Utility of the Sussman Wound Healing Tool in Predicting Wound Healing Outcomes in Physical Therapy

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Abstract

Data demonstrate that the Sussman Wound Healing Tool (SWHT) is effective both as a diagnostic tool that differentiates level of healing and as a predictive measure that determines treatment outcomes.

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THE ABILITY TO PREDICT PRESSURE ulcer healing and treatment outcomes in physical therapy has yet to be reliably effected. Prediction of pressure ulcer treatment outcomes is essential to clinical decision making and triage, and it provides improved utilization management to payers and providers. Current measurements of pressure ulcer healing (Table 1) fail to demonstrate consistent ability to predict outcomes or to monitor the healing response to treatment.[1,2,3]

Risk assessment instruments have been successful in predicting development of pressure ulcers (Norton[4] and Braden[5] scales) but not in predicting wound healing. The Sussman Wound Healing Tool (SWHT) was developed as a diagnostic tool to predict and track over time the effectiveness of physical therapy technologies used for wound healing.

Table 1
HISTORICAL MEASURES OF PRESSURE ULCER IMPROVEMENT

Measures	Definitions
Change in ulcer size	• Area (lengthxwidth) • Depth (for volume) • Perimeter/circumference
Surface appearance	• Red • Yellow • Black
Tissue type	• Necrotic • Granulation • Epithelial • Singly or in combination
Surrounding skin characteristics	• Erythema (color change) • Edema • Undermining or tunneling

The tool

The SWHT is based on an acute wound healing model to highlight the chronological relationship of tissue status and size. The acute wound healing model[6] describes tissue status and size in various wound healing phases. Some of the variables used to describe the wound phase might be considered negative (that is, a variable such as necrosis is thought to be the antithesis of healing), whereas wound variables such as fibro-

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Table 2
CATEGORICAL VARIABLES AND WOUND TISSUE ATTRIBUTES IN SWHT

SWHT variable	Categorical tissue attribute	Attribute definition	Rating	Relationship to healing
1	Necrosis	All type of necrotic tissue including eschar and slough	Present or not present	Not good
2	Undermining	Includes both undermining and tunneling	Present or not present	Not good
3	Maceration	Softening of a tissue by soaking until the connective tissue fibers are soft and friable	Present or not present	Not good
4	Erythema	Reddening or darkening of the skin compared to surrounding skin; usually accompanied by heat	Present or not present	Not good
5	Hemorrhage	Purple ecchymosis of wound tissue or surrounding skin	Present or not present	Not good
6	Fibroplasia—significant reduction in depth	Pink/red granulation tissue filling in the wound bed, reducing wound depth	Present or not present	Good
7	Appearance of contraction	First measurement of the wound drawing together, resulting in reduction in wound open surface area	Present or not present	Good
8	Sustained contraction	Continued drawing together of wound edges measured by reduced wound open surface area	Present or not present	Good
9	Adherence at wound edge	Continuity of wound edge and the base of the wound	Present or not present	Good
10	Epithelialization	Appearance and continuation of resurfacing with new skin or scar at the wound edges or surface	Present or not present	Good

plasia and adherence are considered directly related to an improved wound status. The tool was intended to be used as a benchmark as the wound recovered or healed in phases.

The initial SWHT produced a qualitative instrument. A wound would be described as having certain of the attributes. Subsequently, each SWHT variable was assigned a numeric score, quantified and ranked as *not good* and *good*—producing a quantitative tool. SWHT variables were scored as either *present* or *not present*. In total, 21 variables from the data set were defined. The resulting SWHT is comprised of 10 categorical variables of wound attributes (Table 2) combined with 11 variables of location, acute wound healing phase, and extent of tissue damage (Table 3).

Testing was performed in a long-term–care facility by physical therapists and physical therapy assistants. All wound patients were managed using the SWHT on a weekly basis. Cases qualified for analysis if data were recorded for at least a baseline and a 2-week data point. A total of 112 completed cases were collected over 18 months.

Once a case was closed, it was labeled as *healed* or *not healed* at time of discharge from physical therapy care. The 112 completed cases were then divided into two groups: Group I (healed), comprising 40.5% of total cases, and Group II (not healed), comprising 58.5% of total cases (1% of cases were excluded from analysis because they were seen for less than 2 weeks).

Table 3
SIZE, LOCATION, AND MEASURES OF WOUND HEALING PHASE

SWHT variable	Item description	Rating
11	General wound depth—at least 0.2 cm	Measured as present or not present
12-15	Depth	Measured in cm at four points of clock: 12, 3, 6, 9
16-19	Undermining/tunneling	Measured in cm at four points of clock: 12, 3, 6, 9
20	Wound location	Heel, hip, coccyx, buttock, foot, upper body
21	Wound healing phase	Inflammation, proliferation, epithelialization, and remodeling

Table 4a
KW FINDINGS:
WOUND ATTRIBUTES
Status of dependent (outcome) variable at discharge

Independent variables	Week 0 (significant)	Week 2 (significant)
1. Necrosis		0.5
2. Undermining		0.5
3. Maceration		
4. Erythema		
5. Hemorrhage	0.5	
6. Fibroplasia		
7. Appearance of contraction		0.5
8. Sustained contraction		
9. Adherence		0.5
10. Epithelialization		0.5

