

1990

A Comparison of Predictive Validity of the Norton Scale, the Daly Scale and the Braden Scale

Sharon L. Marini
Grand Valley State University

Follow this and additional works at: <http://scholarworks.gvsu.edu/theses>

 Part of the [Nursing Commons](#)

Recommended Citation

Marini, Sharon L., "A Comparison of Predictive Validity of the Norton Scale, the Daly Scale and the Braden Scale" (1990). *Masters Theses*. 121.
<http://scholarworks.gvsu.edu/theses/121>

This Thesis is brought to you for free and open access by the Graduate Research and Creative Practice at ScholarWorks@GVSU. It has been accepted for inclusion in Masters Theses by an authorized administrator of ScholarWorks@GVSU. For more information, please contact scholarworks@gvsu.edu.

A COMPARISON OF PREDICTIVE VALIDITY
OF THE NORTON SCALE, THE DALY SCALE
AND THE BRADEN SCALE

By

Sharon L. Marini

A THESIS

Submitted to
Grand Valley State University
in partial fulfillment of the requirements for the
degree of

MASTER OF SCIENCE IN NURSING

Kirkhof School of Nursing

1990

Thesis Committee Members:

Associate Professor Patricia Underwood, PhD, RN

Assistant Professor Kay Setter Kline, PhD, RN

Assistant Professor Cindie Peterson, MA, OTR

ABSTRACT

A COMPARISON OF PREDICTIVE VALIDITY OF THE NORTON SCALE, THE DALY SCALE AND THE BRADEN SCALE

By

Sharon Marini

The purpose of this study was to compare the predictive ability of three tools (the Norton Scale, the Braden Scale and the Daly Scale) to predict risk of skin breakdown in a hospitalized population. Neuman's theoretical framework served as the organizational framework for the study.

A convenience sample of 27 patients who were admitted to one of three medical/surgical floors in an acute care hospital were selected for the study. The Braden Scale and the Norton 14 each identified 50% of those subjects who developed pressure ulcers. The Norton Scale 12 identified 96% of those subjects without pressure ulcers who were not predicted and had the lowest false positive rate at 4%. The lowest false negative rate was scored by the Braden and Norton 14 at 50%. The Norton 12 scored highest at 33% for predictive value of a positive test while all three scales scored high at 95% and 96% for predictive value of a negative test.

ACKNOWLEDGEMENTS

This thesis was completed because of the support of many people. I wish to express my deep gratitude to my husband, Ken, and my daughters, Susan and Becky, for their support, encouragement and patience throughout my graduate program.

A special thank you to my thesis committee, Dr. Patricia Underwood, Dr. Kay Setter Kline, and Cindie Peterson, whose combined efforts greatly aided in the completion of this thesis; and especially to my thesis chairperson, Dr. Patricia Underwood, whose professionalism, guidance, and expertise assisted me so greatly in preparation and presentation.

Many thanks to my classmates whose support and encouragement during difficult times inspired me to continue.

A big thank you to Sue Stelton, who was instrumental in assisting me through the Institutional Review Board process and securing three data collectors, Mimi Snyder, Priscilla Beaver, and Betty Daniels, who so willingly collected data for approximately four months.

I also wish to thank Memorial Hospital of South Bend and its staff who provided a setting for data collection and received me so warmly.

TABLE OF CONTENTS

List of Tables.....	vi
List of Figures.....	vii
List of Appendices.....	viii

CHAPTER

1	INTRODUCTION.....	1
2	Literature and Theory.....	5
	Norton Scale.....	5
	Braden Scale.....	10
	Daly Scale.....	13
	Other Studies.....	14
	Theoretical Framework.....	17
	Definition of Terms.....	23
3	Methodology.....	25
	Design and Sample.....	25
	Instruments.....	27
	Procedure.....	29
4	Data Analysis.....	32
	Sample.....	32
	Daly Scale.....	38
	Norton Scale.....	39
	Braden Scale.....	42

TABLE OF CONTENTS
(Continued)

5	Discussion.....	44
	Summary and Conclusion.....	52
	Clinical Implications.....	62
	Limitations and Recommendations.....	63
	REFERENCES.....	67
	APPENDICES.....	71

List of Tables

Table 1	Comparison of Validity Characteristics as Computed by Ira (1987).....	9
2	Comparison of Ranges of Validity of Past Studies.....	28
3	Distribution of Patients in Sample as to Floor, Race, Gender, and Medical Diagnosis.....	35
4	Comparison of Validity of Three Rating Scales.....	36
5	Comparison of Age, Diagnosis, Unit of Assignment of Patients Who Exhibited Pressure Sores.....	38
6	Comparison of True Positive, True Negative, False Positive, and False Negative Scores of the Three Rating Scales.....	40
7	Cost Comparison of Preventive Measures.....	45
8	Comparison of Cost Per Day of Instituting Aggressive Measures of Prevention for False Positive Predictions in This Study.....	46

List of Figures

Figure 1	A Conceptual Schema for the Study of the Etiology of Pressure Sores.....	11
Figure 2	Neuman's Systems Model.....	20
Figure 3	Frequency Distribution of Age.....	33
Figure 4	Calculating Sensitivity and Specificity.....	47
Figure 5	Subjects Who Used Protective Devices.....	49
Figure 6	Comparison of Pressure Sore Development to Age.....	52
Figure 7	Comparison of Gender and Age of Those Subjects Who Developed Pressure Sores.....	52
Figure 8	Comparison of Sensitivity.....	54
Figure 9	Comparison of Specificity.....	55
Figure 10	Comparison of False Positive Rate.....	56
Figure 11	Comparison of False Negative Rate.....	57
Figure 12	Comparison of Predictive Value of a Positive Test.....	58
Figure 13	Comparison of Predictive Value of a Negative Test.....	60

