

Teledermatological Monitoring of Leg Ulcers in Cooperation With Home Care Nurses

Barbara Binder, MD; Rainer Hofmann-Wellenhof, MD; Wolfgang Salmhofer, MD; Aslihan Okcu, MD; Helmut Kerl, MD; H. Peter Soyer, MD

Objectives: To examine the feasibility and acceptance of teledermatology for wound management for patients with leg ulcers by home care nurses and evaluate the reduction of costs and the acceptance of teledermatology by patients and home care nurses.

Design: Case series of telemonitored patients with leg ulcers including cost-effectiveness analysis.

Setting: Home monitoring by home care nurses.

Patients: Sixteen patients with 45 leg ulcers of different origin were included.

Main Outcome Measures: After an initial outpatient visit when the leg ulcers were assessed and classified, teledermatological follow-up was done by home care nurses. Relevant clinical information and 1 to 4 digital images of the wound and surrounding skin were transmitted weekly via a secure Web site to an expert at the wound care center, who assessed the wound and made therapeutic recommendations.

Results: Of the 707 images transmitted for teleconsultation, in 644 (89%) the quality of the images was ex-

cellent or sufficient and the experts were confident in giving therapeutic recommendations. Of the 45 ulcers, 32 (71%) decreased in size and 14 (31%) healed completely, whereas 10 of the 45 ulcers (22%) increased slightly in size despite the teledermatological monitoring. In 3 ulcers (7%), no measurement was possible owing to the overly large size of the ulcers. The acceptance of telemedicine was very good by most patients. Of 15 home care nurses working in the district, 7 were very satisfied with teledermatological monitoring of wound care. There was a reduction of 46% in transportation costs for the insurance companies as well as for the patients owing to a significant decrease in the number of visits to general physicians or the wound care center.

Conclusions: The acceptance of teledermatological monitoring of wound care was very high by patients, home care nurses, and wound experts. Decreased health care costs by reducing the number of visits to wound care centers or specialist physicians and improvement in quality of life for patients with leg ulcers using telemedicine seems possible. Teledermatology offers great potential for long-term wound care.

Arch Dermatol. 2007;143(12):1511-1514

CHRONIC LEG ULCERS ARE A significant problem for both patients and health service resources.¹ Leg ulcers are dynamic, requiring frequent assessment of wound status and surrounding skin, coupled with adjustments to therapy. Repeated visits to specialized wound care centers are often necessary. These visits can be time consuming because of long travel distances and prolonged waiting time, thus being a significant burden for the patients who are almost exclusively elderly. In Styria, a province of Austria with a total population of 1.2 million inhabitants, about 12 000 patients are being treated for leg ulcers of different causes at any given time. Only a few specialized centers have been established for the treatment of chronic wounds. The

inconveniences related to regular clinical visits cause a major discomfort to the patient and reduce the patient's quality of life.

*For editorial comment
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Teledermatology is a new rapidly evolving area in dermatology.² Reasonably priced photographic equipment and quick electronic transfer of high-quality digital images make it possible to get an expert's opinion for diagnosis or recommendation for management without delay. By using teledermatological support in managing leg ulcers, the patients receive expert medical consultation while avoiding the costs and inconvenience of long-distance travel to specialized cen-

Author Affiliations:
Department of Dermatology,
Medical University of Graz,
Graz, Austria.

