Published online: 2019-11-27

Review Article

Telemedicine for wound management

Ravi K. Chittoria

Department of Plastic Surgery and Advanced Center for Telemedicine, JIPMER, Pondicherry, India

Address for correspondence: Dr. Ravi Kumar Chittoria, Department of Plastic Surgery and Telemedicine, JIPMER, Pondicherry, India.
E-mail: drchittoria@yahoo.com

ABSTRACT

The escalating physiological, psychological, social and financial burdens of wounds and wound care on patients, families and society demand the immediate attention of the health care sector. Many forces are affecting the changes in health care provision for patients with chronic wounds, including managed care, the limited number of wound care therapists, an increasingly ageing and disabled population, regulatory and malpractice issues, and compromised care. The physician is also faced with a number of difficult issues when caring for chronic wound patients because their conditions are time consuming and high risk, represent an unprofitable part of care practice and raise issues of liability. Telemedicine enhances communication with the surgical wound care specialist. Digital image for skin lesions is a safe, accurate and cost-effective referral pathway. The two basic modes of telemedicine applications, store and forward (asynchronous transfer) and real-time transmission (synchronous transfer, e.g. video conference), are utilized in the wound care setting. Telemedicine technology in the hands of an experienced physician can streamline management of a problem wound. Although there is always an element of anxiety related to technical change, the evolution of wound care telemedicine technology has demonstrated a predictable maturation process.

KEY WORDS

Application; telemedicine; wound

INTRODUCTION

The World Health Organization (WHO) defines telemedicine (TM) as, "The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities." Indian Space Research Organization's (ISRO) TM pilot project was started in the year 2001 with the aim of introducing the TM facility to the grass root level population as a part of proof of concept technology demonstration. The TM facility connects the remote district hospitals/health centers with super specialty hospitals in cities, through the INSAT satellites for providing expert consultation to the needy and underserved population. Presently, ISRO's TM Network has enabled 382 hospitals with the TM facility. 306 Remote/rural/district hospital/health centers and 16 mobile TM units are connected to 60 super specialty hospitals located in the major cities. The mobile vans are extensively used for tele-ophthalmology, diabetic screening, mammography, child care and community health.

Access this article online

Quick Response Code:

Website: www.ijps.org

DOI: 10.4103/0970-0358.101330

HISTORY

Alexander Graham Bell made the first telephone transmission to his assistant Mr. Watson. It was: "Watson, come here, I need to see you." He was actually asking for Watson's help, as he had spilled acid on his leg. The call for medical help remotely marks the first event in modern TM. [1]

Types of TM [2]

1. Store and forward (SAF) or pre-recorded (asynchronous) TM
2. Real-time or video conference (VC) (synchronous) TM
3. Hybrid TM
4. Mobile or cellular TM
5. Integration model

Store and forward or pre-recorded (asynchronous) TM

In this, information about the wound is acquired and stored in some format before being sent by some appropriate means for expert interpretation. Store and forward (SAF) involves transmission of digital images and asynchronous evaluation is practiced. Simultaneous presence of the health care professional is not required. It is the most commonly used technology. SAF TM has been found to be cheap and easy to set up and practice.

Real-time or video conference (synchronous) TM

In real-time interaction, there is no appreciable delay between the information being collected, transmitted and displayed about the wound. Interactive communication about wound care between individuals at the site is therefore possible. Real-time interaction requires an expert to be available to give an opinion. Real-time or video consultation (VC) uses video-conferencing equipment to connect the patient, often with their General Practitioner (GP) or nurse present, with a distant consultant. The evaluation of diagnostic accuracy varies between 67 and 80% compared to face-to-face consultation. Initial studies on economical evaluation of interactive TM compared to face-to-face consultation considered real-time or VC to be expensive. However, more recent studies have confirmed it to be economical. This is due to the improved technology and decrease in the hardware cost. There is 60–80% total agreement and 70–90% partial agreement when in person diagnosis of wound is compared to both real-time (synchronous) and SAF (asynchronous) TM.

Hybrid TM

The combination of SAF TM in the first step followed by VC TM in the second step is called hybrid TM. It saves time, clarifies doubts and avoids misinterpretation from both the ends. This process achieves best physician and patient satisfaction as far as wound care is concerned.

