

# Visual wound-assessment by population groups with different educational backgrounds

## Prospective analysis of reproducibility of subjective evaluations

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### Keywords

Wound documentation, wound healing, leg ulcers, chronic wounds

### Summary

The documentation of chronic wounds is presently carried out by a number of different occupational groups, partly with considerable differences in knowledge. Besides testing the quality of judgement, the aim of our clinical study was therefore also to test the reproducibility of the visual wound assessment by population groups with different educational backgrounds. **Participants, material, methods:** The subjects, belonging to population groups; experts, doctors, nursing services, hospital nursing staff and laities, were required to assess all relevant parameters of wound assessment at two different points in time. A newly developed digital, colorimetric wound documentation system was used as an objective reference. **Results:** The wound assessment was evaluated both intra-individually as well as inter-individually. A noticeably better quality of assessment of objective parameters, such as length, breadth, surface, wound stage and wound infection, was shown by the population groups with previous experience, both in the single and two phase analysis. The wound coating assessments of all population groups were equally inaccurate at both points in time. **Conclusion:** Consequently, it may be concluded that it is not possible to attain suf-

ficient, reliable and adequate wound documentation without technical aids, for example a digital photo documentation. Especially the assessment of the wound surface and coating is of an insufficient standard, whether carried out at a specific point in time or in a sequence.

### Schlüsselwörter

Wunddokumentation, Ulcus cruris, Wundheilung, chronische Wunden

### Zusammenfassung

Die Dokumentation chronischer Wunden wird aktuell von einer Reihe unterschiedlicher Berufsgruppen wie mit zum Teil erheblichen Wissensunterschieden durchgeführt. Ziel unserer klinischen Untersuchung war es daher neben der Beurteilungsqualität auch die Reproduzierbarkeit der visuellen Einschätzung chronischer Wunden bei verschieden vorgebildeten Populationen zu untersuchen. **Teilnehmer, Material, Methoden:** Die Probanden der Populationen Experten, Ärzte, Pflegedienste, Pflege und Laien sollten alle relevanten Parameter der Wundbeurteilung an zwei verschiedenen Zeitpunkten einschätzen. Als objektive Referenz kam ein neu entwickeltes digitales kolorimetrisches Wunddokumentationssystem zum Einsatz. **Ergebnisse:** Ausgewertet wurde die Wundbeurteilung intra- und interindividuell. Es zeigte sich einerseits eine deutlich bessere Qualität

der Einschätzung objektiver Parameter wie Länge, Breite, Oberfläche, Wundstadium und Wundinfektion in den Populationen mit Vorerfahrungen sowohl in der einzeitigen als auch der zweizeitigen Auswertung. Die Wundbeläge wurden zu beiden Zeitpunkten von allen Populationen gleichmäßig fehlerhaft eingeschätzt. **Schlussfolgerung:** Aus unseren Resultaten kann gefolgert werden, dass eine suffiziente, reliable und adäquate Wunddokumentation ohne technische Hilfsmittel wie z. B. digitale Fotodokumentation unmöglich ist. Besonders die Einschätzung der Wundbeläge und Wundoberfläche erfolgen auf insuffizientem Niveau.

### Mots clés

Documentation sur les plaies, ulcère de jambe, cicatrisation des plaies, plaies chroniques

### Résumé

La documentation sur les plaies chroniques est actuellement du ressort de divers groupes professionnels, dont les connaissances sont en partie très différentes. Outre l'évaluation de la qualité de jugement, notre étude clinique avait pour but de tester la reproductibilité de l'évaluation visuelle des plaies par des populations ayant des niveaux d'instruction différents. **Participants, matériel, méthodes:** Les participants appartenant aux groupes ex-