Table. Clinical Data of the Ulcers

| Ulcer No. by Patient | Cause | Duration, mo ^a | Changes of Therapy Modalities, No. | Size, cm ² | |
|----------------------|--------|---------------------------|------------------------------------|-----------------------|-------|
| | | | | Before | After |
| Patient 1 | | | | | |
| 1 | Venous | 48 | 5 | 10.3 | 5.6 |
| 2 | Venous | | 6 | 147.8 | 79.7 |
| 3 | Venous | | 5 | 0.5 | 0 |
| 4 | Venous | | 5 | 125.0 | 63.2 |
| Patient 2 | | | | | |
| 5 | Mixed | 1 | 3 | 0.5 | 8.0 |
| 6 | Mixed | | 3 | 1.0 | 7.7 |
| 7 | Mixed | | 5 | 14.9 | 52.1 |
| Patient 3 | | | | | |
| 8 | Venous | 120 | 2 | 0.5 | 1.8 |
| 9 | Venous | | 2 | 0.5 | 1.0 |
| 10 | Venous | | 1 | 1.9 | 2.3 |
| 11 | Venous | | 1 | 5.2 | 6.3 |
| Patient 4 | | | | | |
| 12 | Venous | 240 | 4 | NM | NM |
| 13 | Venous | | 3 | NM | NM |
| Patient 5 | | | | | |
| 14 | Venous | 7 | 4 | 24.2 | 1.1 |
| 15 | Venous | | 2 | 10.2 | 9.2 |
| 16 | Venous | | 3 | 4.3 | 3.7 |
| 17 | Venous | | 2 | 22.4 | 3.1 |
| Patient 6 | | | | | |
| 18 | Mixed | 24 | 3 | 1.5 | 2.7 |
| 19 | Mixed | | 3 | 2.0 | 2.2 |
| 20 | Mixed | | 4 | 1.1 | 0 |
| Patient 7 | | | | | |
| 21 | Mixed | 36 | 2 | 0.3 | 0 |
| 22 | Mixed | | 2 | 1.6 | 1 |
| Patient 8 | | | | | |
| 23 | Venous | 24 | 2 | 17.5 | 7.3 |
| 24 | Venous | | 1 | 0.4 | 0 |
| 25 | Venous | | 2 | 1.4 | 0 |
| Patient 9 | | | | | |
| 26 | Venous | 2 | 2 | 2.3 | 1.7 |
| 27 | Venous | | 3 | 1.0 | 0.2 |
| Patient 10 | | | | | |
| 28 | Venous | 0.5 | 1 | 1.9 | 0 |
| 29 | Venous | | 1 | 1.1 | 0 |
| Patient 11 | | | | | |
| 30 | Venous | 12 | 2 | 1.5 | 0 |
| Patient 12 | | | | | |
| 31 | Venous | 3 | 3 | 7.8 | 0 |
| 32 | Venous | | 1 | 8.3 | 0 |
| 33 | Venous | | 1 | 1.3 | 0 |
| Patient 13 | | | | | |
| 34 | Venous | 0.5 | 2 | 0.6 | 0.5 |
| 35 | Venous | | 0 | 0.8 | 0 |
| 36 | Venous | | 0 | 0.6 | 0 |
| Patient 14 | | | | | |
| 37 | Venous | 300 | 2 | NM | NM |
| 38 | Venous | | 0 | 4.7 | 5.1 |
| 39 | Venous | | 0 | 17.2 | 15.6 |
| Patient 15 | | | | | |
| 40 | Venous | 5 | 3 | 9.5 | 5.3 |
| 41 | Venous | | 3 | 2.1 | 0.5 |
| Patient 16 | | | | | |
| 42 | Venous | 12 | 5 | 3.5 | 2.9 |
| 43 | Venous | | 2 | 1.7 | 0.9 |
| 44 | Venous | | 2 | 1.0 | 0 |
| 45 | Venous | | 1 | 6.6 | 4.5 |

Abbreviation: NM, no measurement.

^aDuration refers to the duration of all ulcers of a given patient.

ters. Preliminary results of the studies by Wilbright et al³ and Debray et al⁴ suggest that clinical images together with additional data from the patient's history are usually sufficient for a correct diagnosis and appropriate therapy of diabetes-related foot ulcers and wounds in elderly patients.

We build on our previous report of feasibility and acceptance of telemedicine for wound care in patients with chronic leg ulcers.^{5,6} In the present study, we report on the efficacy of telemedicine for managing leg ulcers in a setting with home care nurses in 16 patients with 45 leg ulcers of different origin. In addition, the reduction of costs and the acceptance of teledermatology by patients and home care nurses are evaluated.