Mobile or cellular TM

Portable devices like cellular phones and Personal Digital Assistants (PDAs) (like laptops and handheld computers) provide inbuilt camera to capture wound's digital images, and computing and networking features to deliver wound care at a distance. They provide immediate image access and direct interaction and it is possible to obtain clarification. Periodic evaluation of leg ulcers and wound images using cellular phones and PDAs is practiced. Quality and speed of image transmission is no longer an obstacle. Chronic wound screening with cellular phones using mobile TM revealed a diagnostic agreement of 90% compared to face-to-face consultation. Cellular phones and PDA allow taking good-quality images and sending them to the expert from remote geographical regions via a wireless network, for example, Global System for Mobiles (GSM) and Universal Mobile Telecommunication System (UMTS). New generation cellular phones allow taking good-quality images and transmitting them directly to other cellular phones (via multimedia messages) and computers (via e-mail or blue tooth-wireless connection) with diagnosis agreement of 82% compared to face-to-face consultation.

Integration model

The systematic functional integration of electronic devices and software to capture, transfer, store, measure and deliver follow-up wound care is the principle of integration model and has been used effectively for wound care in remote geographical regions. Immediate access to visual parameters and measurement of wounds is achieved. Routine follow-up care in a remote area under close supervision of higher center is performed. Computerized measurements are rapid, easy and precise, and suited for SAF TD. This approach enables diagnosis, management and periodic assessment of wounds, and delivers follow-up care to achieve consultant and patient satisfaction. The system automatically plots wound healing regression on the computerized graph. Rapid capture, transfer and calculation with negligible human intervention, minimizing inter-observer and intra-observer variations are achieved. All health care professionals at a tertiary center utilize the software in a

centralized location, maximizing SAF TM center's utility and generalizability.

CLASSIFICATION OF TM CENTRES

The TM centers for wound care are broadly classified into:

i. Primary telemedicine center (PTC)
ii. Secondary telemedicine center (STC)
iii. Tertiary telemedicine center (TTC)

These could be further sub classified as three major levels, L1, L2 and L3, depending on the size and facilities available, the smallest being L1.

INFRASTRUCTURE AND HARDWARE[2]

The hardware platform in most of the TM systems consists of a Personal Computer (PC) normally of desktop type. Depending on the application and space constraints, the platform can also be of different types like mobile system, handheld system or system for home use. The hardware platform can be a laptop computer, palmtop computer, PDA or even a dedicated box (set-top box) with a processor. Minimum specifications required for typical PC are those with standard desktop [Figure 1].

POSITIVE IMPACT OF TM ON TRIAGE AND MANAGEMENT OF PROBLEM WOUNDS

The two basic modes of TM applications, SAF (asynchronous transfer) and real-time transmission (synchronous transfer, e.g. VC), are utilized in the wound care setting.[3] In 2006, Dobke et al. studied the impact of TM for triaging and developing management plans for patients with chronic, problematic wounds in long-term care, skilled nursing, and home care settings. TM was also assessed for its usefulness in enhancing communication with the surgical wound care specialist.[4] Experience of others confirms that referral by digital image for skin lesions is a safe, accurate and cost-effective referral pathway.[5] In a retrospective study by Dobke *et al.*, a database of 120 patients was analyzed to determine whether every patient management plan had to be formulated by the multidisciplinary team (MDT). There was a 93.6% concordance with the management plan established by the surgeon based on the TM consultation alone in comparison to the plan established by the MDT with direct patient contact. This study showed that TM technology in the hands of an experienced physician could streamline management of a problem wound.[6] It has been established that the low availability of specialists in wound care programs and the corresponding hindrance for rapid treatment can be ameliorated by TM.[7]