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Evaluation visuelle des plaies par des groupes de connaissances professionnelles différentes – Étude prospective de la reproductibilité d'appréciations subjectives

perts, médecins, services de soins, personnel hospitalier et profanes devaient, à deux moments distincts, évaluer tous les paramètres importants pour apprécier une plaie, la référence objective étant un nouveau système numérique colorimétrique de documentation sur les plaies. **Résultats:** L'appréciation des plaies a été évaluée tant intra-individuellement qu'interindividuellement. Chez les groupes disposant d'une expérience antérieure, la qualité d'appréciation de paramètres objectifs, tels que longueur, largeur, surface, stade et infection de la plaie, était notablement supérieure lors de la première analyse et lors de la deuxième. A ces deux moments du test, les groupes ont tous également mal évalué les dépôts des plaies. **Conclusion:** En conséquence, nos résultats indiquent qu'une documentation suffisante, fiable et adéquate sur les plaies ne peut se réaliser sans aide technique, p. ex. une documentation photographique numérique. C'est principalement l'appréciation de la surface et du dépôt d'une plaie qui s'avère de qualité insuffisante

In the scope of modern moist wound therapy, an objective wound healing progress report is very important as a quality assurance parameter, alongside an exact diagnosis and phase adapted wound treatment. In many countries this has become relevant for billing for health-care of patients with chronic wounds (4, 8, 15). Fundamental mistakes in wound documentation are currently still based on, for example, inconsistently implemented metrics or a purely visual assessment of wound conditions (21, 25). Documentation with

- metric size specifications in cm and
- colour photos with size specifications

should be mentioned as a minimum criteria to be implemented for a qualitatively well carried out wound documentation in the scope of a conventional progress report (5, 10, 18). This objective documentation, which should be comprehensible in every detail, is a compulsory and essential component in the continued care of chronic wound patients.

Currently, the documentation is carried out by a range of persons with different educational backgrounds, some with enormous differences in knowledge. This is particularly so in the growing outpatient sector. In a preceding clinical study, it was shown by our

team that there were enormous variances between the different occupational groups concerning the quality of assessment of objective wound healing parameters, subject to educational background (14). The assessment of subjective parameters, such as the different wound coatings, could not be assessed adequately by any of the occupational groups. Yet, especially in the assessment of chronic wounds, an exact and reproducible documentation is essential for the healing process and also for therapeutic decisions with successive economic consequences.

For this reason, the aim of our study was to prospectively evaluate the reproducibility of visual assessments of the different occupational groups.

## Participants, materials and methods

A total of 12 pictures of leg ulcers were handed to 50 test subjects from five population groups. These pictures were to be analysed without technical aid at two different points in time, at least 60 days apart. A colour chart with an edge length of 3.0 cm was displayed on every photo as an orientation guide.

The pictures used for this study were taken of patients with chronic leg ulcers in the outpatient wound healing clinic of the Department of Dermatology of the University of Essen. The photographic technique followed the manufacturer's instructions.

## Design of evaluation sheet

To enable an evaluation of the parameters previously discussed, in different population groups, an evaluation sheet was designed that could be filled in independently by the test subjects without aids such as a ruler or similar. A standardised colour chart on each photo served as an orientation guide. All population groups received standardised instructions for the commentary of the specified parameters and terms.

## Configuration of population groups

Five different population groups were to be included in our clinical study. Ten subjects,

who were prepared to fill in the evaluation sheets in full, were included from every population group.

1. Doctors, who deal with leg ulcer patients regularly in the course of their job – henceforth called “experts”.
2. Doctors, who do not deal with leg ulcer patients regularly in the course of their job – henceforth called “doctors”.
3. Hospital nursing staff, who are regularly occupied with practical wound care of leg ulcer patients – henceforth called “hospital nursing staff”.
4. Staff members of nursing services – henceforth called “nursing services”.
5. Medical laypersons – henceforth called „laities“.

## IPS (imageprocessing system)

Computer-assisted wound analysis software was used prior to the study to generate reference data for the questions involved, with external validation, for each individual photo. This served as an analysis reference. The IPS is based on standardised, digital colour photography. In addition, metric and colorimetric matching may be carried out by the simultaneous use of a reference card. Subsequently, processing and objective analysis of different parameters is made possible by a newly developed software module.