Table 4b
KW FINDINGS:
LOCATION, WOUND HEALING PHASE, EXTENT
Status of dependent (outcome) variable at discharge

Independent variables	Week 0 (significant)	Week 2 (significant)
11. Wound site	0.5	0.5
12. Wound healing phase		0.5
13. Depth at 12 o'clock		0.5
14. Depth at 3 o'clock		0.5
15. Depth at 6 o'clock	0.5	0.5
16. Depth at 9 o'clock		0.5
17. Undermining at 12 o'clock		0.5
18. Undermining at 3 o'clock		
19. Undermining at 6 o'clock		0.5
20. Undermining at 9 o'clock		0.5
21. General depth		0.5

The data points used for the preliminary analysis were baseline, week 0, week 2, and week 4.

Individual variables were typed, based on the attributes associated with the acute wound phase healing model. Variables that were considered *good for healing* were epithelialization, sustained contraction, appearance of contraction, fibroplasia, and adherence of wound edges. Variables related to failure to heal or *not good for healing* were hemorrhage, maceration, undermining, erythema, and necrosis. A weight item analysis demonstrated differences in predicting wound healing. For this analysis, 111 of the 112 cases were included, with 383 evaluations of tissue variables.

Outcome analysis

Two outcome questions were tested. The first analysis focused on the predictive capability of the SWHT (Tables 4a and 4b). The second identified the correlational importance of an item or item set to the outcome (Table 5).

The Kruskal-Wallis (KW) statistical test was used to determine predictive capability of tissue type. The KW test is a nonparametric, one-way analysis of variance (ANOVA) that is applicable when the groups are independent, dependent variables are ordinal, independent variables are noninterval, and population normality is not

assumed. As is seen in Tables 4a and 4b, there is a significant difference in findings for Group I (healed) and Group II (not healed). Group data suggest (at .05 alpha) that at week 0, the presence of hemorrhage and the location of the wound indicated an unfavorable outcome. At weeks 2 and 4, many variables (necrosis, undermining, wound healing phase, and depth), indicated a potentially unfavorable outcome.

Although the first analysis is suggestive of a predictive tool, a more precise relationship between the individual variables, time, and outcome is needed. A Rasch analysis (a weighted-interval analysis) was conducted for wound healing and for ranking variables in order of importance. The Rasch analysis used the categorical data to assign a vertical scale ranking by severity and healing by tissue types.

Variables determined to be *not good for healing* were ranked in ascending order of importance: hemorrhage and maceration, followed by undermining, erythema, and necrosis (Table 5). Of the variables considered *good for healing*, the lowest ranking was adherence, followed by fibroplasia, appearance of contraction, and epithelialization.

Discussion

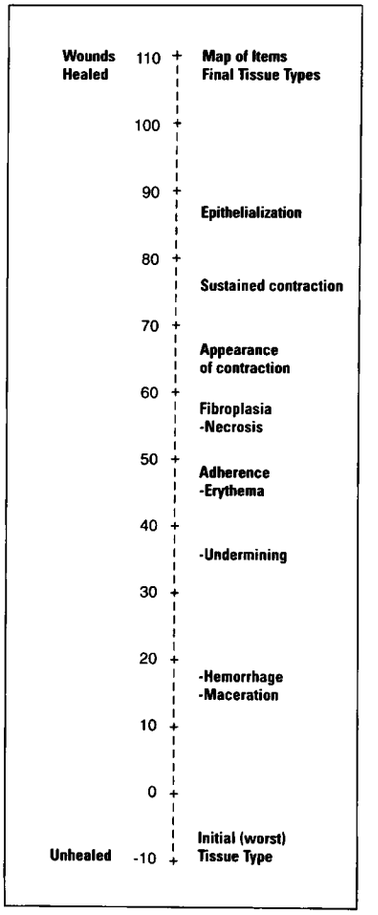
The results of the KW statistical test demonstrate: (1) correlational validity between two groups (those that healed and those that did not heal) and the attributes tested, and (2) predictive validity for 21 variables related to healing.

The significance of the findings of the Rasch analysis of the SWHT is that the wound healing progression for pressure ulcers follows the trajectory of healing described in the acute wound healing model by tracking change in tissue status over time. Rearrangement of the attributes on the assessment form to correspond to the ranking of severity demonstrated by the Rasch analysis is now in order. The next step will be to give numeric scores to the 10 attributes based on the weighted analysis.

The SWHT relies primarily on visual observation skills, is not reliant on accuracy of linear measurements or arithmetic calculations, and has the capability of predicting outcomes and measuring change in tissue status and size (i.e., depth and undermining) over time. Therefore, the SWHT is capable of predicting and monitoring pressure ulcer healing quickly and acurately.

Achievements from the preliminary analysis of the SWHT include: definition, ranking, ordering for importance of the key variables, and identifying the key risk factors that predict nonhealing of pressure ulcers. Statistical analysis shows statistical validity and the ability to predict and monitor pressure ulcer healing. The SWHT is a diagnostic tool that differentiates between healing severity and level of healing and will provide a score if tissue attributes are present or absent. There is rigor to the findings and confidence in the data set. Further analysis is underway, and a scoring system will follow.

Table 5
RASCH ANALYSIS



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