Telemedicine for wound care: Current practice and future potential

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Summary

Telemedicine offers the potential to improve access to specialist care for people in rural communities, and for those with chronic illness, disability and limited support of carers, including in metropolitan settings. Individuals with chronic ulcers and wounds will often meet these criteria. The declining cost of equipment and improving access to the internet will add to the attractiveness of the telemedicine option.

In this paper, the current status of telemedicine is reviewed, and the application of telemedicine techniques for wound care assessment and management explored. The store-and-forward approach, where images are recorded remotely and transmitted to a wound specialist for diagnostic and management review, supported by a protocol-driven approach, appears suited to chronic wound care. The available evidence supporting diagnostic accuracy, patient acceptance, clinical outcomes and cost-effectiveness suggests this strategy to have considerable merit.

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Current investment in the national broadband network, and policy and funding developments in healthcare in Australia, may open the door to more extensive use of telemedicine in wound care.

Introduction

Telemedicine involves the application of telecommunication technologies to exchange medical information at a distance. While telemedicine was primarily developed to serve people living in rural and remote communities, where distance compromises access, many aspects of telemedicine are proving to be useful for local application within metropolitan communities. Telemedicine minimises the need for travel, thus facilitating interactions between patients and health professionals and among collaborating health professionals. It also involves transmission of information about patients for review by specialists. Telemedicine improves access to specialist services, and enables more efficient healthcare service delivery.

In regard to patient interactions, there are clear advantages for people living in remote communities, where specialists, for a variety of reasons, do not reside. In some cases, lack of specialist availability is attributable to an overall shortage of specialists, but in others, there is insufficient demand within the community to justify the continuing presence of the specialist. He/she must then visit the community, with the consequent time burden of travel. Alternatively, the patient might travel to the specialist, with attendant inconvenience, cost and, in some cases, discomfort.

Travel is a particular problem for people with poor health, disability and inadequate income. If the person has a chronic problem, with the need for regular specialist review, the problem is amplified. If there is disability, physical or cognitive, the person will require an escort, or even special transportation, escalating the cost to the health system, or the person, and often both. Similarly, the costs of transporting children are much higher due to the need for an accompanying parent or guardian.

Persons with chronic wound care requirements often fill a number of these categories. They may be old, disabled and unwell, and have multiple comorbidities. Travel is a challenge. They often require multiple consultations, with long term follow-up. Many are older people living at home, who cannot visit a clinic without an assistant. Others live in residential aged care facilities, where travel to a specialist clinic may require specialised transportation and an escort. Wound care is, therefore, a specialty that is well suited to telemedicine strategies, if indeed services can be delivered at a distance.

Modes of telemedicine delivery

Telemedicine interactions are broadly divided into two categories: store-and-forward (asynchronous) and real-time (live interaction).

Store-and-forward typically involves the transmission of pre-recorded information (such as text, images or both) to a remote party, who in turn is able to review the information and respond at an appropriate time. Common modalities include email, short message text (SMS) and the general post (courier services). A well-known example of store-and-forward telemedicine is teleradiology, whereby specialists assist with diagnosis of radiographs sent from remote locations[1]. Another example is telepathology, where pathologists may be sent electronic images of microscope slides for histological examination[2,3]. Other examples of store-and-forward telemedicine include web-based counselling services where email is used for confidential correspondence between patients and health professionals; and peer-to-peer case consultation amongst health professionals[4,5]. The discipline of dermatology, which is highly focused on skin appearance, with limited history taking and physical examination, is particularly suited to this store-and-forward approach[6,7].

Store-and-forward approaches have the advantage that they avoid the need to have two parties scheduled to be present simultaneously. The responding health professional can review the information and respond at his convenience. The main caveat is that the response is not instant – and therefore is not well suited for emergency situations which warrant an immediate response.

Real-time (live) consultations enable the rapid, simultaneous exchange of information between parties. It is of advantage when the conversation is complex, varied in direction or of an urgent nature. The most common methods include case discussions over the telephone and patient consultations by videoconference. The inclusion of video enables a partial physical examination, quite apart from the ability to observe facial expression and posture. It is well suited to patient interview, and to some aspects of physical examination. Research has demonstrated that the quality of the video image and sound is critically important for effective interview and patient acceptance.

