Review Article
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Medical Journal of the Islamic Republic of Iran (MJIRI)
Iran University of Medical Sciences

A systematized review of telemedicine applications in treating burn patients

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Received: 15 April 2016 Accepted: 19 August 2016 Published: 24 December 2016

Abstract

Background: Telemedicine has been used in different fields of medicine in the past 20 years. The main advantages of this technology include saving costs, improving quality of care, and increasing access to specialists. This study aimed to review telemedicine applications in treating burn patients.

Methods: In this systematized review study, related papers were searched using various databases, including PubMed, Scopus, and Science Direct. The time frame was between January 2000 and March 2016; finally, 32 papers were included in the study.

Results: The findings revealed that telemedicine was used in burn care in three different ways: Remote patient follow-up, teleconsultation, and patient assessment.

Conclusion: It seems that telemedicine can be easily applied in treating burn patients even when there is a limited financial resource. The use of this technology can help reduce possible errors in categorizing burn patients and decrease patients' transportation and treatment costs.

Keywords: Telemedicine, Burns, Remote Consultation, Medical Informatics.

Cite this article as: Hoseini F, Ayatollahi H, Salehi SH. A systematized review of telemedicine applications in treating burn patients. *Med J Islam Repub Iran* 2016 (24 December). Vol. 30:459.

Introduction

Current developments in the field of information technology and telecommunication have led to a breakthrough in different aspects of human life. These changes have also affected medical care by introducing new requirements and demands for new services (1). Telecommunication technology has made medical interventions possible even in the situations that physicians and patients are far from each other. This technology, telemedicine, has made it possible for the patients to access specialists and receive healthcare services even when there is a limited financial resource; therefore, by this technology distance loses its importance (1-5). Telemedicine is defined as the electronic exchange of medical information between two places (6), and it has been used in different fields of medicine, including dermatology, pathology, radiology, etc. in the past 20 years (7-9).

Telemedicine provides the patients with the opportunity to access physicians and medical services that are not available mainly due to the geographical distribution (10-14). Telemedicine has made virtual communication possible between physicians to be able to diagnose, consult, and treat patients (15). One of the most important applications of telemedicine is in diagnosing and treating burn patients. Due to the limited number of specialized burn centers (6), this technology can be used in the process of burn assessment, primary diagnosis, triage and making decision about transferring a burn patient to anther medical center (7,16-19).

Several studies have revealed that telemedicine has potentials to offer services to

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burn patients (7-9,16,17,20). For example, it helps nurses to provide high quality medical services based on the specialist's advice (2-4). Moreover, burn patients have to dedicate a considerable amount of money and time to travel and receive wound care and follow-up services. According to Redlick et al., unnecessary costs of travel would be saved by using this technology (18). Furthermore, the use of technologies such as digital imaging and video conferencing have increased the precision and efficiency of telemedicine and marked its importance in burn clearly (14,19,21). The main aim of this study was to review telemedicine applications in treating burn patients. In this study, the strengths and weaknesses of each application were also investigated.

Methods

In this systematized review study, papers related to the role of telemedicine in the treatment of burn patients were investigated. A number of databases, including Scopus, Web of Knowledge, Science Direct, Ovid, and PubMed were searched to obtain the related papers. The entry terms included burn, scar, and wound, which were combined with teleconsultation, telehealth, e-health and telemedicine. Boolean operators (AND/OR) were used to find the most related papers and the time frame was between January 2000 and March 2016 (Fig. 1).

All review and research papers, all written in English, were included in the study and the non-English documents and editorial letters were excluded. In addition, if the full text of the paper was not available and the researchers failed to access it, then the article would have been excluded. Moreover, papers related to the long-term care, burn emergency services, mortality rate, and medical errors, general dermatology, general teledermatology and legal and ethical issues in burn patients were excluded from the study.

