Knowledge development and research utilization in evidence-based wound care
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Is the red-yellow-black scheme suitable to classify donor site wounds? 
An inter-observer analysis

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ABSTRACT

**Background:** The red-yellow-black-scheme (RYB) is a well-known and validated scheme to classify chronic and acute wounds, based on wound color and moistness. We investigated whether this RYB-scheme is also useful to classify donor site wounds uniformly (DSW).

**Methods:** Twenty-three digital photographs of DSWs in various stages of wound healing were presented to internationally renowned wound scientists (n = 11), surgical doctors (n = 31), specialized wound nurses (n = 55), and surgical nurses (n = 28). These observers classified the color and moistness of the wound according to the RYB-scheme, yielding seven wound categories. Inter-observer agreement (IOA) was expressed as a kappa (k) value.

**Results:** IOA’s among specialized wound nurses were moderate when based on wound color and moistness (k = 0.41, 95% CI 0.33 to 0.49), wound color only (k = 0.41, 95% CI 0.29 to 0.53), or moistness only (k = 0.54, 95% CI 0.45 to 0.64). However, these IOA’s tended to be better than those among the scientists, doctors and nurses. Scientists showed the lowest agreement (k-values between 0.17 and 0.25). Doctors scored slightly better than nurses.

**Conclusion:** Clinicians and scientists have difficulty with classifying DSWs by means of the RYB-scheme. Therefore, this scheme does not appear useful to classify donor site wounds in a uniform manner.
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BACKGROUND

Classification of wounds is important to help clinical decision-making. The present-day variation in wound types, the huge number of dressing products available, and a myriad of opinions among doctors and nurses involved calls for uniformity in wound classification and subsequent dressing choice to optimize quality of care.

Available classification schemes are the RYB (red-yellow-black) scheme, TIME (tissue, infection, moisture, edge) scheme, MEASURE (measure, exudate, appearance, under-mining, reevaluate), and PUSH (Pressure Ulcer Scale for Healing). Only the first two are well described in scientific journals. These schemes are used to assist clinical judgment and to get insight in the progression of wound healing in a uniform way.

The RYB-scheme appears particularly useful because it is simply based on the color and moistness of the wound and is capable of guiding the appropriate choice of wound care interventions. The color ‘red’ indicates granulation tissue, which merely requires protection and is usually indicative of proper healing. ‘Yellow’ indicates yellow necrosis (slough) requiring wound cleansing, while ‘black’ stands for black necrosis, for which debridement is necessary.

Previous research on the RYB-scheme shows that it can be helpful in chronic and acute wounds. This suggests usefulness in donor site wounds (DSWs) after split skin grafting (SSG). These are acute wounds created under standard conditions. SSGs are used to repair skin defects (e.g. burns, chronic, and traumatic wounds) and involves the harvesting of only the epidermal layer and part of the dermis. Depending on the thickness of the SSG and an uneventful healing period, a DSW fully re-epithelializes in 7–21 days. Categorizing DSWs might help choosing an appropriate wound dressing, particularly because a large variation exists among health care professionals regarding their choice for wound dressing materials or topical agents to treat DSWs.

The value of the RYB-scheme has not been studied in DSWs. This should be done because they differ from the previously studied acute wounds as to depth of the wound and healing time. We therefore investigated whether the RYB-scheme helps professionals involved in wound care to uniformly judge DSWs in order to improve the care for patients with these wounds.

METHODS

Digital photographs

To assess inter-observer agreement using the RYB-scheme, we obtained digital photographs of DSWs from Dutch hospitals via a national wound care network. We used photographs rather than in vivo observations to avoid observers judging the
same wounds at different moments during the healing process, which could affect the reliability of the study. Furthermore, using photographs was obviously the only way to get an international group of observers to judge the same wounds.

A first selection of high-quality and representative photos was made by our hospital’s Wounds and Pressure Ulcer Committee, consisting of experienced plastic and general surgeons and specialized wound care nurses. Representative photographs were defined as those demonstrating wounds in various stages of wound healing and reflecting the six possible combinations of color (red, yellow, and black) and moistness (dry or wet).