Image quality during videoconference consultations is subject to a number of factors, including the rate at which data can be transmitted (bandwidth). Higher bandwidth allows more information to be sent – often resulting in less video pixilation and better image quality. In specialities such as foetal medicine, when live ultrasound images are being transmitted, minimum transmission speeds of 384kbit/s have been shown to be required[8]. In sessions which involve face-to-face conversations, lower bandwidth speeds (down to 128kbit/s) are usually tolerated.

In disciplines where physical examination is not of major importance, such as psychiatry, videoconsultation is well suited. Diagnostic accuracy has been repeatedly shown to be good in many aspects of psychiatry[9-11]. In memory disorders clinics, diagnosis of dementia is as accurate when established by video as live consultation[12], and physical examination rarely influences the diagnosis[13].

Appraising the suitability of telemedicine

If a clinical service is to take advantage of telemedicine, it is important that a number of key criteria are met. Firstly, the appropriate technology and clinical systems to support the interaction must be readily available at a reasonable price. The information should be shared in a manner that respects the privacy of individuals and meets medical information security requirements of the local jurisdiction. Emails sent in plain text format over the public network are not encrypted and, therefore, represent a privacy and confidentiality risk when patient information is transmitted. For legal and ethical reasons, it is important that clinical work conducted by email includes an appropriate level of encryption[14].

Videoconferencing presents similar privacy concerns, especially when the conference is carried over the public internet. The risk to privacy may be reduced substantially by the use of encryption. This may be achieved using inbuilt features of the videoconferencing equipment or by establishing a virtual private network (VPN) between videoconference endpoints. Such approaches provide

increased privacy by making the video stream difficult to identify and intercept while it traverses the public network. A VPN can be established over all commonly available connection technologies allowing secure communication wherever it is needed.

Freely available internet-based services such as Skype and MSN Messenger have been used by some for clinical services; however, caution regarding privacy should be observed. While these services may indeed encrypt their traffic, they may present a false sense of security and privacy. Firstly, these networks offer free access to all without robust checking of identity and, therefore, authenticity of the user cannot be guaranteed. Secondly, because call setup, routing and encryption is mediated by third-party servers, often using proprietary mechanisms, there can be no guarantee that traffic is only visible to the intended recipients. While this level of trust in the third-party messaging network may be sufficient for social networking purposes, it falls short of the level of privacy usually expected in the clinical setting.

Assessments performed via telemedicine should be proven to be clinically reliable and at least comparable to conventional methods of delivering care. Inaccurate diagnosis or assessment can lead to errors, sometimes with dire consequences (for example, misdiagnosing a melanoma). The interaction should be acceptable to clinicians, patients and other stakeholders. Preferably, the clinical outcomes achieved should be as good as conventional approaches. Finally, the cost should be appraised and demonstrated to be less than the cost of bringing the clinician and the patient together through travel.

Wound care and telemedicine

Wound care services usually attract the most complex wounds and ulcers, which are often slow to heal and require complex treatment regimens. This usually entails detailed initial assessment with frequent follow-up assessments of wound status and repeated adjustment of therapy. Increasing availability of inexpensive high-resolution cameras, videoconferencing and the internet, enable exchanges of information, images and conversations between patients and wound specialists.

A brief summary of the published literature in relation to wound care is presented here.

The most frequently reported practice model utilises initial face-to-face assessment, supplemented by a store-and-forward approach to sharing wound images, to monitor progress and adjust treatment[15-17]. This has been implemented in home care and nursing home settings[18].

Several reports support the efficacy of a telemedicine approach to wound care: Buckley demonstrated that when digital images were added to verbal reports to wound care nurses providing advice remotely, there was a change in assessment or recommendations in over 50% of cases[19]. A preliminary telemedicine-based communication to link a surgical wound care specialist to field nurses in skilled nursing facilities in the USA resulted in reduction of subsequent face-to-face consultation time and impacted on the accuracy of decisions and patient satisfaction[18].

A telewound program comprising transmission of digital photographs and a clinical protocol to a plastic surgeon applied to 19 home-bound patients resulted in reductions of visits to the emergency department, hospitalisation, hospital utilisation and cost[20]. A teledermatology service for patients with leg ulcers, which conducted follow-up of patients initially assessed in a face-to-face setting, using digital images transmitted via a secure website to a wound care centre, resulted in a reduction in face-to-face visits and transport costs, with good levels of patient satisfaction[15].