The hardware component consists of a digital camera (Olympus, Hamburg, Germany), with a resolution of 4 megapixel, as well as automatic exposure with indirect lighting. A newly-developed, self-adhesive colour chart was used to standardise the analysis of the individual photos. The software enables an analysis of the following parameters: size, area as well as the surface, including its composition. As every pixel may be allocated to a defined colour category, allocation to a pre-defined wound component is possible (► Fig. 1). The size parameters should be viewed objectively, due to matching with the standardised colour chart, with a defined size. In the course of the current study, the IPS offered an objective comparison of the data collected in two phases.

A detailed description of the validation from the IPS can be found in the article of Körber et al. (14).

## Analysis of individual parameters

The data collected at the 2<sup>nd</sup> point in time was only analysed and documented after the data collected during the 1<sup>st</sup> point in time had been completely analysed and documented. The pictures were distributed in a different sequence at the 2<sup>nd</sup> point of time, compared to the 1<sup>st</sup> point in time. The interval between the two surveys was a minimum of 60 days. After entering all parameters for all populations in an Excel table, the result at the 1<sup>st</sup> point in time was compared to the evaluation at the 2<sup>nd</sup> point in time for every single subject and a percentage variance calculated. The average, median and the standard deviation was calculated for the individual values of each population group. This course of action was carried out for all 12 pictures.

Subsequently, the averages for the individual pictures of each population group were added and the total value was divided by the number of pictures. Hence, the result is indicated as average percentage variance of a population with corresponding standard deviation. The statistical analysis of tested population groups was carried out using Microsoft® Excel 2000.

## Results

Our results document the deviation of the single visual assessments by the subjects at the two points in time. Additionally, the absolute deviations are compared to the data collected by the wound analysis software.

### Length

The length parameter as the maximum wound dimension was assessed the best at two points in time, henceforth called T1 and T2, by the expert population group with a deviation of 20.8% and 26.5% compared to the IPS system. The laities carried out the weakest assessment at both points in time with a deviation of 38.7% and 39.0%. (► Fig. 2a). Changes of between 0.3% and 8.2% were noted when comparing the results taken at the two points in time. The hospital nursing staff showed a small improvement in T2, compared to T1. The experts and nursing ser-

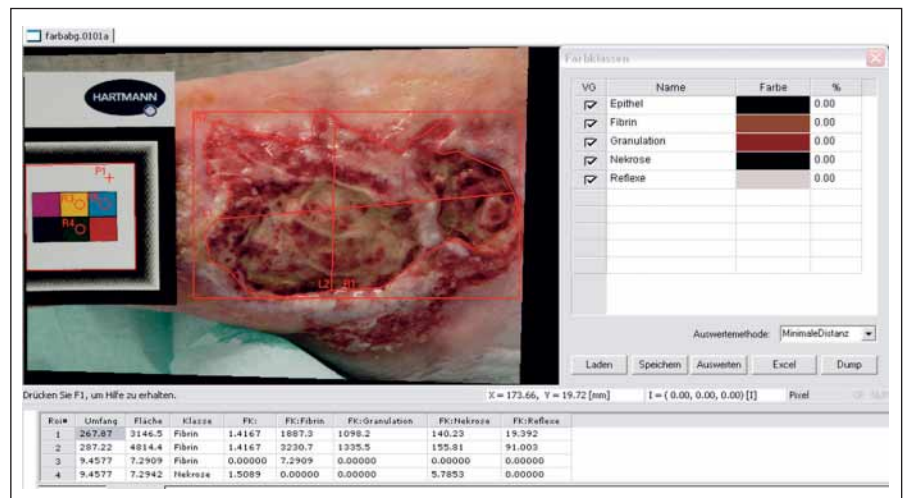


Fig. 1 Evaluated leg ulcer within IPS-matrix

vices had the most noticeable deterioration of 5.6% and 8.2% (► Fig. 2b).