We used these two mutually exclusive categories for moistness because photographs hardly allow discernment of the three levels of wound moistness (dry, moist, or wet) according to the RYB-scheme. In addition, we created an extra category, i.e. “completely healed” DSWs. This was defined as complete re-epithelization of the skin without defects or scabs.

Finally, a set of 23 representative photographs was converted into a slide presentation.

Observers
The 23 slides were judged by a selected group of internationally renowned scientists in wound care, as well as groups of doctors (surgeons, plastic surgeons, trauma surgeons, residents and research fellows), surgical nurses, and specialized wound care nurses of the Dutch wound care network and employed by different Dutch hospitals or community care. These latter groups were considered a representative sample of those who clinically judge DSWs in real life.

Judgment procedures
Judgment of the slides took place during a national meeting of specialized wound care nurses and during a presentation to our local department of surgery, using electronic voting devices: ResponseCard™ keypads linked to TurningPoint for Microsoft® PowerPoint® (Turning technologies, Ohio, USA, version: 4.1.0.9020). Each wound slide was presented for 15 seconds to be judged. During these sessions we emphasized the observers should enter their judgments independently and without discussion during the presentation.

Secondly, we distributed 35 CDROMs with the slide presentation (also programmed to show each slide for 15 seconds) and a scoring form to doctors and nurses of 12 Dutch medical centers and the international group of scientists.

Before viewing the DSW slides all observers were given the same instructions about the RYB-scheme and definitions used by means of a few introductory slides.
All observers were blinded to additional information about wound and patient characteristics.

We also collected basic demographic data from the various observer groups, including their age and educational level.

Data analysis

Inter-observer agreement (IOA) according to the RYB-scheme among scientists, doctors, specialized wound care nurses, and nurses involved in DSW care was expressed as group kappa (k) values. These were calculated using AGREE for Windows version 7.002 (Science plus Group, Groningen, The Netherlands). K-values lie between 0 and 1. A k-value above 0.8 is interpreted as 'very good', between 0.8 and 0.6 is 'good', between 0.6 and 0.4 'moderate' and below 0.4 'poor'. We calculated group k-values including 95% confidence intervals to assess the IOA in the groups of scientists, doctors, specialized nurses and surgical nurses. We imputed missing values by the median value (i.e. the most common answer for each slide) of the judgment of a slide to assess the effect of any missing value on the resulting k-values. If more than 50% of the answers were missing, the data of this observer were excluded from the analysis.

Next to the overall IOA as to wound color and moistness, we also calculated the group k-values using wound color or moistness or complete healing separately, to see whether one of these characteristics were easier to assess. For wound color agreement four categories were used (i.e. completely healed wounds and red, yellow, and black wounds), while for the agreement on moistness two categories were used (i.e. dry and wet).

RESULTS

Eventually, 11 international wound care scientists (from Canada, Australia, UK, USA, Switzerland, New Zealand, and the Netherlands), 31 doctors from five Dutch hospitals, 55 Dutch specialized wound care nurses and, 28 surgical nurses from 12 Dutch hospitals contributed. The characteristics of the four groups are shown in Table 1.

Completeness of data

None of the observers had to be excluded from the analysis due to >50% missing answers. In total, 45 out of 2875 (1.5%) answers were missing and were therefore imputed. Most of the answers missing were found among the specialized wound care nurses (32/1265; 2.5%), followed by nurses (7/644; 1.1%), and doctors (6/713; 0.8%). No missing answers were found among the scientists.
Inter-observer agreement

An overview of the IOA among the different observer groups is shown in Figure 1. Overall agreement regarding the classification of DSWs was moderate at best. IOA among specialized wound care nurses ($k = 0.41$, 95% CI 0.33 to 0.49) tended to be higher than those among scientists, doctors, and surgical nurses, who showed a poor agreement. Conversely, IOA among the scientists were always lower than those among the other observer groups. These observations were also true for the IOAs based on “color” only, “moistness” only, and “complete healing” only IOA for all four observer groups were best when judging moistness and complete healing. Surgical doctors generally scored higher IOAs than surgical nurses.