A wound care service for patients with chronic leg ulcers was offered through an initial physician face-to-face assessment, with subsequent follow-up by home care nurses, who transmitted digital images to the specialist via a secure website[17]. The majority of images (89%) were of sufficient quality to permit assessment by the specialist. Such reviews resulted in changes to management in one-third of consultations and were associated with a significant decrease in centre visits. Acceptance was high among patients, nurses and wound experts.

In Australia, a randomised controlled trial (of clinical sites to minimise contamination effects) conducted over 12 months, using remote expert wound consultation and The Alfred/Medseed Wound Imaging System[21] as the intervention, demonstrated significantly better healing rates (6.8% average reduction in wound size per week) compared to controls who received normal care (increase in wound size of 4.9% per week)[22]. Many of the patients were Indigenous Australians. Digital images were uploaded onto the software system every two weeks, to enable expert review and advice. A costing study suggested significant cost savings.

Several studies have examined the accuracy of assessments and treatment decisions using digital images[23-25]. A study

which compared surgical evaluation of wounds in person and via digital imagery, using a single 3.3 megapixel camera image, demonstrated very good agreement in measuring wound size, exposed bone, cellulitis, purulence, swelling, granulation tissue and colour, and depth[25].

Dobke and colleagues demonstrated that when a plastic surgeon reviewed 120 patients after an initial telemedicine consultation involving a communication tool and digital images, the diagnosis or management plan was altered in only two cases[26].

Salmhofer and colleagues demonstrated high levels of agreement between face-to-face and digital image-based assessments in 110 patients with chronic leg ulcers (including pressure, vascular, diabetic foot and mixed aetiology ulcers) with regard to both evaluation: slough (84.6%), necrosis (98.2%) and granulation tissue formation (76.4%), and treatment recommendations[27].

Patient and clinician acceptance of the telemedicine approach seems to be good. In a study that aimed to examine the role of clinicians' medical decision-making in nursing homes using videoconsultation, clinicians found the method of interaction valuable, particularly in regard to wound care[28].

The case for wider application

While several governments in Australia, particularly in Queensland and Western Australia, have invested in infrastructure and systems to support telemedicine, the uptake has not been as widespread as might have been anticipated[29]. Given the mounting evidence for technical accuracy and acceptance of telemedicine in several disciplines – dermatology, psychiatry, diabetology and paediatrics – it is surprising that uptake has not been more extensive.

In Australia, we have identified a range of influences which appear to retard uptake of telemedicine, including lack of shared (electronic) medical records, inadequate training, poor coordination, under-investment in clinical manpower, and lack of appropriate incentives for clinicians to use the telemedicine format[29]. Lack of hardware is frequently not an issue.

Recent Australian Government policy decisions may serve to address some of these issues. The National Health and Hospitals Reform Commission flagged the need to increase health resources for rural communities and recommended a greater investment in electronic health records[30]. In August 2010, the Australian Government announced a significant commitment to support telehealth, including assignment of Item Numbers on the Medical Benefits Schedule to support distance consultations, together with training strategies and other funds for telehealth infrastructure[31].

In our own Centre for Online Health at the University of Queensland, although we do not operate a discrete wound service, we have extensive experience with two patient groups pertinent to wound care services. One service relates to telepaediatrics – and includes the delivery of post-acute care services to patients and families living in rural and remote areas of Queensland[32]. The telepaediatric burns service was established in November 2000 to help reduce the need for families of children with burn injuries to travel to the specialist hospital (up to 2000 kilometres away) for long-term follow-up. Instead of travelling back to Brisbane

Figures 1 & 2. Examples of digital images for the post-acute care of children with burn injuries.

periodically, families are able to have an appointment at a hospital close to where they live; allowing assessment by a local therapist (usually an occupational therapist), and then review by the specialist burns team (by videoconference). For many of these consultations, digital images are collected by the local therapist and sent by email to the specialist burns team prior to each appointment. These images are invaluable and provide a high-quality, detailed perspective of the burn injury (Figures 1 & 2).