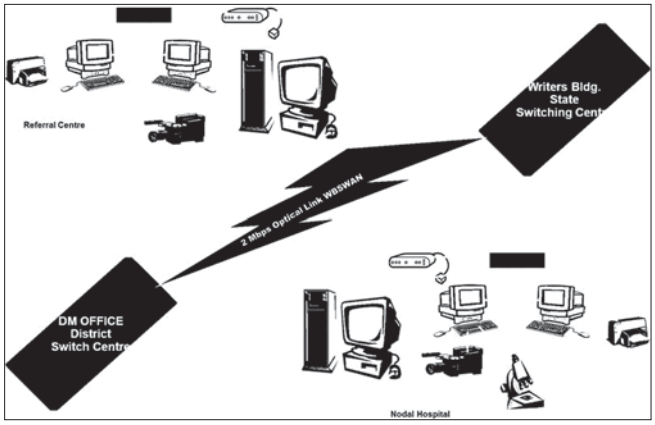

Figure 1: Infrastructure for telemedicine application

Technical considerations

Selecting a camera for wound care by TM requires consideration of various capabilities and features. Consideration of key optical parameters such as color bit depth, white balance, focus and macro is important. As mentioned above, image quality cannot be low; however, it cannot also be impractically high, requiring lengthy downloading time and lengthy transfer time. This can be especially problematic when transferring multiple high-pixel files from "the field" to the specialist. Therefore, excellent compression to reduce image file size and retain relevant details is a valuable and desirable feature.[8] There are two general types of image compression: "lossy" and "lossless." Lossless compression guarantees that the process of compressing and decompressing an image will not alter the image in any way. However, the rate of image compression is relatively low, typically 2:1. Much better rates of compression can be achieved by using lossy compression. Lossy compression systems discard some information from the image, usually by removing small differences in pixel color that, ideally, are inconsequential. For wound care applications, it is important to test the image compressing ratios and determine the maximum compression of the image for speedy transfer that will retain the minimum image quality for accurate clinical decision-making from the recipient.[9]

Patients' perceptions

The literature reports indicate that TM for wound care is well received by patients. Fears that patients will reject

"anonymous" electronic communication between the patient and physician, or physician and specialist, appear unsubstantiated. TM consultations provide accurate assessment for the treatment of problem wounds. They are well received by patients and have the potential to expedite and streamline care for patients with chronic wounds. The addition of TM as an initial, intermediate communication step with a patient seems to educate the patient and ultimately enhances a bond with a specialist consultant.[10, 11]

Physicians' perceptions

A survey of physicians who are clients of TM services indicates overall good satisfaction rates and revealed that TM could result in an earlier initiation of wound treatment than conventional delivery of wound care. [12] Concerns that a TM consultant may take over patient management and negatively impact the primary health care practitioner practice, as espoused, by those questioning the suitability of the teleconsultations, are unfounded. Potential problems with continuity of care and uncertainty about the follow-up process were not experienced.[4, 10, 12, 14] Ultimately, the success of TM for patient diagnosis and treatment depends on the support and willingness of physicians and other health care providers. This motivation often depends on physicians' experience and attitudes with prior TM experiences, even if it is just a single prior exposure. Experience with TM increases a physician's predisposition to use TM in their practice and even augments the breadth of implementation in different facets of his or her practice. Other ways to enhance physician acceptance are to have support from a sponsoring Organisation, provide structural legitimacy and a cohesive network.[15]

Video conferencing as an operational, research and educational tool in wound care

It has been demonstrated that students who participated via videoconferencing remotely asked four times as many questions of the faculty, and vice versa faculty to students, than occurred when students were physically present in the operating room. Feedback from the study shows that students gain more from the TM experience than from being physically in the operating room as measured by several objective and subjective criteria. Telemonitoring may also serve as a sustainable way to bring mentors and trainees together in regions of the world with a shortage of certain specialists, educators, mentors, public facilitators and organizers of wound care.[16]

Assessing outcomes and providing long-term wound care

Another area of ongoing research in TM is to evaluate its use as a tool to assess outcomes in wound care practice. It appears that the delivery of wound care through TM to medically underserved patient populations or even unsupervised settings is safe and meets demands of rural or wilderness settings. Wound care outcomes did not seem to be impacted negatively by the TM and remote management of certain components of the overall care.[17]

Limitations

The main limitation could be non-availability of TM facilitation centers in rural areas, lack of training on use of data transfer to most of the individuals including urban population and fear of using technology-based gadgets. Poor quality of images (300 dpi or less), "pixelisation" of the image and/or perspective distortion may lead to clinically important differences between an electronically transmitted photo and direct examination. This may result in an erroneous proposed diagnosis and management plan.[4]

Future

As technologies supporting TM are developed and perfected, they will help to advance wound care into the digital era. TM will certainly help in globalization of wound care delivery. This technology will be instrumental in addressing basic needs of wound care in medically underserved areas and the most complex surgical needs by enabling sophisticated expert consultations. With both technological advancements and growing physician exposure, TM for wound care will continue to thrive in increasing applications. Ultimately, TM will be essential for the development of remotely steered or assisted wound procedures, both robotic and traditional, performed by a human health care professional. Finally, the development of home TM programs for direct communication between a wound care specialist and a patient at home may facilitate an improved quality of wound care. This could occur, for example, by means of as little as a cellular phone with a camera. This will hopefully enhance postoperative follow-up by improving time spent between wound specialist and patient.[7]