List of Appendices

Appendix A Norton Scale.....	71
Appendix B Norton Scale with Descriptors.....	72
Appendix C Larson Formula.....	73
Appendix D Braden Scale.....	74
Appendix E Daly Scale.....	75
Appendix F Verbal Script.....	76
Appendix G Informed Consent.....	77
Appendix H Demographic Data.....	78
Appendix I Monitoring and Skin Protection Tool.....	79
Appendix J Skin Assessment Tool.....	80

CHAPTER 1
INTRODUCTION

Pressure ulcers (pressure sores, decubitus ulcers) are an all too common nursing care problem. They cause pain to the patient, they require hours of nursing time and they are expensive to treat. In 1979, a study by Robinson estimated the medical and nursing costs of treatment to be near \$35,000 per patient (Brown, Boosinger, Black & Gaspar, 1985). In a prior study by Sather, Allen & George (1977) costs had been estimated to be between \$15,000 and \$30,000 per patient. With rapidly escalating health care costs, the price is sure to be higher today.

There is likely to be a higher incidence of pressure ulcers in the elderly because they are living longer and may have illnesses which in the past have been fatal. The geriatric population was studied by Brown et al. (1985) who estimated the frequency of pressure ulcers to be between 11% and 33%, while in neurological patients Daechsel & Conine (1985) reported an incidence of 30% to 60%. More recently Linares, Mawson, Suarez & Biundo (1987) reported that 40% of spinal cord injury patients developed pressure ulcers. Pajik, Craven, Cameron-Barry, Shipps & Bennum (1986) state that seven to eight percent of deaths to these

patients was due to pressure ulcers. Maklebust, Mondoux & Siergreen (1986) estimate that in U.S. hospitals, the annual incidence of pressure ulcers is from three percent to five percent or between approximately 1.1 and 1.8 million patients per year. This is a significant health care problem. As the elderly live longer the incidence of pressure ulcers will likely increase and cost of treatment of pressure ulcers is also likely to continue to increase.

The assessment of skin integrity and estimation of risk problems is a first step in the nursing management of skin problems. The treatment and prevention of pressure ulcers has been considered to be in the domain of nursing. In December 1989, a new agency under the Department of Health and Human Services Public Health Service was created: The Agency for Health Care Policy and Research (AHCPR). This agency is focused on encouraging research related to the quality, delivery and costs of health services. AHCPR also focuses on the effectiveness and outcomes of health care services and is developing guidelines for the management of clinical conditions. In February 1990, members of the agency met with nursing experts to discuss the nursing implications of this initiative. The nurses identified three areas where there is sufficient scientific data to validate nursing's management of clinical problems. These include skin problems, pain and urinary incontinence.

The initiation of a valid tool to predict skin breakdown would be useful in identifying patients who are at

risk for development of pressure ulcers. Preventative measures could then be implemented which would potentially reduce patient pain, emotional trauma, and health care costs. Although treatment and prevention costs vary from one health care facility to the next, the range in dollars is from the cost of time that it takes one to two nurses to turn a patient to the cost of an expensive mattress or bed which may be as much as \$160.00 or more per patient per day. Standard nursing care for the prevention and treatment of pressure ulcers includes turning the patient every two hours, massaging bony prominences with lotion and keeping the skin clean and dry. For those patients who are at high risk, more aggressive measures for prevention may be taken. High risk patients are identified as thin, elderly, incontinent, and immobile. More aggressive measures may include turning, massaging and keeping the skin dry every one hour, sheepskin under suspect skin areas, and special mattresses (e.g., eggcrate, Soft-Care) or special beds (e.g., Ken-Air, Fluid-Air).

Prevention of pressure ulcers is less costly than treating them. When treating pressure ulcers, standard care needs to be done in addition to dressing changes three to four times a day, extra charting and documentation, wound cultures, possible whirlpool baths or hyperbaric oxygen chamber, surgical debridement, pain medication, antibiotics, explanations to family, and a special mattress or bed. Length of stay may also need to be extended.

Currently, several tools have been proposed to predict risk of pressure ulcers and varying results have been reported. The testing of these tools has not always been done in carefully controlled conditions. Control can be compromised when more than one nurse collects data for the tool being tested. Bias can be introduced when the same nurse may have also completed the visual skin assessment. Differences in the simplicity and ease of use of the tools contribute to differing results. Variations in methodology and results underscore the need to compare and evaluate the various tools more directly.

This study sought to answer the question: how do the Norton Scale (1962), the Braden Scale (Bergstrom 1987) and the Daly Scale (1985) compare in their ability to predict the risk of skin breakdown. The major purpose of this study was to compare the predictive validity of the Norton Scale, the Braden Scale and the Daly Scale in a convenience sample of 30 patients admitted to three medical-surgical floors of an acute care hospital. The second purpose was to institute greater control in the design of this comparison.

To enhance the methodology, this study controlled for bias by using a different data collector for each tool and yet another data collector for skin assessment. All four data collectors remained blind to the results of each other. Each data collector was assigned a tool to be used throughout the study.