METHODS

Sixteen patients aged between 47 and 86 years (median, 73 years) with 45 leg ulcers of different causes were included in this study (male to female ratio, 4:12) (**Table**). Informed consent was obtained from all patients. Initially, the patients came to the wound care center at the Department of Dermatology, Medical University of Graz, Graz, Austria, where their leg ulcers were assessed by the same wound care experts over the duration of the study. The following visits within the next 3 months or until the leg ulcer was healed were conducted by home care nurses, who were trained in taking and transmitting the images and trained in wound care. Once a week, 1 to 4 digital images of each ulcer and surrounding skin including relevant clinical information were transmitted to the wound care center. At the end of the study, the patient was examined once again in-person at the wound care center.

Digital images were taken with a 3.3-megapixel camera (Coolpix 995; Nikon Corporation, Tokyo, Japan) and stored on a built-in flash card. The image size was 2048 × 1536 pixels, and the images were compressed to approximately 1.5 megabytes in Joint Photographics Experts Groups (JPEG) format. All images had a standardized color graduation included and were taken without flash, with uniform room illumination and a high-sensitivity setting on the camera.

After logging in to a secure Web site (<http://www.teleulcus.at>), specifically designed for this study, the images were downloaded from the camera to a server via universal serial bus (USB) connection without any modification or processing. Selected clinical data were also transmitted via this Web application to an expert in wound care for independent teledermatological assessment. The procedure took about 5 minutes per ulcer. The experts provided an assessment of wound status and therapeutic recommendations within 24 hours.

The acceptance of teledermatology was assessed by questionnaires (patients and home care nurses); the patients completed one unvalidated questionnaire before and one at the end of the study. The transport costs for each patient from his or her home to the wound care center in Graz or to their general practitioners 3 months before the beginning of the study were compared with those 3 months during the study.

RESULTS

GENERAL FINDINGS

The 45 chronic leg ulcers in the 16 patients were monitored by teledermatology during the 3-month period. In

total, 470 teleconsultations were performed. Altogether, 707 digital images were sent to the experts. Of 724 images, 644 (89%) were of excellent or sufficient quality. The grading was performed for each image separately and included the categories excellent, sufficient, and insufficient. For the remaining 63 cases, the images were slightly blurred, underexposed, or the framing of the image was not optimum.

Certain questions about pain, inflammation, and itching of the surrounding skin, among other questions, were brought to the experts' attention in 79 cases. Experts made changes in treatment plan in 108 of the 470 teleconsultations (23%).

As outlined in the Table, the sizes of the ulcers before and after treatment changed as follows: of the 45 ulcers, 32 (71%) decreased in size and 14 (31%) healed completely, whereas 10 of the 45 ulcers (22%) increased slightly in size despite the teledermatological monitoring. In 3 ulcers (7%), no measurement was possible owing to the overly large size of the ulcers. Remarkably, in these 3 ulcers, no notable change in size was observed.

ACCEPTANCE BY PATIENTS

Before starting the study, the patients were asked about their expectations concerning telemedicine. Seven patients thought that telemedicine could be useful, but the other 9 patients were not optimistic about this new form of wound care. At the end of the study, 9 patients were very satisfied, 3 partly satisfied, and 4 were not satisfied with telemedicine in wound care. All 4 patients who were not satisfied showed a poor healing rate. Twelve patients thought that teledermatology was able to replace a personal consultation with a general physician or with an expert of the wound care center.

NURSES AND COSTS

All 7 home care nurses participating in the study were satisfied with the teledermatological monitoring by experts, and they believed that the quality of their treatment was improved. The possibility of consulting the experts every week was a great advantage for them.

In the 3 months before the inclusion into the study, the patients together required 64 consultations with the general physician or the dermatology department. Over the course of the study, only 9 consultations of a general physician were required. The reasons for these consultations were fever, mechanical debridement of the ulcer, and antibiotic prescriptions. This trend led to a significant decrease in transportation costs (46%) on the basis of the original data from the insurance companies, although not all patients had been treated in the wound care center regularly during the 3 months before participating in the study.