Medicolegal aspects of TM

There are many issues of concern regarding the legal and ethical aspects of TM. These include the responsibilities and potential liabilities of the health professional, the duty to maintain the confidentiality and privacy of patient

records, and the jurisdictional problems associated with cross-border consultations. There is also the issue of reimbursement for care provided using a TM service. TM allows the transmission of health information across the borders of nation states. Cross-border TM services have begun, particularly in specialties such as teleradiology, but questions of jurisdiction and registration have yet to be answered definitively. While this may be true of many of the legal and ethical aspects of TM generally, it is also the case that health care professionals who undertake TM in a prudent manner will minimize the possibility of medico legal complications.[18]

E-consultation

In order to foster the use of e-consultation in primary care, both GPs and non-users must be informed about the possibilities and consequences of e-consultation through tailored education and instruction. We must also take into account patient profiles and their specific demands regarding e-consultation. Special attention should be paid to patients who can benefit the most from e-consultation while also facing the greatest chance of being excluded from the service. As health care continues to evolve towards a more patient-centered approach, we expect that patient expectations and demands will be a major force in driving the adoption of e-consultation.[19]

Use of TM In mobile ambulance

A mobile TM system uses multiple public wireless cellular phones to transmit video and patient bio signals from a moving ambulance to a hospital and delivers to the desktop computer of the receiving physician. The mobile unit on the ambulance is turn-key operated and has an image selection controller for paramedics to send images at specific times and to capture images at high frame rates.[20]

Telemonitoring of diabetic foot ulcers

Wound assessment and monitoring is an important element of managing diabetic foot ulcers. However, wounds managed in the outpatient setting are assessed by the clinician less frequently than those among inpatients, leaving the outpatient exposed to lengthier periods of ineffective treatment and the possibility of undetected life- and limb-threatening wound deterioration between clinic appointments. TM allows the clinician to remotely monitor wounds. The standard current model of telecare of diabetic foot includes experts at hospital who conduct clinical examinations and decision-making at a distance, in close cooperation with a visiting nurse and the patient.[21]

Email based TM

It is shown that email-based TM can be practiced in a large number of medical specialties and has application in primary consultation, second opinion consultation, telediagnosis and administrative roles (e.g. e-referral). Email has niche applications in low-bandwidth, image-based specialties (e.g. dermatology, pathology, wound care and ophthalmology) where attached digital camera images are used for telediagnosis. Diagnostic accuracy of these images has been the predominant topic of research, and results show email as a valid means of delivering these medical services. Email is also often used in general practice as an adjunct for face-to-face consultation. Further, a number of organizations have significantly improved the efficiency of their outpatient services when using email as a triage or e-referral system. Email-based TM provides specialist medical opinion in the majority of reviewed services and is most likely to be instigated by the patient's primary care giver. However, email consultations between patient and primary care and between patient and secondary care are not uncommon. Most email services are implemented using ordinary email. Email-based TM is generally regarded as underutilized. However, the potential is well recognized.[22]

TM and telephonic consultation in burn patients

TM and telephonic consultation is appropriate and cost-effective for treatment and follow-up of patients in burn units with personnel with limited experience. Patients admitted to the burn unit are consulted with burn surgeon via telephone and audiovisual transmission of data (TM). Three basic systems currently in use are: live interactive video, SAF images and telephone.[23]

Teleconferencing using multimedia messaging service

Accurate diagnosis can be made on wound images transferred via Multimedia Messaging Service (MMS) using a conventional camera phone and meaningful decisions can be made on these images. This method of consultation also proved to be highly convenient and cost-effective using simple and relatively cost-effective existing mobile phone network services and conventional hand phones with built-in cameras to capture carefully selected images and transferring these images for consultation and management plan.[24]

CONCLUSION

Wound care is a visual specialty. Image is the gold standard for diagnosis and treatment. Chronic wounds that require a long duration of treatment need frequent monitoring and several follow-up visits. It involves travel expenses and a prolonged waiting time. These circumstances have made wound care specialty an ideal specialty for TM applications for wound care.