### Breadth

The breadth parameter as maximum wound breadth dimension was judged best at T1 by the experts and best at T2 by the nursing services. The two groups had a comparable error level of 45%. The laities were the weakest again at both points in time with deviations of 91.9% and 87.3% (► Fig. 2a). When comparing the two points in time, the breadth parameter also only had a slight deviation at both points in time of 2.1–6.6%. Only the doctor and expert groups showed a slight decline compared to T1 (► Fig. 2b).

### Surface

A greater deviation presented itself in the assessment of the wound surface than in the assessment of length and breadth. Here, too, the experts offered the most reliable assessment. The poorest assessment was carried out by the laities with a deviation of 237.4% and 221.1%. In the comparison of the two points in time, the hospital nursing staff presented a definite improvement with up to 21.5%. All population groups, with exception of the experts, produced an improvement too, compared to T1 (► Fig. 2b).

In the two-phase analysis all population groups demonstrated a good reproducibility

with a maximum deviation of 8.2% in the parameters length and breadth. Small improvements as well as deteriorations were shown by the individual population groups. As expected, the assessment of the wound surface produced a greater deviation. Amazingly, in the assessment of the surface all groups except the experts attained a better assessment in T2 than in T1. The deviations, ranging from 8.9% to 21.4%, were all within an acceptable limit. Presumably, the most common reason for deviation was the use of a rectangular wound as a basis for surface calculations.

### Wound stages

In the assessment of the predominant wound stages of infection, granulation or epithelialization, the expert population group was the most secure once again at both points in time. All population groups presented an improvement in T2, compared to T1. Some groups had a marked improvement of up to 46.5%. Especially the nursing services and hospital nursing staff groups had an enormous improvement, however this can be ascribed largely to the high quota of abstentions in T1 (► Fig. 2c). While the nursing services were the weakest in T1, with 35% correct assessments, they were the second best in T2 with 81.7%. The laities also showed a clear improvement of almost 20%, but were still the weakest at T2 with 59.2% correct assessments.

All populations showed an improvement in the wound stage assessment in T2. The

number of abstentions was also significantly less than in T1. The expert population group was still the most reliable, but by a smaller margin than in T1. The improvement in the assessment of the wound stages could most likely be ascribed to the learning effect on the population groups, even if the results of T1 were not known. Particularly the dramatic reduction in abstentions underlines the greater confidence of the single participants.

### Wound composition

Already in T1, there was no clear tendency between the different population groups in the assessment of wound coatings. No population could stand out against the others. In fact, the continuous inconsistency of data collected repeated itself. When comparing T1 and T2, an examination of the single values of the granulation and fibrin parameters shows minimal deviation of the individual population groups:

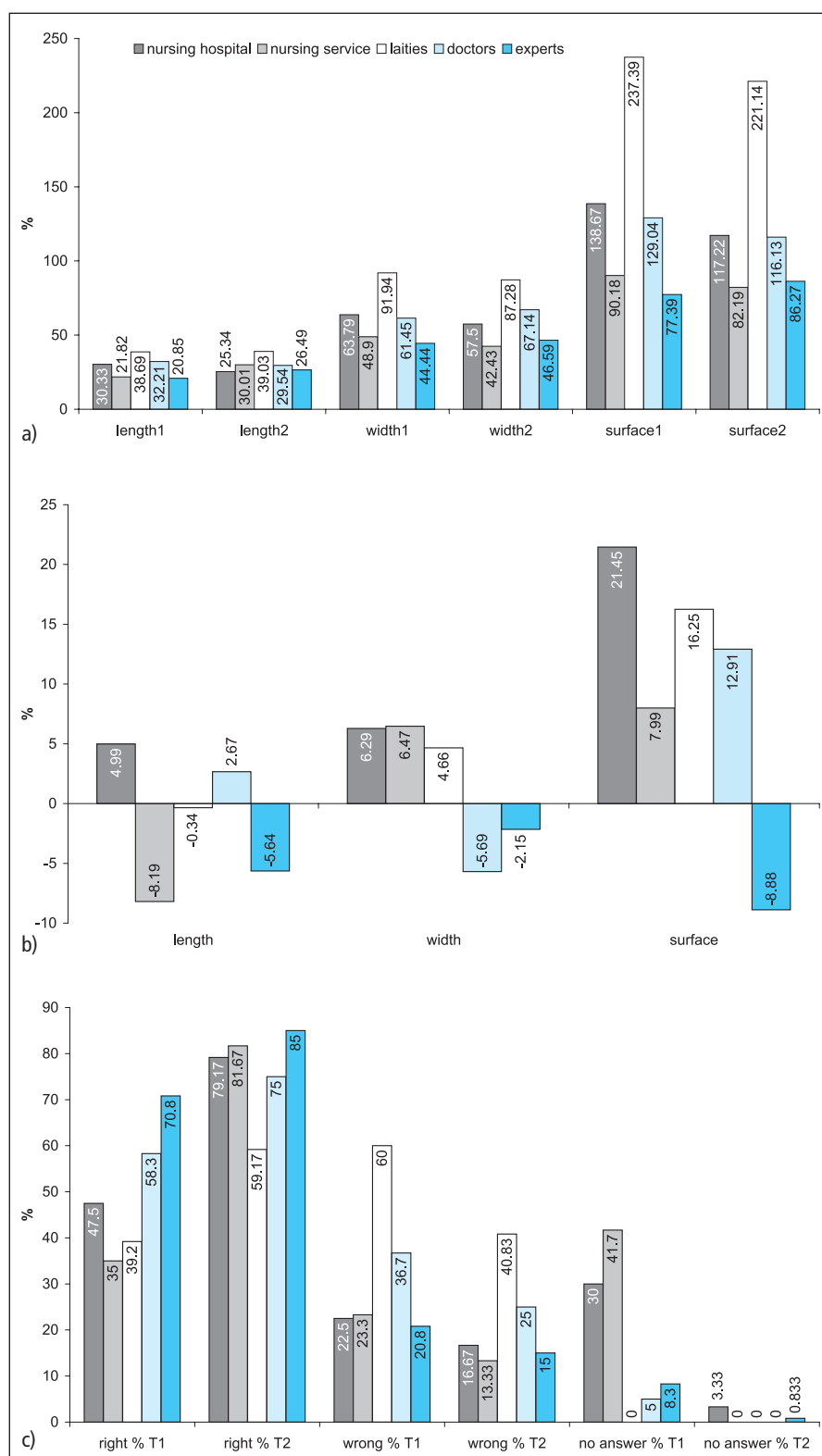
- fibrin 0.4–19%;
- granulation 0.7–6.6%.

A higher absolute deviation in the assessments was presented in the epithelium and necrosis parameters, which were not present on all photos, as the single values were very small. There was also a greater difference between the values of the two points in time, T1 and T2, with deviations of up to 300% compared to those calculated by the IPS system (► Fig. 2e).

