degradation of excessive extracellular matrix and immature type III collagen, leading to the formation of mature type I collagen.[6] Understanding these physiological processes is essential for effective tele-monitoring of wound healing. As wounds progress through these stages, changes in physical appearance — such as colour, size and texture — can be captured through tele-monitoring technologies. This allows healthcare providers to assess the healing remotely, identify potential complications early, and make timely interventions. By integrating the physiological aspects of wound healing with tele-monitoring, patient outcomes can be enhanced and resource utilisation can be optimised.[7]

It is crucial to acknowledge the substantial advantages that tele-monitoring of wound can provide. Wound care prevents chronic and debilitating conditions that require long-term specialised management.[8]

The use of telemedicine in situations where wound

[1,2]Department of Anatomy, NUST School of Health Sciences, Islamabad, Pakistan; [3,5]Combined Military Hospital, Lahore, Pakistan; [4]Department of General Surgery, NUST School of Health Sciences, Islamabad, Pakistan.

Correspondence: Fateema Tanveer. **Email:** fateema.work98@gmail.com

ORCID ID: 0009-0008-6800-2295

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specialists and home health nurses collaborated via a two-way video visit resulted in improved healing rates, shortened wound healing duration, reduced home health visits, and resulted in a decline in hospitalisations linked to its complications.[9]

Delayed wound healing can result in complications, such as Marjolin's ulcer, an infrequent and serious type of skin cancer that typically emerges in chronic ulcers, scar tissue, or areas affected by inflammation. According to estimates, it accounts for 1-2% of all burn scars. Squamous cell carcinoma (SCC) is the most common kind, and it is sometimes discovered during inspection of lesions forming in scars and chronic wounds that are difficult to cure, like leg ulcers and pressure sores[10]. Hence, effective wound care is essential not only for promoting optimal wound healing, but also for preventing such complications, enhancing patient comfort, and ultimately contributing to an improved quality of life.

The current systematic review was planned to evaluate the role of RPM with respect to wound care in terms of improving patient outcomes and facilitating the overall care process.

Materials and Methods

The systematic review was conducted from July 2 to October 15, 2023, and comprised literature search on PubMed using key words, including "tele-monitoring", "remote patient monitoring", "telehealth", "telemedicine", "wound care", "home health monitoring", and "self-monitoring".

In order to guarantee the inclusion of thorough and robust findings, unpublished work and solitary abstracts were excluded. To ensure that current research and insights from the modern era are included, only human studies published from year 2008 to 2023 were included.

Results

Of the 490,337 search results, 168,457(%) were those identified against the key word “wound care” (Table 1).

Of the 51 studies identified, 48(94.11%) were reviewed (Figure). After excluding 32(66.66%) irrelevant studies, 16(33.33%) were included for analysis.[3,7,9,11-20] Only 1(6.25%) study[12] reported that mortality rate increased in individuals monitored by telemedicine, while 15(93.75%) highlighted favourable results of RPM and its efficacy in wound care[3,7,9,11,13-21]

Of the total, 6(%) studies concluded that incorporated telemedicine into the practice of monitoring patient wounds resulted in reducing hospitalisation duration and

Table-1: Search results with simple Keywords & Mesh words.

Key words	Database	Number of results
Remote patient monitoring	Pub med	9,962
Tele-monitoring	Pub Med	2565
Wound care	Pub Med	168,457
Telemedicine	Pub med	14090
Wound healing	Pub med	167,592
Remote patient monitoring and wound care	Pub Med	122
Tele-monitoring and wound care	Pub med	21
MeSH key words	Database	Number of results
Telehealth	Pub Med	58,563
Home health monitoring	Pub Med	14,090
Self-monitoring	Pub Med	51,875

MeSH: Medical subject headings.