CHAPTER 2

Literature and Theory

Pressure ulcers are a challenging and frustrating problem to the people who develop them and to the caregivers. Many studies have been done related to prevention and treatment of pressure ulcers. Some studies attempted to identify factors which correlated with skin breakdown. Other studies attempted to develop predictive tools giving consideration to factors which influence accuracy of prediction, reliability, and ease of use. The three tools that were tested in this study were the Braden Scale, the Norton Scale, and the Daly Scale. The Norton and Braden scales have been discussed in the literature while the Daly Scale has been developed and tested on a more local basis. This study compared the three tools (Braden, Norton, and Daly Scales) in their ability to predict risk of skin breakdown. Several people have attempted to incorporate various combinations of factors into the tools to be used by nurses to predict skin breakdown. Discussion of the three scales will focus on findings from previous research. A discussion of Neuman's (1972) theoretical framework that was used in this study will follow. Definition of terms significant to this study will then be explained.

The Norton Scale

Some of the first nursing researchers to develop a patient scoring system to identify risk factors for the

development of pressure ulcers were Norton, McLaren & Exton-Smith (1962). The purpose of the tool was early identification of patients at risk to develop pressure ulcers. The assessment form (Appendix A) was simple. The developers stated that the tool was reliable in evaluating a patient's general condition and risk of developing pressure ulcers; however, data was not provided to support this claim. Scores ranged from a maximum of 20 for a patient with very little risk to a minimum of 5 for a patient with high risk. Categories included physical condition, mental condition, activity, mobility, and incontinence. A scoring system was implemented in which a total score of 14 or less indicated the patient was at risk; if the score was lower than 12, the risk was great. In one study composed of 250 patients who were admitted to a hospital without pressure ulcers, fifty-nine (24%) developed pressure ulcers while hospitalized. Thirty-four percent developed pressure ulcers within one week, while 70% developed pressure ulcers within two weeks. The study showed a positive relationship between a lower score and the development of pressure ulcers. Fifty percent of the patients with scores less than 12 developed pressure ulcers compared to 5% of those patients with scores of 18 to 20. The number of patients with pressure ulcers may have been higher, but many patients with the lowest scores died within a few days of admission. The average score of all patients developing pressure ulcers was 12.9. Those clients who did not develop pressure ulcers had an

average score of 15.7. The clients who did, had an average score of 11 compared to 14.9 for those clients who were discharged from the hospital.

Lincoln, Roberts, Maddox, Levine and Patterson (1986) studied 73 patients over 65 years of age using descriptors with the Norton Scale (Appendix B). The percentage of interrater agreement rose from 88% to 100% in the first three weeks, then decreased to 60% in the fourth week with an average percentage of agreement regarding risk to be 84.75% for four weeks. Five experts in medical-surgical nursing practice were asked to determine content validity. Responses were both negative and positive. Three respondents agreed that the tool identified patients at risk, but two of them expressed reservations. One of these experts believed that the terms were not well defined and the other believed that nutritional status was important and should be a separate category. The other two respondents questioned the accuracy of the instrument. The fifth expert believed the tool would be worthwhile if the categories were worded differently.

Predictive ability of the Norton Scale was studied with a sample of 36 patients aged 65 to 89 years. Validity scores (Table 1) were calculated by Ira (1987) using the Larson (1986) formula (Appendix C). The findings were as follows: specificity (proportion of patients who do not have pressure ulcers who have a negative test) of 94%, predictive value of a negative test (proportion of patients

who have a negative test who do not have pressure ulcers) of 85%, and misclassification (those incorrectly classified) rate of 19%. Not all validity calculations could be computed because the at risk patients did not develop pressure ulcers. Results showed no statistically significant difference between patients who developed pressure ulcers and those who did not. This study showed limitations in face validity, interrater agreement and predictive validity (Lincoln et al. 1986).

Norton, McLaren and Exton-Smith (1962) did not present figures for predictive validity, but Ira (1986) computed predictive validity (Table 1) using data from the Norton, McLaren and Exton-Smith study. Ira, using the Larson formula, computed a sensitivity (proportion of patients who have pressure ulcers who have a positive test) of 63%, a specificity of 39%, the predictive value of a positive test (proportion of patients who have a positive test who have pressure ulcers) of 39%, the predictive value of a negative test of 86% and a misclassification rate of 33%.

Roberts and Goldstone (1979) used the Norton Scale in a study of 64 orthopedic patients 60 years of age or older. Predictive ability of this study was calculated (Table 1) by Ira (1986) as follows: sensitivity of 92%, specificity of 57%, a predictive value of a positive test of 38%, a predictive value of a negative test of 96% and a misclassification rate of 34%.

Table 1

Comparison of Validity Characteristics of
Pressure Sore Studies Calculated by Ira (1987).

Study	Characteristic				
	% Sensitivity	% Specificity	% Predictive value of positive	% Predictive value of negative	% Misclassification rate
Norton, McLaren, & Exton-Smith (1962)	63	39	39	86	33
Roberts, & Goldstone (1979)	92	57	38	96	34
Goldstone, & Goldstone (1982)	88	36	53	80	40
Lincoln, Roberts, Maddox, Levine, & Patterson (1986)	--	94	--	85	19
Bergstrom, Braden, Laguzza, & Holman (1987)	* 100A + 100B	90 64	-- -- --	-- -- --	-- -- --
Bergstrom, Demuth, & Braden (1987)	83	64	--	--	--
Daly (1987)	86	100	100	98	2
	* First Study	+ Second Study			

A study of the Norton Scale by Goldstone and Goldstone (1982) investigated the predictive value of routine admission data, the Norton Scale and some variations of the

Norton Scale. Their sample contained 40 patients over 60 years of age on an orthopedic ward. Predictive validity demonstrated sensitivity of 89% and specificity of only 36%. Ira (1987) calculated (from their data) the predictive value of a positive test to be 53% and a predictive value of a negative test to be 80%. This study also reported a total misclassification of 40% for predicting pressure ulcers that did not materialize.