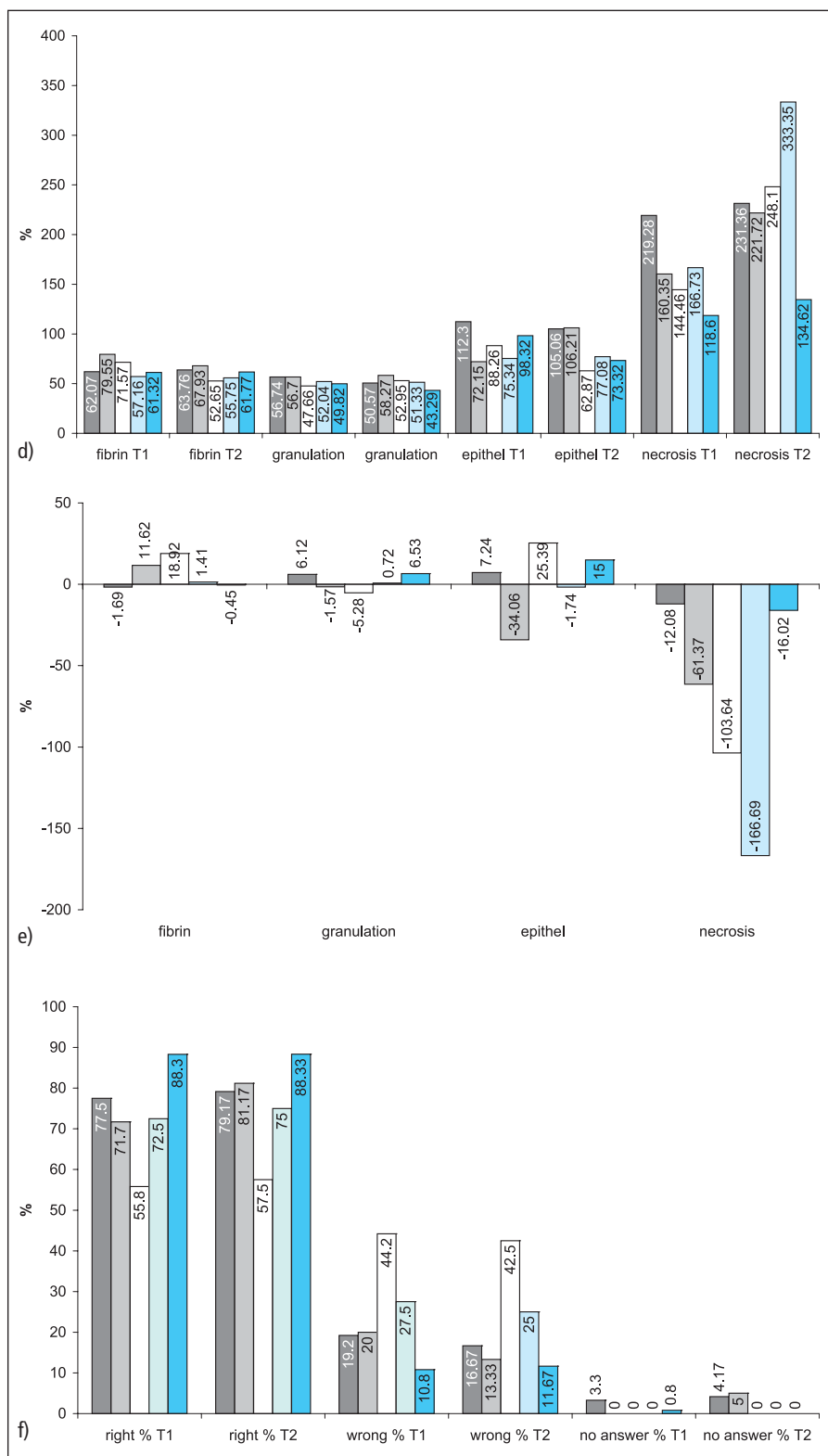
The reproducibility of the single wound coatings must be regarded individually. In the assessment of the predominant wound coatings, granulation tissue and fibrin, only minimal deviations compared to T1 were exhibited. These deviations were

- 0.7–6.5% for granulation tissue,
- 0.5–18.9% for fibrin.

The assessment of wound coatings with a smaller occurrence on the wound exhibited greater deviations. This was expected, because the absolute values were so small and consequently even small deviations lead to higher percent values. Thus, the assessment of the epithelium in comparison to T1 produced deviations of 1.7–34.1% and the assessment of presented necrotic areas even deviations of 12.1–166.7%.