Initially, 158 papers were obtained, and 28 papers were excluded due to the unavailability of the abstracts or duplication. The remaining papers (n=130) were

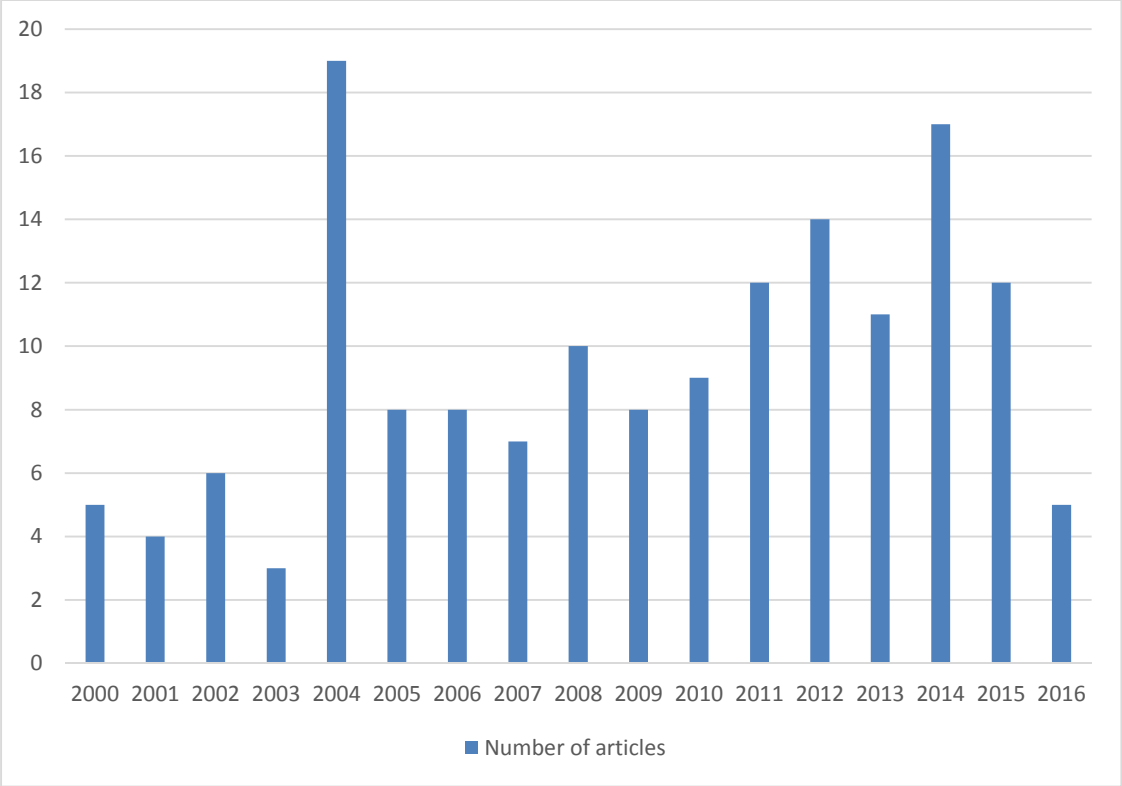

Fig. 1. Number of Papers Published from January, 2000 to March, 2016

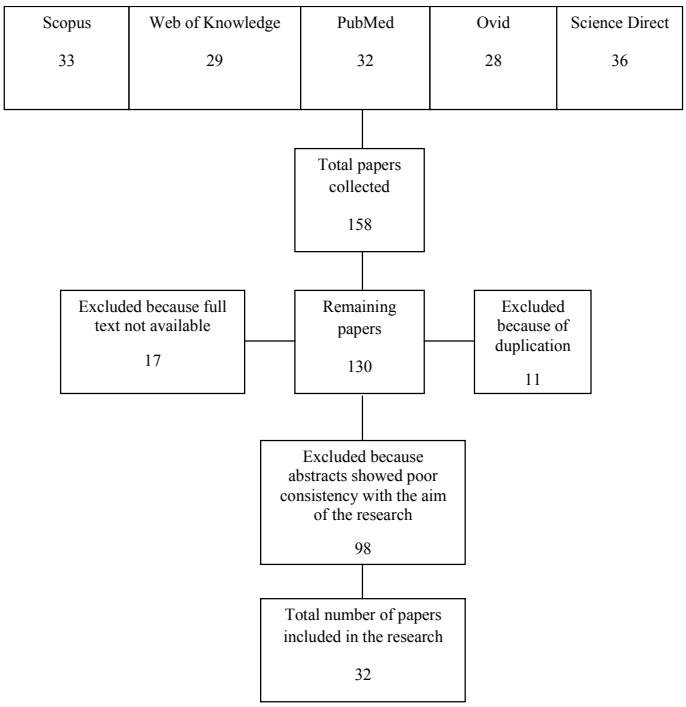

Fig. 2. The Process of Selecting Papers for Review

screened with respect to their titles and the relevancy of their abstract to the subject of the study. Finally, 32 papers were identified as relevant, and their full texts were included in the study (Fig. 2).

Results

Our investigations about the telemedicine applications in treating burn patients revealed that remote patient follow-up, teleconsultation, and patient assessment were three major areas to help burn patients.

Remote Patient Follow- Up

Since most of the specialized burn centers offer their services in large cities, accessing these centers is considerably time consuming and sometimes expensive for those who live farther from these cities (18). Telemedicine provides an opportunity to offer health care services to this group of patients (2,6,8,10,18,22,23). For example, burn patients' follow-up can be conducted via video conferencing in the hospitals or the burn centers of the cities where the patient lives (5,18,22,24-26).

In 2002, Redlick et al. conducted a study to evaluate patients and physicians' satisfaction with burn patient follow-up through telemedicine. The findings indicated that both patients and physicians were satisfied with the remote follow-up process. In fact, they found the remote follow-up process more convenient and economical than the conventional face-to-face follow-ups. Although some physicians believed that providing health care services through remote follow-ups are more time-consuming than conventional follow- ups, the results revealed that remote follow-ups do not necessarily make examinations and diagnosis difficult (18,27). In particular, telemedicine applications in various hospitals have proved to be a successful experience for the burn patients who live in distant areas (9, 25).

In 2007, Sagraves et al. conducted a feasibility study on offering teleburn services to patients who were referred to rural trauma centers for further follow- ups after being discharged from specialized burn centers. The results of this study are in line with those of a similar study in 2016. The researchers suggested that this method has been beneficial for the patients and physicians (26,28).