Conclusions were that the Norton Scale was a reliable guide to the incidence of pressure ulcers (63% sensitive), but had a tendency to overpredict (33%). A limitation of the Goldstone and Goldstone study was its selection method of every other patient after a random selection of the first patient.

The Braden Scale

The Braden Scale (Bergstrom 1987) was developed to provide early identification of patients at risk for acquiring pressure ulcers. The Braden Scale is composed of six subscales that may be rated from 1 to 4 with a score of 1 reflecting high risk and a score of 4 indicating no risk. The subscales reflect sensory perception, moisture, activity, mobility, friction and shear, and nutritional status (Appendix D). Scores range from 6 to 24 with 6 indicating high risk and 24 no risk.

Bergstrom, Braden, Laquzza and Holman (1987) presented a conceptual schema (Figure 1) for depicting factors in etiology of pressure ulcers. Critical determinants of

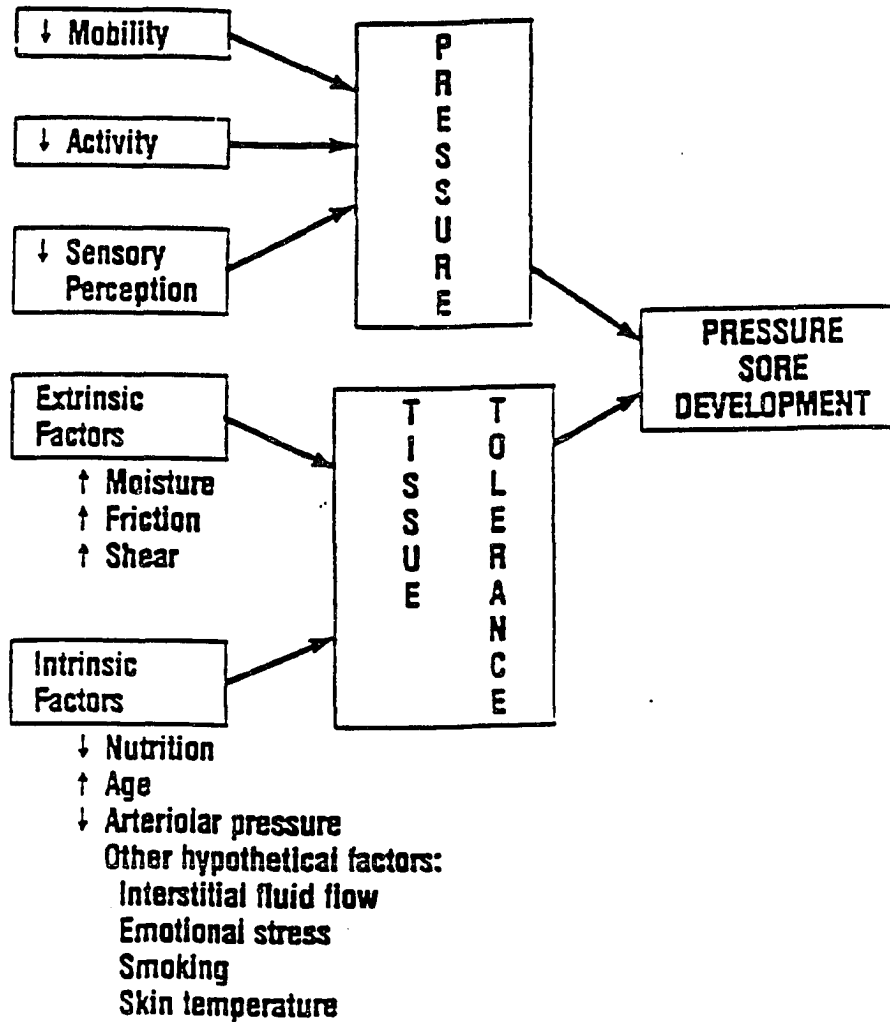


Figure 1. A conceptual schema for the study of the etiology of pressure ulcers.

Source: Braden, B. & Bergstrom, N. (1987). A conceptual schema for the study of the etiology of pressure ulcers. Rehabilitation Nursing, 12(1), 9.

pressure ulcer development are considered pressure and tissue tolerance. Sensitivity and specificity were tested in two studies. The first study consisted of 99 patients of which seven patients (7%) developed pressure ulcers. The Braden Scale predicted sensitivity at 100% and specificity at 90% for that study. In the second study, 100 patients were assessed and nine patients (9%) developed pressure ulcers. Sensitivity was calculated to be 100% while specificity was calculated at 64% (Table 1) in the second study.

Three reliability studies were completed by Bergstrom et al. (1987). In study number one, a registered nurse and a graduate student rated 20 patients ages 55 to 96 in a nursing home. Results using the Pearson product moment correlation between observers was $r=.99$, $p<.001$ (degrees of freedom were not available). In study number two, licensed practical nurses (LPN) and nursing assistants (NA) rated the patients in the same setting. A sample of 54 patients was randomly drawn. Correlations of total Braden Scale scores were calculated. Reliability of scores assigned by both LPN and NA ranged from a low of $r=.83$, $p<.001$ for the day shift to a high of $r=.87$, $p<.001$ for the evening shift. In study number three, a different geographical region was used. The raters were four LPN's and NA's from the day and evening shifts. The sample consisted of 50 patients. Correlations computed using pairs of raters were as follows: one LPN on the day and evening shift was $r=.93$, $p<.001$; one LPN and NA on the day shift was $r=.94$, $p<.001$.