**Fig. 2** Deviation (in %) at the two time points T1 to T2 in comparison of  
**a)** population groups versus the IPS system  
**b)** population groups (positive values: improvement; negative values: deterioration)  
**c)** assessment of wound stage



**Fig. 2**  
**d)** assessment of wound coatings  
**e)** population groups (positive values: improvement; negative values: deterioration)  
**f)** assessment of wound infection

It became evident that the standard of reproducibility of wound composition, excluding necrosis, is unexpectedly stable. However, the actual existing wound coatings cannot be represented realistically, even in the two-phase study. In this study no population group could improve itself by means of a learning effect.

**Wound infection**

The assessment of an existing infection should only take place on the basis of the picture on hand, in the context of classical, clinical signs. In the comparison of T1 and T2, only the nursing services showed small changes of around 10%. These changes were in the form of an improvement in the assessment. Other population groups showed a maximum change from T1 to T2 of 2.5% (► Fig. 2f).

The assessment of an existing wound infection in the two-phase study also displayed an improvement in almost all population groups with an improvement of up to 9.4% in their assessment. In this case, too, a learning effect may be assumed. However, the expert population group presented the best assessment in all aspects.

**Discussion**

The essential function of meaningful wound documentation is the objective assessment of the impact of a therapy. This is essential for further planning of a goal orientated therapy. Due to the inter-professional and trans-sectoral link-up in the therapy of patients with chronic wounds, a range of different occupational groups is directly involved with the therapy and documentation of these patients. However, there is no consensus, neither nationally nor internationally, as to which parameters are prognostically and medically meaningful for sufficient wound documentation (13). The German Society of Phlebologie (DGP) recommends in their actual guidelines for venous leg ulcer a specific diagnostic approach for the documentation and assessment of venous leg ulcer, what is important for all colleagues working with chronic wounds (5). Actually, there are more than 20 different wound documentation sys-

tems in Germany alone, available either as exclusively handwritten or electronic. Added to this, some parameters are documented very differently, so that the results are often not comparable (3, 17, 19). In literature the criteria to be documented are mostly described as type of wound

- stage,
- duration,
- localisation,
- surroundings,
- infection,
- edge,
- pain and
- size.

Different documentation processes exist for each of these parameters. For example, the wound size is mostly objectified through the determination of length, depth and breadth by means of ruler measurement or planimetry (9, 11). Despite all the differences, it is often agreed that wound size is the fundamental factor for assessment and prognosis for wound healing and for differentiating between healing and non-healing wounds (1, 9, 12, 13, 23, 24).

### Choice of study parameters

The choice of data to be evaluated in our clinical study was based on which parameters are documented most commonly in practice. Furthermore, the assessment of the wound composition with the potentially present tissue types; granulation, necrosis, fibrin and epithelium, forms the basis for the choice of therapy regime (9). The judgement of an existing infection is also of enormous clinical importance. A faulty assessment can lead either to an unnoticed progression in the infection or an unwarranted application of antiseptics or antibiotics. The allocation of the wound into a wound healing stage provided the information which determined to what extent the total wound situation could be assessed correctly by the subjects.

### Quality of results of individual population groups

By presenting the results as a percentage deviation to the actual values determined by the

computer programme, a comparison can be made of the individual values of each individual population group and also of the particular photos. However, in the analysis currently presented, the reproducibility of the values between the studies taken at the two different points in time is especially important.

### Results of the single phase T1

As discussed initially, the results at the first point in time T1 showed that the assessment of the various parameters by subjects with different educational backgrounds is carried out with considerable differences. Overall, an unexpected deviation of the values calculated by the subjects to the digitally evaluated values was noted. In some cases the deviations amounted to over 100% for the wound surface as well as for the single wound components. The evaluation of the parameters length, breadth, surface, infection and wound stage were shown to depend on experience. The wound coating could not be distinguished adequately by any of the population groups (14).