Some studies have found that travel costs, environmental barriers, distance from specialized burn centers, time restriction and patient negligence are the main reasons for decreasing patient follow- ups (23,29). However, a number of studies revealed that the application of telemedicine could save time and traveling costs (5,9,18-20,23,26). Moreover, remote patient follow- up can save hospital resources and increase efficiency (6,9,18,22,27). Some studies indicated that both patients and physicians are satisfied with the application of telemedicine for patient follow- up (6,9,18,29). While the number of studies conducted on the technical difficulties or poor quality of video conferencing is limited (19), some studies indicated that physicians' resistance (9,17), and legal challenges are the main obstacles of using telemedicine in treating burn patients (5,9).

Teleconsultation

There is an increasing number of patients that seek physicians' advice for their burn wounds; however, distance between patients and hospitals or the burn centers is a major problem in receiving a prompt consultation (30,31). Teleconsultation is a solution for those patients who want to acquire their physician's recommendations, continue their treatment, and receive training and consultation (19,29). In addition, it can accelerate the process of clinical decision-making, especially in the acute conditions (18,28,32).

In 2011, Clegg et al. evaluated the risks and benefits of remote consultation in burn patients (30). They established remote consultation equipment in two separate hospitals and asked specialists to consult patients remotely. The results revealed declining trends in patients' examination time, patients' referral to the specialized burn centers, and total costs (19,30,32). These benefits are consistent with Wallace et al's findings. However, Wallace et al. reported some drawbacks of remote consultation, which included high costs, the necessity of using advanced equipment and an integrated system (30,32). In a similar study, Wallis et al. mentioned that the use of cell phones in burn triage has many advantages (33). This report revealed that the use of teleconsultation for managing outpatient burn injuries has been successful; however, the possibility of making errors in clinical decision-making should not be underestimated (19,33).