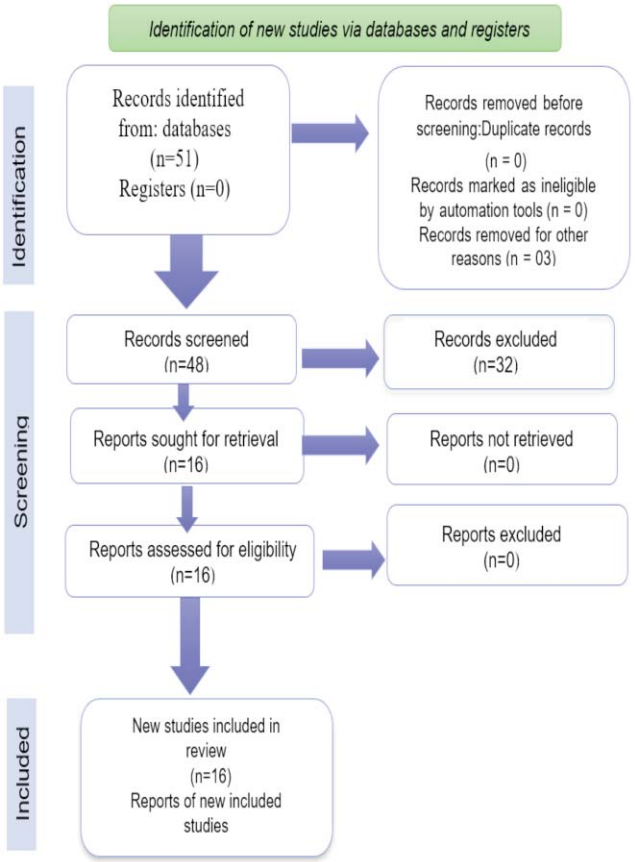

Figure: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart.
Source: Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

healing time, decreasing unnecessary hospital visits, and increasing patient satisfaction and self-awareness regarding the service and their wound Table-2.[3,7,9,11,12,20]

A prospective randomised study on vascular surgery

Table-2: The studies reviewed and their findings.

	Year	Country	Conclusion	Study design
Dured Dardari[3]	2023	France	Hospitalization duration and direct costs while using telemedicine were lower as compared to conventional follow-ups, with no decrease in the effectiveness of wound care.	Randomized controlled trial
Lihong Chen[7]	2020	China	Current evidence indicates that telemedicine appears to have comparable efficacy and safety to conventional standard care for chronic wounds	Systematic Review_ Metaanalysis
L Kobza[9]	2000	USA	Cost-effective telemedicine had a positive effect on healing rate, healing time, number of home health visits, and hospitalizations post-discharge, in regard to wound care.	Quasi-experimental design
Albeir Y Mousa[11]	2019	USA	TeleHealth Electronic Monitoring had a positive influence on patient satisfaction and also increased the number of patients in distant areas, wanting to gain access to health care services.	Randomized controlled trial
Benjamin S B Rasmussen[12]	2015	Denmark	Telemedicine, when compared to standard follow ups, did not show any improvement in the healing time or a reduction in the need for amputations in patients with diabetic foot ulcers. Higher mortality incidence was recorded with Telemedicine.	Randomized controlled trial
Jenny Zhang[13]	2019	USA	Online physician-patient messaging services have helped assess post-op wound condition and severity, reducing unnecessary clinic visits and prompt in-patient treatment of wound complications, if any.	Retrospective review
Rebecca L Gunter[14]	2018	USA	Patients and healthcare professionals showed a positive inclination toward the usage of mobile health programs/applications for the remote monitoring of post-op wounds	Interventional study
Barbara Binder[15]	2007	Austria	Teledermatological monitoring of wound care was widely accepted by patients and home care nurses. Has the potential to reduce health care costs and improve wound care management thus improving quality of life.	Case report
Michelle Barakat-Johnson[17]	2022	Australia	AI Application enabled remote patient monitoring and ensured optimal wound care.	Quasi-experimental
Tayebeh Baniasadi[18]	2023	Iran	Telehealth systems developed for post-operative wound care offered favourable outcomes. Potentially feasible and acceptable.	Literature review
Joseph M Pappachan[19]	2022	UK	Mobile apps integrated with Artificial Intelligence are expected to improve the remote monitoring of diabetic foot ulcers.	Single blind peer-review
Marie-Pierre Gagnon[20]	2014	Canada	Teleassistance service has shown a positive influence on nursing practices regarding the care of wounds.	Case report
Saagar Walia[21]	2019	Canada	Internet clinic has proven to be effective in delivering services to patients with pressure injuries secondary to spinal cord injuries. This method of service delivery is feasible.	Multicenter study
Meryem Kilic[22]	2020	Turkey	Mobile foot care applications improved patient awareness and showed a positive effect on their knowledge, behavior, and self-efficacy.	Randomized controlled trial
Francesco Paolo Gesuete[23]	2023	Italy	Telemedicine proved beneficial in assessing chronic wounds, offering the same results as standard outpatient follow-ups. Patient satisfaction and a reduction in costs was also noted.	Case report
Myriam Le Goff-Pronost[24]	2018	France	This trial indicates that telemedicine reduces travel expenses and leads to shorter healing times compared to traditional follow-up methods..	Prospective observational study

patients demonstrated the benefits of TeleHealth Electronic Monitoring (THEM) compared to standard care. Patients in the THEM group were provided with home monitoring tools, such as image capture devices, blood pressure cuffs and thermometers, allowing for real-time data transmission to the care managers. Although there was no significant difference in wound or 30-day readmission rates between the two groups, THEM patients reported higher satisfaction, improved physical function, and enhanced quality of life on several metrics. The study concluded that telehealth monitoring was technically feasible and beneficial, especially for patients in geographically isolated areas, with the potential to improve both patient satisfaction and healthcare access.[11]