### Relevance of results

After critically reviewing the current literature, we could not find any comparable study. Only Quan et al. studied the assessment of wounds on the basis of digital photos at two points in time (16). In this study, a good reproducibility was also shown by the individual subjects. In the study, however, only nine subjects, all with previous experience in assessment of wounds, were questioned. Added to this, solely a wound measurement with maximum diameter and a reproduction of the wound on the digital image was carried out.

As described, wound documentation is needed for different purposes. The main purpose is to objectively offer an understandable and reproducible account of the healing process of wounds. In many parts of the world, an increasing number of sections and also outpatient wound care, including wound documentation, are delegated to establishments without specialised knowledge. This is caused by changes in the health care system. A high quality link-up of collected information is vitally important, especially in these interdisciplinary, transsectoral domains. Digital

photographs have become widely available due to the rapid advancement of technical development in the last ten years. However, these are still not used across the board for the documentation of chronic wounds.

Yet, as a minimum requirement, the literature recommends that a photo with a size scale should be produced and the wound should be measured with a ruler (5, 13, 22).

These results, together with other parameters, are mostly recorded in writing on a ready-made form. The abundance of parameters that have to be documented additionally can present a problem, as the test subjects are often unsure which conditions can be referred to as physiological (22). Falanga also observed the more complex the configuration of the classification, the less manageable it becomes (9). Yet, to date no studies exist that examine how well different population groups involved in wound healing can reproduce their assessments and how well these assessments correlate with the actual conditions presented. Kantor and Margolis showed that the quality of assessors is of enormous importance in the assessment of wound changes and that a simple measurement of the length and breadth of the wound is useful for the clinical routine documentation (12).

On the basis of our results it was clearly shown that the parameters assessed by different population groups may be well reproduced, but the standard really encountered is partly far from reality. In addition, the assessment of length, breadth, surface, wound stage and wound infection strongly depends on experience. These parameters were assessed most successfully by the expert population group. Yet, a learning experience was encountered, especially with respect to the assessment of wound stage and wound infection.

Thus, it may be concluded that it is important to adequately educate all people involved in wound healing because this improves the quality of care.

In practice, however, most persons involved in wound therapy and wound documentation take advantage of few of the above-mentioned documentation aid possibilities

or training and/or show a lack of knowledge and training (17). Elliot et al. showed that 50% of nurses in Great Britain only undertake a visual assessment of wounds (6, 20). The documentation is often limited to statements such as “become smaller/larger” or “unchanged condition” or “wound coated”. An improvement in quality could be achieved by the use of the simple model of Quan et al., thereby using subjective perception and description as a basis for documentation (16).

In addition to the objective parameters, a subjective assessment of wound coatings is still undertaken today in many of the available wound documentation systems. No studies dealing with the quality of these parameters are available in the literature. On the basis of our test results, it must be concluded that it is not possible for one subject alone to provide a reliable assessment of wound coating. A good reproducibility was shown by the individual population groups in the 2-phase studies, especially for the granulation tissue and fibrin parameters. Yet, the absolute deviation to the actual results was clearly too high, with values of between 43% and 67%, and as such cannot be recommended as parameters to be documented. Also, no population group showed a form of learning effect comparable to the objective parameters. The limits of the human eye, which cannot always distinguish exactly between different wound coatings, also result in assessment constraints. This is especially evident if the colours red and yellow lie adjacently. Added to this, difficulties arise from the partially subjective character of wound coatings and problems are associated with assessments in different lighting conditions.

## Conclusion

The assessment of chronic wounds, especially objective parameters such as length, breadth and surface, can be reproduced by different

population groups, but does not suffice as a sole documentation basis. Due to the high error quota, purely visual assessment of wound coatings should not be carried out any more, despite its good reproducibility.

To establish a high quality wound documentation, trained personnel should be appointed and digital wound recording should be established. This avoids cost intensive false assessments, which cause a delay in the wound healing processes. A computer based wound documenting software is obligatory in the scope of clinical studies and also desirable in the daily clinic routine.

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