REFERENCES

1. Perednia DA, Allen A. Telemedicine technology and clinical applications. JAMA 1995; 273:483-8.
2. Chittoria RK, Singh U, Muralidhar A. Telemedicine for Doctors. 1st ed. New Delhi (India): AITBS Publishers; 2009.
3. Meyer BC, Friedman LS. Telemedicine-closing in on distance medicine. San Diego Physician 2010; 97:36-9.
4. Dobke MK, Renkielska A, De Neve J, Chao J, Bhavsar D. Telemedicine for problematic wound management: Enhancing communication between long-term care, skilled nursing, and home caregivers and a surgical wound specialist. WOUNDS: A Compendium of Clinical Research and Practice 2006; 18:256-61.
5. Tadros A, Murdoch R, Stevenson JH. Digital image referral for suspected skin malignancy - a pilot study of 300 patients. J Plast Reconstr Aesth Surg 2009; 62:1048-53.
6. Dobke MK, Bhavsar D, Gosman AA, De Neve J, De Neve B. Streamlining the management of patients with problematic wounds: Must a multidisciplinary team formulate all patient management plans? WOUNDS: A Compendium of Clinical Research and Practice 2007; 19:340-4.
7. Terry M, Halstead LS, O'Hare P, Gaskill C, Ho PS, Obecny J, *et al*. Feasibility study of home care wound management using telemedicine. Adv Skin Wound Care 2009; 22:358-64.
8. Patricoski C, Ferguson AS, Brudzinski J, Spargo G. Selecting the right digital camera for telemedicine. Telemed J E Health 2010; 16:1-8.
9. Jones SM, Banwell PE, Shakespeare PG. Telemedicine in wound healing. Int Wound J 2004; 1:225-30.
10. Dobke MK, Bhavsar D, Gosman A, De Neve J, De Neve B. Pilot trial of telemedicine as a decision aid for patients with chronic wounds. Telemed J E Health 2008; 14:245-9.
11. Berguist TF, Thompson K, Gehl C, Muno Pineda J. Satisfaction ratings after receiving Internet- based cognitive rehabilitation in persons with memory impairments after severe acquired brain injury. Telemed J E Health 2010; 16:417-23.
12. Bridgen M, Minty A, Pilatzke S, Vidova LD, Sherrington L, McPhail K. A survey of recipient client physician satisfaction with teleoncology services originating from Thunder Bay Regional Health Sciences Centre. Telemed J E Health 2008; 14:250-4.
13. Hanson D, Calhoun J, Smith D. Changes in provider attitudes toward telemedicine. Telemed J E Health 2009; 15:39-43.
14. Loera JA. Generational differences in acceptance of technology. Telemed J E Health 2008; 14:1087-90.
15. May C, Harrison R, MacFarlane A, Williams T, Mair F, Wallace P. Why do telemedicine systems fail to normalize as stable models of service delivery? J Telemed Telecare 2003; 9(suppl 1):25-6.
16. McIntyre T, Monahan T, Villegas L, Doyle J, Jones DB. Teleconferencing surgery enhances effective communication and enriches medical education. Surg Laparosc Endosc Percutan Tech 2008; 18; 45-8.
17. Nesbitt TS, Hilty DM, Siefkin A. Development of a telemedicine program. Western J Med 2000; 173:169-74.
18. Stanberry B. Legal and ethical aspects of telemedicine. J TelemedTelecare 2006; 22:166-74.
19. Nijland A, Julia EW, Pinjen GV. Increasing the use of e-consultation in primary care: Results of an online survey among non-users of e-consultation. Int J Med Inform 2009; 78:688-703.
20. Xiao Y, Gagliano D, LaMonte M, *et al.* Design and evaluation of a real-time mobile telemedicine system for ambulance transport 2000;9:47-56.
21. Foltynski P, Ladyzynski P, Wojcicki JM. Telemonitoring of diabetic foot ulcers being managed in the outpatient setting. The Diabetic Foot Journal 2012; 15:74-82.
22. Caffery LJ, Smith AC. A literature review of email-based telemedicine. Stud Health Technol Inform 2010; 161:20-34.
23. Turk E, Karagulle E, Aydogan C, Oguz H, Tarim A, Karakayali H, *et al.* Use of telemedicine and telephone consultation in decision-making and follow-up of burn patients: Initial experience from two burn units. Burns 2011; 37:415-9.
24. Waran V, Selladurai BM, Bahuri NF, George GJ, Lim GP, Khine M. Teleconferencing using multimedia messaging service (MMS) for long-range consultation of patients with neurosurgical problems in an acute situation. J Trauma 2008; 64:362-5.

How to cite this article: Chittoria RK. Telemedicine for wound management. Indian J Plast Surg 2012;45:412-7.

Source of Support: Nil, **Conflict of Interest:** None declared.