Patient Assessment

A number of studies revealed a significant difference between the experienced and inexperienced physicians when estimating the burn size (17,34,35). Incorrect assessment may lead to invalid decisions that increase healthcare expenses and decrease the quality of healthcare services (17,27,36). Unnecessary fluid resuscitation (36), incorrect and unnecessary tubing of respiratory tract, making improper decisions about transferring the patient to the specialized burn centers and over-triage or under-triage are among inappropriate decisions that are caused by inaccurate assessment and diagnosis (22).

According to the study conducted in the U.S., the estimation of the burn size made by the referring physicians was about 6% more than the burn size assessment by the specialists. Estimation of the burn size according to the total body surface area (TBSA) index was higher in 30% of the cases, and lower than normal in 13% of the cases (36). Moreover, transferring 29% of patients was found unnecessary, and their referral was found to be a waste of time and money (27). Nevertheless, due to the visual nature of burn injuries and the possibility of external observations, it is possible to use imaging techniques to assess and diagnose burn injuries (6,25,34,37).

Numerous studies demonstrated that the results of burn size estimation and assessment through imaging techniques and telemedicine is very close to the results of the face-to-face assessments and diagnosis (21,28,37). Various findings indicated that using telemedicine to assess and diagnose burn injuries results in saving time and

money, increasing productivity, reducing unnecessary referrals, and choosing the right and efficient method for patient transfer. Consequently, it can improve the quality of healthcare services and patient care management (6,22,25,27,34).

Roa et al. performed a study to evaluate the quality and density of burn patients' digital images to use it in telemedicine applications. They reported that digital images are economical and easily transferable and do not cause tension in the patients. They also demonstrated that diagnoses made based on these images were completely valid and that digital photography could be used as an efficient and appropriate method to diagnose burn injuries (28, 38).

Numerous imaging tools have been introduced for burn clinical diagnosis; however, the use of these tools outside the specialized burn centers is limited due to their cost (39, 40). As a result, low cost tools such as mobile phones are preferable. To have a preliminary assessment and diagnosis of burns, Shokrollahi et al. evaluated the use of mobile phones for digital photography in telemedicine (41). The results of this study revealed that the low cost, no need for specific infrastructure or training, and transferring images without losing quality were among the benefits of using this device. The usability of this method has been proven for minor burn injuries. However, the screen resolution of mobile phones is as important as its camera quality. In addition, privacy concerns and medico-legal aspects are other issues that should be taken into account when using mobile phones (28,40, 41).

Other methods for transferring digital images include e-mail, instant photo sharing using the internet infrastructure, and video conferencing (24,42). Nevertheless, Simon noted that the main difficulties of digital imaging in telemedicine technology are related to a lack of access to the thickness, flexibility and swelling of the wounds (42). Probable telemedicine inaccessibility during natural or man-made disasters is another problem of this technology (25). It is worth mentioning that despite the weaknesses noted above, the use of telemedicine for different purposes is increasing in the specialized burn centers (6), and it has been suggested that wounds digital imaging would be a substantial part of telemedicine in the future (37). A summary of the strengths and weaknesses of telemedicine applications in treating burn patients are presented in Table 1.

Discussion

Telemedicine is defined as the electronic exchange of clinical data between two locations and has been developed in the last two

Table 1. The Strengths and Weaknesses of Telemedicine Applications in Treating Burn Patients