COMMENT

Several studies showing the feasibility and the usefulness of teleconsultations in dermatology have already been described in the literature, and high accordance for diagnosis and treatment between face-to-face visits and tele-

consultations has been reported in all of them.⁷⁻⁹ Up to now, only a few reports have discussed the use of teledermatology in the diagnosis and care of patients with leg ulcers.^{3-6,10,11}

The diagnosis of leg ulcers is usually straightforward, whether it is made by clinical examination or based on a digital image. A correct classification of the leg ulcer can usually be made, based on clinical presentation and additional data from the patient's history, concerning both the ulcer and concomitant diseases. Treatment suggestions are commonly based on the clinical presentation of the leg ulcer and the surrounding skin, the classification of the leg ulcer, information on previous therapeutic modalities and therapeutic response, known allergic reactions of the patient, and the clinician's personal experience with wound healing.

In general, the quality of digital images in our study was excellent and the experts were able to give therapeutic recommendations, which subsequently were carried out by the home care nurses. Based on this combined approach of teledermatological expert monitoring and treatment performance by home care nurses, a good healing rate was achieved. More than 70% of the ulcers showed a decrease in size, and approximately one-third healed completely. In addition, the home care nurses successfully requested help in the treatment of different ulcers in 79 instances. The acceptance of the new method was very good in most patients and was remarkably better in patients with good wound healing. Unsurprisingly, all 4 patients who were not satisfied with this combined approach showed a poor healing rate.

The acceptance of teledermatology was also high by home care nurses. Following a short settling-down phase, they learned to take images, upload them, and use the Web application for the store-and-forward communication with the experts. In their opinion, this method improves the quality of the treatment.

In general, our patients with leg ulcers consult the general physician or our wound care center every 3 weeks for therapy adjustment. In our study, we found a marked reduction in these outpatient visits. Therefore, a distinct reduction in transport costs for the patients was achieved, an advantage of teledermatology¹² over the usual treatment modalities.

Teledermatology holds great potential for the future of long-term wound care. It could increase the quality of medical care¹³ for patients by enabling general practitioners and home care nurses¹⁴ in any location to receive diagnostic and treatment support from experts in wound care. By reducing the need for travel, wound care teleconsultations might lower the health care costs. Improvement in the patient's quality of life will be possible by reducing inconveniences such as long waiting times for appointments at specialty clinics, often located some distance away, and repeated visits to those clinics. Training of home care nurses in taking and transmitting images as well as special training in wound care are prerequisites to successfully implement telemonitoring for patients with chronic leg ulcers.

Accepted for Publication: April 6, 2007.

Correspondence: H. Peter Soyer, MD, Department of Dermatology, Research Unit of Teledermatology, Medical Uni-

versity of Graz, Auenbruggerplatz 8, A-8036 Graz, Austria (peter.soyer@meduni-graz.at).

Author Contributions: Dr Soyer takes responsibility for the integrity of the article. *Study concept and design:* Binder, Hofmann-Wellenhof, Salmhofer, and Soyer. *Acquisition of data:* Binder, Hofmann-Wellenhof, Salmhofer, and Okcu. *Analysis and interpretation of data:* Binder, Hofmann-Wellenhof, Salmhofer, and Soyer. *Drafting of the manuscript:* Binder. *Critical revision of the manuscript for important intellectual content:* Binder, Hofmann-Wellenhof, Salmhofer, Okcu, Kerl, and Soyer. *Administrative, technical, and material support:* Binder, Salmhofer, and Okcu. *Study supervision:* Hofmann-Wellenhof, Kerl, and Soyer.

Financial Disclosure: Dr Soyer is cofounder and managing director of e-derm-consult GmbH, a spin-off of the Medical University of Graz. The Web application on which the Web site <http://www.teleulcus.at> runs has been developed and provided by e-derm-consult GmbH.

Funding/Support: This study was supported in part by a grant from the Austrian Ministry of Education, Science, and Culture.

Role of the Sponsor: The sponsor had no role in the design and conduct of the study; in the collection, analysis, and interpretation of data; or in the preparation review, or approval of the manuscript.

Additional Contributions: Walter Burgdorf, MD, provided critical review of the manuscript and editorial help.

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