Since the service began, over 1300 burns consultations have been carried out by videoconference, with certain benefits including reduced travel costs; continuity of care; engagement with local services and reduced stress and inconvenience normally associated with travel away from home[32-34].

The second service is operated through the Centre for Research in Geriatric Medicine (CRGM) at the Princess Alexandra Hospital – and provides online geriatric consultation (using structured assessment protocols in a store-and-forward mode)[35], as well as in-patient consultation via wireless, mobile videoconsultation[36]. Our experience in consulting by videoconsultation with older patients, many of whom have pressure and leg ulcers, has been well accepted.

Conclusion

There is emerging evidence that telemedicine strategies can be applied to wound care. There appear to be advantages, particularly for patients located in rural settings, in nursing homes and in home care programs, where combinations of distance and disability make it difficult for the patient to visit a clinic and expensive for a wound specialist to visit the patient.

The store-and-forward approach, using digital images taken according to a strict protocol, and transmitted to the specialist via a secure method, would seem to offer the opportunity for specialists to appraise wounds, prescribe treatment and monitor progress. However, at the patient location, there is a need for appropriate training of staff to record information, capture images, take measurements, and administer treatment. This can become challenging if the patients are dispersed over a wide geographical area. In any given jurisdiction, there may be only a few patients who would interact with the specialist wound service at any time. Therefore the training and supervision of the local staff would need to be coordinated with a local agency, most likely a nursing service. In a residential care setting, similar challenges exist.

Supplementation of store-and-forward approaches with videoconsultation might offer advantages where history taking is complex, or patient counselling is required. It could also be used to instruct local nurses to manage wounds. Currently, videoconferencing capability is not widely available in the patient homes or in aged care facilities. This can be expected to change in the near future, as broadband connectivity improves and the price of equipment and other infrastructure declines.

References

1. Krupinski EA. Virtual slide telepathology workstation-of-the-future: lessons learned from teleradiology. Semin Diagn Pathol 2009; **26**:194–205.
2. Brauchli K, O'Mahony D, Banach L & Oberholzer M. iPath - a Telemedicine Platform to Support Health Providers in Low Resource Settings. Stud Health Technol Inform 2005; **114**:11–7.
3. Williams S, Henricks WH, Becich MJ, Toscano M & Carter AB. Telepathology for patient care: what am I getting myself into? Adv Anat Pathol 2010; **17**:130–49.
4. Caffery L, Smith AC & Scuffham PA. An economic analysis of email-based telemedicine: a cost minimisation study of two service models. BMC Health Serv Res 2008; **8**:107.
5. Wootton R, Youngberry K, Swinfen P & Swinfen R. Prospective case review of a global e-health system for doctors in developing countries. J Telemed Telecare 2004; **10(Suppl 1)**:94–6.
6. Massone C, Wurm EMT & Soyer HP. Teledermatology. G Ital Dermatol Venereol 2008; **143**:213–8.
7. Levin YS & Warshaw EM. Teledermatology: a review of reliability and accuracy of diagnosis and management. Dermatol Clin 2009; **27**:163–76, vii.
8. Chan FY, Whitehall J, Hayes L *et al.* Minimum requirements for remote real-time fetal tele-ultrasound consultation. J Telemed Telecare 1999; **5**:171–6.
9. Reilly RO, Bishop J, Maddox K, Hutchinson L, Fisman M & Takhar J. Is telepsychiatry equivalent to face-to-face psychiatry? Results from a randomized controlled equivalence trial. Psychiatr Serv 2007; **58**:836–43.
10. Hyler SE, Gangure DP & Batchelder ST. Can telepsychiatry replace in-person psychiatric assessments? A review and meta-analysis of comparison studies. Cns Spectrums 2005; **10**:403–13.
11. Singh SP, Arya D & Peters T. Accuracy of telepsychiatric assessment of new routine outpatient referrals. BMC Psychiatry 2007; **7**.
12. Martin-Khan M, Flicker L, Wootton R *et al.* Multicentre pilot for assessing the diagnostic accuracy of cognitive assessment via video consultation. Australas J Ageing 2008; **27**:A21.
13. Martin-Khan M, Varghese P, Wootton R & Gray L. Physical Examination and Diagnosis of Dementia for Video Consultation. J Am Soc Geriatr Dent 2008; **56**:947–9.
14. Caffery L & Smith AC. A literature review of email-based telemedicine. Stud Health Technol Inform 2010; in press.
15. Binder B, Hoftnann-Wellenhof R, Salmhofer W, Okcu A, Kerl H & Soyer HP. Teledermatological monitoring of leg ulcers in cooperation with home care nurses. Arch Dermatol 2007; **143**:1511–4.
16. Kim HM, Lowery JC, Hamill JB & Wilkins EG. Patient attitudes toward a Web-based system for monitoring chronic wounds. Telemed J E Health 2004; **10**:S26–S34.
17. Hofmann-Wellenhof R, Salmhofer W, Binder B, Okcu A, Kerl H & Soyer HP. Feasibility and acceptance of telemedicine for wound care in patients with chronic leg ulcers. J Telemed Telecare 2006; **12**:15–7.
18. 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.
19. Buckley KM, Adelson LK & Agazio JG. Reducing the Risks of Wound Consultation Adding Digital Images to Verbal Reports. J Wound Ostomy