Telemedicine Applications	Strengths	Weaknesses
Remote patient follow-up	Patients' and physicians' satisfaction A convenient and a cost-saving approach Saving hospital resources and increasing efficiency	Time-consuming in some cases Technical difficulties (e.g., poor quality of images during video conferencing) Physicians' resistance Legal challenges
Teleconsultation	Receiving physicians' recommendations Continuous treatment Training	The necessity of using advanced equipment (e.g., videoconferencing) The necessity of using an integrated system The possibility of making errors
Patient assessment	Improving the estimation of the burn size Saving time and costs Increasing productivity Reducing unnecessary referrals Choosing the right and efficient methods for patient transfer	Privacy concerns and medico-legal aspects A lack of access to the thickness, flexibility and swelling of the wounds Inaccessibility during natural or man-made disasters

decades (6). This method has been used in different fields such as radiology, dermatology, psychology, cancer therapy, burn patient follow-up, emergency medical services, kidney and urinary tract diseases, and home care (6,25). Among the benefits of telemedicine, the following advantages are noteworthy: Making medical information available to improve decision- making at the point of care, reducing unnecessary patient transfer, and improving patient access to the specialists regardless of the distance. Furthermore, telemedicine helps decrease medical errors in diagnosis and treatment, and improve general physicians' experience and skills by connecting physicians and specialists and conducting examinations from distance (7,14).

Telemedicine technology in burn patients is one of the areas that has received the attention of healthcare providers (7,23). In fact, telemedicine has been used to facilitate caring for burn patients due to the limited number of specialized burn centers, the importance of caring for a burn patient in the first 24-48 hours after injury, and a lack of adequate medical experience to deal with these critical situations among physicians and nurses (24). The use of telemedicine in treating the burn patients can lead to a significant reduction in medical errors made by general physicians, which is of crucial importance for patients (43). In addition, due to the inadequate experience of physicians in the remote areas and the necessity of patient assessment by the burn specialists, the use of telemedicine technology can be useful in burn treatment and follow-up (11,44).

It is notable that burn intensity and degree are two important factors for assessing burn patients (43,45,46). There are also some other criteria for wound measurement in burn patients such as wound size, wound color, and even mental factors such as pain and itching (47,48). Although proper assessment of these signs is crucial for treating burn patients, the literature shows that general physicians may assess the burn injuries differently from the specialists; and as a result, their care plan and clinical decisions will be affected (36,43). On the other hand, collecting detailed information in burn treatment is very complex and time-consuming and all required information is rarely collected. Hence, the use of telemedicine can help collect in-depth data and helps physicians to choose more appropriate treatment plans (49). Since burn injuries usually accompany external signs, digital imaging along with telemedicine can be used to diagnose and assess the status of burn injuries (6).

Currently, digital imaging devices, such as mobile phones that are equipped with a digital camera and low cost infrastructures for delivering images, such as the internet are available in most healthcare centers (41). Moreover, this method is reliable and digital photography is useful and convenient for remote diagnosis of burn injuries (12). It is worth mentioning that teleconsultation, in addition to the effective role in treatment and improving quality of care, can be useful in training and preventing burn complications (50).

Burn patient follow-up is another important application of telemedicine. Since referring the patients to the burn centers might be difficult for them, patients' follow-up can be done, using telemedicine via videoconferencing and video calls. This approach can save money and time both for patients and for health care centers (22). In fact, telemedicine technology has made connection between specialists and patients feasible regardless of the patient's residential location (51,52). However, it should be noted that telemedicine, despite all the advantages has some drawbacks as well. The possibility of unavailability of technology in certain situations, e.g. power outage, and the issue of privacy and legal aspects are some of disadvantages, which should be taken into account when investing the technology (22, 41).

Conclusion

Telemedicine can be easily used in treating burn patients even when financial re-

sources are limited. This technology can help reduce possible errors in categorizing burn patients, patients' unnecessary transportation and healthcare costs. Other advantages, include improving the communication between healthcare providers and specialists, which in turn, may lead to improving the quality of care. However, the possibility of drawbacks should not be underestimated. The strengths and weaknesses of different methods should be investigated before investing financial and human resources. This approach can help achieve the best outcome via applying telemedicine technology.

Acknowledgments

This study was funded and supported by Iran University of Medical Sciences (IUMS/SHMIS_93/2).

Conflict of Interest

The authors declare that they have no conflict of interest.

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