Bergstrom, Demuth and Braden (1987) studied 60 consecutive admissions to an adult intensive care unit and reported the sensitivity of the Braden Scale to be 83%, specificity to be 64%, predictive value of positive scores of 61% and predictive value of negative scores of 85%. Construct validity of the scale continues to be evaluated.

The Daly Scale

The Daly Scale (1985) was developed to provide objective criteria for assigning patients to Clinitron or Mediscus beds in an acute care setting. The Daly Scale has 8 categories which may be rated from 1 to 4. It is a revised and expanded version of the Norton Scale. Parameters include physical condition, mental condition, activity level, mobility, moisture contamination of skin, nutrition and fluid, presence of disease with inherent potential for alteration in skin condition, and cardiovascular state (Appendix E). Scores range from a maximum of 32 for those who are at the least risk to a minimum of eight for those who are at the greatest risk. A chart audit of 25 patients with a diagnosis of craniotomy without trauma was completed by Daly in 1985, comparing the Daly Scale with the Norton Scale. This study found that the Daly Scale was more accurate in predicting if pressure ulcers would develop (Ira, 1987). For this study, sensitivity was calculated at 86%, specificity was

calculated at 100%, predictive value of a positive test at 100%, predictive value of a negative test at 98%, and a misclassification rate of 2% (Table 1).

The Daly Scale (1985) was examined to determine content validity by four experts. Criticisms were as follows: use of activities of daily living for the physical condition rating made this category conceptually the same as the category for mobility; categories with multiple indicators were not mutually exclusive; and a hemoglobin of less than 10 is more serious for men than women. Two experts felt that instead of adding more categories, it would be more productive to concentrate on directly related factors such as pressure and circulation. One expert gave an excellent rating (Ira, 1987).

Other Studies

Many studies have been conducted to determine etiology, risk factors, and predictive tools for pressure ulcers. Bereck (1975) classified the etiology of pressure ulcers in five categories as follows: 1. physical factors which includes pressure (compression), shearing force, heat (fever), moisture, friction and hygiene; 2. nutrition which includes general undernutrition and specific nutritional deficiencies such as protein and ascorbic acid; 3. anemia; 4. infection; and 5. movement or mobility. If patients exhibit one or more of the following conditions, they are at higher risk of having a pressure ulcer: poor nutrition that is associated with anemia, hypoproteinemia or

vitamin deficiencies; aging process associated with blood vessel changes, loss of tissue elasticity, or senility; motor paralysis; lack of awareness of pain due to sensory loss; and deteriorating autonomic function, especially bowel and bladder control.

Tepperman, Swireck, Chiarocossi & Jimenez (1977) believe that the single most important factor influencing the risk of pressure ulcers is the degree of mobility of patients who are bedridden or who sit in chairs for extended periods of time without change of position. Other intrinsic contributing factors are malnutrition or obesity, advanced age, cardiovascular disease, oxygenation, mental status, and presence of motor or sensory (1977) deficit. Extrinsic factors are defined by Tepperman et al. as the quality of nursing care which includes positioning, turning, passive mobilization, condition of bedclothes and skin care. Tepperman et al. (1977) believe that to prevent pressure ulcers, the intrinsic and extrinsic risk factors need to be identified so that a preventative management program can be implemented.

In his studies with dogs, Kosiak (1959, p. 68) found that ischemic ulcers were produced by "high pressures applied for short durations or low pressures applied for long durations." Microscopic metabolic changes were seen in the tissue after only one hour of being subjected to pressure equal to 60mm Hg. Kosiak also found nutrition, edema and anemia to be contributing factors in pressure

ulcers. In a later study Kosiak (1961, p. 28) confirmed these findings and also reported "no detectable microscopic differences between normal or denervated muscle following the application of either constant or alternating pressure."

A study completed by Gosnell (1973), had two objectives. The first objective was to identify variables that influence development of pressure ulcers. The second objective was to devise and evaluate an assessment tool to identify patients at risk for developing pressure ulcers. For this study, Gosnell used a sample of 30 patients 65 years of age or older who were admitted to an extended care facility and were pressure ulcer free on admission. The five variables rated were mental status, continence, mobility, activity and nutrition. This tool was based on the findings of Norton (1962) and included vital signs, skin appearance, skin tone, skin sensation and medications. The assessment form was simple, versatile and required little time. Limitations of the assessment tool were that it did not identify motivation of the patient to function to his potential nor did it identify or measure the amount of consistency of nursing care.

Gosnell (1987) stressed the assessment of the integumentary system and provided a descriptive outline of the patient's potential for pressure ulcer development. For this study the original Norton instrument was revised as follows: 1) reversed the scoring order so that the higher the number, the greater the risk; 2) refined the guidelines;

3) eliminated skin tone and sensation categories and added moisture, temperature, color and texture; 4) made provision for more detailed information regarding medications; 5) added a diet category; 6) added a 24 hour fluid balance category; and 7) added an intervention category. The instrument was designed to provide not only a risk factor score, but descriptive data regarding risk factors.

"Preliminary research on the revised instrument indicated interrater and intrarater reliability to be at a 0.9 level of agreement. The content validity was established by a panel of three content experts. The content validity index was 0.98" (Gosnell, 1987, p. 409).

Studies completed by Bereck (1975), Tepperman et al. (1977), Kosiak (1959, 1961), and Gosnell (1973) seem to be in agreement as to the etiology of pressure ulcers which include degree of mobility, moisture, and nutrition. The Braden, Daly, and Norton scales were designed to identify patients who are at risk for development of pressure ulcers so that interventions may be implemented as soon as possible. This study sought to compare the three scales in their ability to predict risk of skin breakdown.