Continence Nurs 2009; **36**:163–70.

20. Rees RS & Bashshur N. The effects of TeleWound management on use of service and financial outcomes. Telemed J E Health 2007; **13**:663–74.
21. Santamaria N & Clayton L. Cleaning up. The development of the Alfred/Medseed Wound Imaging System. Collegian 2000; **7**:14–5, 7–8.
22. Santamaria N, Carville K, Ellis I & Prentice J. The effectiveness of digital imaging and remote expert wound consultation on healing rates in chronic lower leg ulcers in the Kimberley region of Western Australia. Primary Intention 2004; **12**:62–70.
23. Halstead LS, Dang T, Elrod M, Convit RJ, Rosen MJ & Woods S. Teleassessment compared with live assessment of pressure ulcers in a wound clinic: a pilot study. Adv Skin Wound Care 2003; **16**:91–6.
24. Salmhofer W, Hofmann-Wellenhof R, Gabler G *et al.* Wound teleconsultation in patients with chronic leg ulcers. Dermatology 2005; **210**:211–7.
25. Murphy RX, Bain MA, Wasser TE, Wilson E & Okunski WJ. The reliability of digital imaging in the remote assessment of wounds – Defining a standard. Ann Plast Surg 2006; **56**:431–6.
26. Dobke M, 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.
27. Salmhofer W, Hofmann-Wellenhof R, Gabler G *et al.* Wound teleconsultation in patients with chronic leg ulcers. Dermatology 2005; **210**:211–7.
28. Laflamme MR, Wilcox DC, Sullivan J *et al.* A pilot study of usefulness of clinician-patient videoconferencing for making routine medical decisions in the nursing home. Journal of the American Geriatrics Society 2005; **53**:1380–5.
29. Smith AC & Gray LC. Telemedicine across the ages. Med J Aust 2009; **190**:15–9.
30. National Health and Hospitals Reform Commission. A healthier future for all Australians – Final Report of the National Health and Hospitals Reform Commission. In: Government NHaHRC-A, ed. Commonwealth of Australia, 2009.
31. Australian Labor Party. Australian Labor Party Fact Sheet: Connecting health services with the future: Modernising medicare by providing rebates for online consultations, 2010.
32. Smith AC, Youngberry K, Mill J, Kimble R & Wootton R. A review of three years experience using email and videoconferencing for the delivery of post-acute burns care to children in Queensland. Burns 2004; **30**:248–52.
33. Smith AC, Scuffham P & Wootton R. The costs and potential savings of a novel telepaediatric service in Queensland. BMC Health Serv Res 2007; **7**:35.
34. Smith AC, Kimble R, Mill J, Bailey D, O'Rourke P & Wootton R. Diagnostic accuracy of and patient satisfaction with telemedicine for the follow-up of paediatric burns patients. J Telemed Telecare 2004; **10**:193–8.
35. Gray L & Wootton R. Comprehensive geriatric assessment 'online'. Australasian Journal on Ageing 2008; **27**:205–8.
36. Gray LC, Wright OR, Cutler AJ, Scuffham PA & Wootton R. Geriatric ward rounds by video conference: a solution for rural hospitals. Med J Aust 2009; **191**:605–8.