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Median age category</th>
<th>Professional background</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientists</td>
<td>11</td>
<td>41-50</td>
<td>Surgeon Plastic surgeon Vascular surgeon</td>
</tr>
<tr>
<td>Doctors</td>
<td>31</td>
<td>&gt;31-40</td>
<td>Surgeon Plastic surgeon Vascular surgeon</td>
</tr>
<tr>
<td>Spec. nurses</td>
<td>55</td>
<td>41-50</td>
<td>Nurse practitioner Wound consultant Wound and decubitus nurse</td>
</tr>
<tr>
<td>Nurses</td>
<td>28</td>
<td>&lt;30</td>
<td>Ward manager Senior staff nurse Nurse (RN)</td>
</tr>
</tbody>
</table>

Figure 1. Inter-observer agreement among the four observer groups
Is the red-yellow-black scheme suitable to classify donor site wounds?

**DISCUSSION**

This inter-observer study showed that the RYB-scheme, based on wound color and moistness, does not appear useful to uniformly classify donor site wounds. The inter-observer agreement was moderate at best when assessed by specialized wound care nurses. Judging only wound color, moistness, or complete wound healing only slightly improves judgment agreement among each of the four groups of professionals.

Present findings are in contrast with previous studies which are performed regarding the classification of (open) surgical -and chronic wounds according to the RYB-scheme. These studies found a moderate to good agreement. Agreement in judgment as found here about whether a DSW is completely healed is in accordance with the study of Margolis et al. They found a good agreement in chronic wounds based on the definition of wound healing according to the Wound Healing Society. We also strictly predefined the definition of completely healed wounds because wound healing is frequently based on subjective assessments of wound closure by care providers and scientists.

Although DSWs of SSGs are surgical wounds, the variation in the appearance of DSWs is probably too small to make a proper distinction based on the RYB-scheme. Indeed, the majority of DSWs are red wounds, in which infection (with yellow slough) is rare, and which virtually never lead to black necrosis. When variation is small, agreement is supposed to be larger and this is taken into account when kappa values are calculated. This may be the reason why our kappa values may be an underestimation and are therefore in contrast with previous studies. Additionally, our kappa values could be underestimation of the truth in daily wound care practice, because in real life situations many more elements can be taken into account, including patient characteristics. The difference in IOA between in vivo and in vitro situations for health care workers is difficult to assess. Doctors and nurses are not
able to classify DSWs simultaneously, but after a certain time lapse, in which wound characteristics could have changed. Furthermore, even if photographs are harder or easier to judge than in vivo, our results do not differ substantially. However, it may also overestimate the true values for agreement. The observers were instructed about the definitions of the categories used in the RYB-scheme before assessing the slide presentation. There are some limitations to this inter-observer agreement study. First, the photographs we used for assessment of DSWs were taken with different digital cameras. This is not the same as clinically judging DSWs in real life. However, there is evidence that selected photographs can be assessed in a reliable way based on studies with different classification schemes\(^9,22\). Second, wound and patient characteristics, such as age, comorbidity, time interval after graft take, presence of odor or pain, were not available. Awareness of clinical information provides indirect knowledge and may influence the observer’s decision\(^18\). For example, it is easier to make a distinction between dried blood and black necrosis if it is known how many days after graft take the photograph is taken. Third, determination of validity is usually accomplished by comparing the measurement against a reference standard. In this study a reference standard was lacking, so the correctness of the judgments as made by the four groups of professionals could not be verified.

Present day reality is that there is no reliable scheme for the assessment of DSWs, although a lot of classification schemes are used in clinical practice (e.g. RYB, TIME, and MEASURE) for acute and chronic wounds. Most chronic wounds are seldom uniform in color\(^7\). However, this does not appear to be the case for DSWs, which are usually red, well granulating and quickly healing wounds. Despite this uniformity, based on national surveys, large variation was found among health care workers regarding the dressing materials currently in use to cover DSWs\(^15,16\). Apparently, a uniform ‘standard’ wound is not associated with a uniform assessment and dressing choice for DSWs.

We conclude that the RYB-scheme appears to be unreliable in daily clinical practice to classify DSWs and to guide treatment decisions. These findings call for a new evidence-based classification scheme to assess DSWs in a uniform manner.
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REFERENCES