Theoretical Framework

Wound healing is influenced by both intrinsic and extrinsic factors. Intrinsic factors are defined as those factors that are related to the patient's condition while extrinsic factors are those factors related to nursing activity (Abbey, 1985).

Neuman's Health Care Systems Model (1974, 1980) focuses on two major components: the patient's response to stressors and the nature of the relationship between the patient and the nurse. The model has been used in research although operational definitions and empirical indicators are not fully developed. Neuman identifies the main concepts as stressors, lines of defense, levels of prevention, individual variables, basic structure, interventions and reconstitution. The model focuses on reactions of the client systems to stress and on factors that influence reconstitution. Neuman seems to indicate that the environment is a source of stress, but stress may be harmful or beneficial. The model is based on a person's reaction to stress, the adjustment, and factors of reconstitution. It is a holistic model that "views the patient as a total person, encompassing all aspects of the human being and the multiplicity of variables that may effect behavior" (Neuman, 1972, p. 264).

Neuman views the person as an open system that interacts with the environment through interpersonal and extrapersonal factors. Interpersonal factors are those forces occurring between one or more individuals, while extrapersonal factors are those forces occurring outside the individual. Although individuals are constantly exposed to both beneficial and noxious stressors, it is their response to these stressors that is crucial. A stressor is defined as any problem, condition, force or potential force capable

of causing instability of the system by penetration of the normal line of defense. Stressors in this study included pressure, shearing force, decreased activity, decreased mobility, moisture and decreased mental status. The individual maintains both internal and external harmony through interactions and adjustments. Neuman conceptualizes the individual as composed of a central core with three protective layers (Figure 2). The central core comprises a normal temperature range, genetic structure, response pattern, organ strength, weakness and ego structure. These may be referred to as survival factors (Fawcett, 1984). The outer layer known as a flexible line of defense, is a rapidly changing buffer of stressors, but is also vulnerable to internal factors or situational circumstances such as amount of sleep, degree of heat or cold or intensity of stress. The second layer, known as the normal line of defense, consists of coping patterns, life style and the person's adaptation to stress. It consists of responses which have developed over time and which serve to maintain equilibrium; it represents a state of wellness. The innermost layer known as lines of resistance consists of internal factors that restore the normal line of defense if a stressor breaks through; it attempts to stabilize the individual.

Neuman provides a framework that can be used to classify risk factors of pressure ulcers. The central core and lines of resistance are affected by intrinsic or

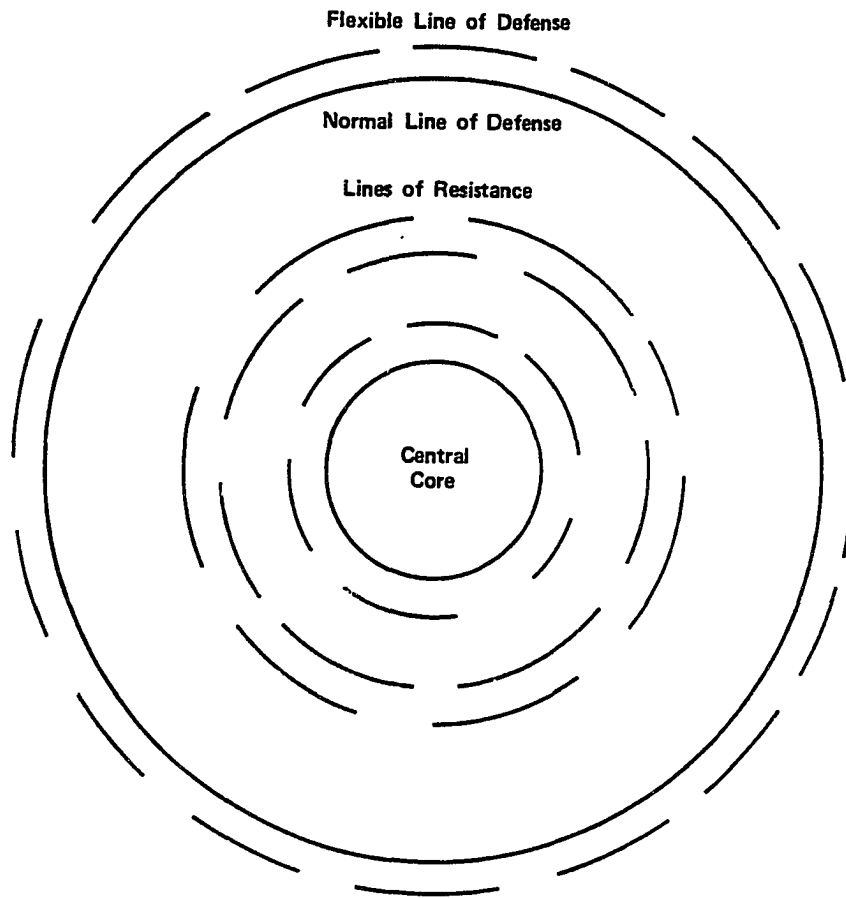


Figure 2. Neuman's systems model.

Source: Fawcett, J. (1984). Neuman's systems model.
Analysis and Evaluation of Conceptual Models of Nursing
(p. 149). Philadelphia: F. A. Davis Company.

intrapersonal factors while the normal line of defense and the flexible line of defense are affected by extrinsic or extrapersonal risk factors. Extrapersonal risk factors include the physical risk factors of pressure, shearing force, friction injury and moisture. The extrapersonal factors are believed to be major causes of pressure ulcers. The buffering ability of the flexible lines of defense depends upon the degree to which the individual is able to resist these stressors. The buffering ability of the flexible line of defense may be diminished in the presence of extrapersonal risk factors such as the onset of acute conditions (surgery, fractures, trauma or infection). Intrapersonal risk factors may be defects in the energy resources and basic biological structure of the central core. These "include age related changes and the effects of chronic or debilitating diseases such as malnutrition, anemia, reduced mobility, altered consciousness and sensory loss that serve to weaken the stabilizing force of the interior lines of resistance" (Ira, 1987, p. 6).