On the other hand, a randomised controlled trial, comprising 736 screened individuals with diabetic foot ulcers, concluded that there was no effect on the healing time of the ulcers, nor was there a reduction in the need

for amputations with the usage of telemedicine monitoring. Conducted in Denmark, the study did record a higher rate of mortality in among patients on telemedicine monitoring compared to those receiving the standard outpatient follow-up management of the ulcers.[12]

Discussion

The integration of telehealth technologies into wound management has shown significant promise in enhancing patient care and outcomes. Research indicates that remote monitoring through telehealth platforms can improve adherence to treatment plans and facilitate timely interventions, ultimately reducing complications associated with chronic wounds. For instance, one study emphasised that telehealth interventions effectively reduced post-surgical complications and hospital readmissions, particularly benefiting patients from geographically isolated areas.[22] Another investigation highlighted how telemedicine can improve access to care and patient satisfaction, enabling healthcare professionals to monitor wound healing more effectively and address issues promptly.[23] These findings collectively underscore the transformative potential of telehealth in managing complex wound care and improving patient outcomes.

During the recent coronavirus disease-2019 (COVID-19) pandemic, an Australian study lauded the thermatic analysis (TA) application for quick wound assessment, collaborative planning, heightened patient adherence, and improved virtual care efficiency. The app, facilitating remote monitoring, cut patient commute time. As an innovative tool for clinicians and patients, the TA app could positively influence wound-related patient outcomes.[2]

Another study indicated a widespread approval of tele-dermatological monitoring for wound care by patients, home care nurses, and wound experts. This positive reception was associated with lower healthcare expenses and an enhanced quality of life for individuals managing leg ulcers. Moreover, the healthcare practitioner maintained a daily record and provided patients with education on recognising the symptoms of wound infection. This aimed at enhancing patient understanding and promoting increased attentiveness to wound care. Tele-dermatology showed significant potential for long-term wound care, with a 46% reduction in transportation costs for both insurance companies and patients due to fewer visits to physicians or wound care centres.[21]

Evidence from telemedicine practice in Pakistan shows that mobile apps could greatly enhance remote healthcare access, particularly in rural regions. The success of telemedicine during COVID-19 has been recorded, suggesting that mobile apps could further streamline communication and improve outcomes for patients, especially with the growing prevalence of smartphones in the country.[24]

The incorporation of telemedicine into wound care practices not only demonstrates its effectiveness in improving patient outcomes and reducing healthcare costs, but also establishes it as an important element in the continuous advancement of healthcare provision. Continued research and validation will be crucial to solidify the role of telemedicine in the broader landscape of wound management and healthcare at large.

The current systematic review has limitations, like lack of access to some studies due to subscription requirements, which may have led to the exclusion of pertinent studies. Furthermore, the review's focus on English-language publications could introduce language bias, potentially overlooking valuable research published in other languages. Publication bias is another concern, as studies with significant findings are more likely to be published, potentially skewing the overall conclusions. Additionally, variability in study quality may affect the reliability of synthesised evidence. Heterogeneity among the studies reviewed, including differences in populations, interventions and outcomes, may limit the ability to draw definitive conclusions. Finally, time constraints and resource limitations may have restricted the scope of the search strategy, potentially omitting recent evidence or relevant studies.

The need for more research and the creation of creative solutions is rather strong. Developing a specific mobile app is one way to enable smooth remote communication between patients and healthcare professionals in Pakistan. The proposed app could act as a focal point for doctors and patients, providing a user-friendly interface for tracking progress and real-time communication. Features like automated dressing-change reminders, warning sign alerts, and educational materials could enable patients to take an active role in their treatment, while giving medical staff timely information to direct actions. In essence, the call for future research should extend beyond the evaluation of existing tele-monitoring systems to actively contribute to the development and refinement of practical tools, such as a dedicated mobile app.

Conclusion

Several of the studies reviewed indicated that the tele-monitoring system is an efficient approach to managing

wound care, while also enhancing the overall quality of healthcare. It was observed that employing an online platform for communication between physicians and patients proved beneficial in preventing unnecessary hospital visits, consequently reducing the patient burden in outpatient settings.

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FT: Literature search, Prisma diagram, data collection, discussion and data analysis.
KS: Literature search, data collection, introduction and conclusion.
MSH: Results, data interpretation and drafting.
MY: Supervision.
UBZ: Abstract and formatting.