Nursing is concerned with a patient's reactions to stressors and strives to assist the patient in achieving or maintaining a system balance and in controlling energy by controlling variables that affect the patient. Neuman describes three levels of prevention. Primary prevention is an intervention initiated before or immediately after an encounter with a stressor; that is, it can be initiated at any point that a stressor is suspected or identified. A

reliable and valid predictive tool would make early intervention possible. Primary prevention includes both decreasing the possibility of an encounter with stressors and strengthening the flexible line of defense in the presence of stressors. Secondary prevention is an intervention initiated after an encounter with a stressor and includes early identification and treatment of symptoms following a reaction to a stressor. Those pressure ulcers missed by a predictive tool would fall into this category. Optimum use is made of a person's external and internal resources in an attempt to stabilize the individual or strengthen internal lines of resistance to reduce the reaction. Reconstitution is seen as a resolution of the stressor from the deepest degree of reaction back toward the normal lines of defense. Tertiary prevention is an intervention generally initiated after treatment and focuses on readaption, reeducation and maintenance of stability (Griffith-Kenney & Christensen, 1986).

Neuman believes "that nursing is concerned with all potential stressors; therefore, the way in which all data regarding stressors and reactions to stressors may be organized is very important" (Fitzpatrick & Whall, 1983, p. 205). A valid tool or scale that assesses the risk factors or potential stressors for development of pressure ulcers would alert the caregiver (nurse) to institute interventions to prevent penetration of stressors. Neuman recognizes that the nurse has the responsibility in primary prevention so

that this framework can serve to guide the actions of the nurse in assessment and intervention. It is because of these attributes that Neuman's framework can serve as an organizational framework for research related to risk factor identification. This study therefore, has identified the following research questions:

1. What is the relative ability (sensitivity) of the three scales to predict patients who develop pressure ulcers?
2. What differences are there in predictability among the scales, based on over-prediction of pressure ulcer development?

Definition of Terms

Sensitivity and specificity are defined literally and mathematically by Larson (1986) (Appendix C). The following terms are used in evaluating the predictive abilities of the tools:

Sensitivity is the proportion of patients who have pressure sores and were predicted to have pressure ulcers. The characteristic was classified correctly.

Specificity is the proportion of patients who do not have pressure ulcers and were not predicted to have pressure ulcers. The absence of the characteristic was correctly classified.

Predictive value of a positive test is the proportion of patients who have a positive test and have pressure ulcers.

Predictive value of a negative test is the proportion of patients who have a negative test and do not have pressure ulcers.

False positive rate is the proportion of patients who do not have pressure ulcers, but have a positive prediction.

False negative rate is the proportion of patients who have pressure ulcers, but have a negative prediction.

CHAPTER 3

Methodology

Design and Sample

A descriptive correlational design was used to determine how three tools (the Norton Scale, the Braden Scale and the Daly Scale) compare in their ability to predict the risk of skin breakdown in hospitalized patients. The dependent variable in this study was the ability to predict pressure ulcer development.

The design of this study was carefully controlled to manage extraneous variables. Each data collector remained blind to the results of each other to prevent one score or scale from influencing another. The data collector who visually assessed the skin of each patient was not influenced by the scores of the three tools. Each data collector was assigned one tool to be used throughout the study.

Withholding preventive measures was morally and ethically not permitted in this study. No attempt was made to intervene or control utilization of protective devices. Some patients may have developed pressure sores if preventive devices had not been used.

Initially, data was collected from a convenience sample of a total of 30 patients who were admitted to three medical/surgical floors in a 525 bed midwestern hospital. The sample size for this study was 27 patients. Three

patients were not used because their length of stay was too short for data analysis. All patients admitted without pressure ulcers and with a medical diagnosis that had an average length of stay of six days on the selected hospital floors were considered for the study. There was no attempt to restrict subjects because of gender, race, age or marital status. All participants were adults and spoke English.

There were no foreseeable risks associated with this study. The assessments were a part of routine daily care. The procedure was explained to each participant via a verbal script (Appendix F). The procedure consisted of a visual inspection of the participants' skin in areas most likely to develop pressure ulcers (Appendix J). Each inspection took less than ten minutes. A verbal script (Appendix F) and consent form (Appendix G) was read to each participant. Each participant was asked to sign the informed consent form. Copies of the verbal script and the consent form were given to each participant.

Protocol forms were completed, submitted and approved by the Institutional Review Board of the acute care hospital, where the research took place. Grand Valley State University granted an exempted review.

A tool designed to collect demographic data on each participant (Appendix H) was used. The data included age, race, gender, weight, height, primary diagnosis, secondary diagnosis, length of stay and whether the participant is a smoker. Bergstrom's monitoring and skin protection

tool (Appendix I) was also utilized. This tool includes lowest diastolic blood pressure, highest body temperature, steroid therapy, serum albumin, lymphocyte count and white blood count. It also includes any skin protection interventions that may be utilized. The skin assessment tool, also developed by Bergstrom, (Appendix J) lists all of the assessment sites. This tool was used to gather data on the dependent variable.

Instruments

The Norton Scale, which was devised in 1962, by Norton, McLaren and Exton-Smith, has five categories. They are physical condition, mental condition, activity, mobility, and incontinence (Appendix A). Each category is scored from one to four. The higher the score, the lower the predicted risk. The possible range of the total scores is from 5 to 20. A total score of 14 or higher indicates little risk, while a score of less than 12 indicates high risk. Several other studies (Roberts and Goldstone 1979, Goldstone and Goldstone 1982, and Lincoln et al. 1986) also recommended using 14 as the cutoff point. For this reason, a cutoff point of 14 was used to predict risk in this study. Ira (1987) calculated predictive validity of previous studies done using the Norton Scale with varying results: Sensitivity ranged from 63% to 92%, specificity ranged from 36% to 94%, predictive value of a positive test ranged from 38% to 53%, predictive value of a negative test ranged from

Table 2

Comparison of Ranges of Validity of Past Studies

	<u>Norton</u>	<u>Daly</u>	<u>Braden</u>
Sensitivity	63% - 92%	86%	83% - 100%
Specificity	36% - 94%	100%	64% - 90%
Predictive value of positive test	38% - 53%	98%	61%
Predictive value of negative test	80% - 96%	98%	85%
Misclassification rate	19% - 40%	2%	

80% to 96%, and misclassification rate ranged from 19% to 40% (Table 2).

The Daly Scale (Appendix E) was developed and tested in 1985. It is a revised and expanded version of the Norton Scale. The Daly Scale contains eight categories which include physical condition, mental condition, activity level, mobility, moisture contamination of skin, nutrition/fluid, presence of disease with inherent potential for alteration in skin condition, and cardiovascular state. Each category may be scored from 1 to 4. Range of total scores is from eight for those patients who are at greatest risk to 32 for those patients who are at least risk. The cutoff point for the Daly Scale was 18 for this study. Validity of the Daly Scale was calculated by Ira (1987) as follows: sensitivity 86%, specificity 100%, predictive value of a positive test at 100%, predictive value of a

negative test at 98%, and misclassification rate of 2% (Table 2).

The Braden Scale (Appendix D) was developed in 1985, by Bergstrom, Braden and Laquzza. This scale has six categories which are sensory perception, moisture, activity, mobility, nutrition, and friction and shear. Each category may be scored from 1 to 4 except friction and shear, which is scored from 1 to 3. The total scores ranged from 6 to 23 with 6 being highest risk, 23 the lowest risk, and the cutoff point at 16. Sensitivity of previous studies ranged from 83% to 100%, while specificity ranged from 64% to 90%. Predictive value of a positive test was calculated at 61%, and predictive value of a negative test was calculated at 85% (Table 2).

Past studies indicate that the Braden Scale has the highest sensitivity which ranges from 83% - 100%. The Daly Scale has the highest specificity at 100%. The Daly Scale also has the highest predictive value of a positive test at 100%, and predictive value of a negative test at 98%, although the Norton range was between 80% and 96%.

Procedure

Assessments began 24-48 hours following admission and continued every 48-72 hours for a minimum of one assessment and a maximum of six assessments for each participant. Assessments were done on Monday, Wednesday, and Friday. These days fit the 24-48 period after admission and the 48-72 hour period between assessments, including weekends.

None of the data assessors routinely worked weekends and they had their regular duties to complete, so selecting Monday, Wednesday, and Friday as assessment days provided some structure for them. These assessments were a part of routine daily care. Three different nurses gathered data from the subject's chart on each assessment day. Each nurse was assigned to use only one tool and the same nurse used the same tool throughout the study.

After each nurse completed the predictive assessment, the assessment form was sent to a neutral person for collection and a new predictive data assessment form was used for the next assessment. Therefore, an unused predictive data collection form (scale) was used for each and every predictive assessment, thereby attempting to eliminate bias of previous assessments. A fourth nurse assessed each subject's skin using the skin assessment tool (Appendix J) on the same day that the three tools were used in the predictive assessment. The primary researcher who completed the visual assessments remained blind to the predictive assessments. Each subject was assessed a minimum of 3 times and a maximum of 18 times or two weeks using the three tools; and each subject had a maximum of six visual skin assessments and a minimum of one visual assessment.

Each data collector was a registered nurse who remained "blind" to the scores assigned by the others. Only one rater was present while each assessment was completed.

The four stages of skin classification were utilized by the nurse who assessed the skin condition. The four stages are as follows:

Stage 0 - No redness or breakdown.

Stage 1 - Erythema only: redness does not disappear within 15 minutes.

Stage 2 - Break in skin such as blisters or abrasions.

Stage 3 - Break in skin exposing subcutaneous tissue.

Stage 4 - Break in skin extending through tissue and subcutaneous layers, exposing muscle or bone.

CHAPTER 4

Data Analysis

Data were analyzed in relation to the research questions and the results are being reported in relation to each of the predictive tools. The sample was dichotomized according to whether the subject did or did not develop pressure ulcers. The independent variables were the scores on the Norton, Daly and Braden Scales. The dependent variable was the ability to predict pressure ulcer development. The scores were conceptualized as interval data with the ranges varying as follows: Daly Scale 8-32; Norton Scale 4-20; and Braden scale 6-23. Formulas developed by Larson (1986) were used to determine the specific components of predictive validity: the percent of misclassified subjects, sensitivity, specificity and predictive value of a positive test and predictive value of a negative test of each of the three scales (Appendix C). The most desirable scores using the Larson Formula are low values for false positives and false negatives and high values for sensitivity, specificity, and predictive ability.

Sample

The majority of the subjects in the sample were women (67%) and the ages of all subjects in the sample ranged from 25-94 (Figure 3). The mode or age group that occurred most frequently was in the seventies, the median age was 65, while the mean or average age was 59.5.

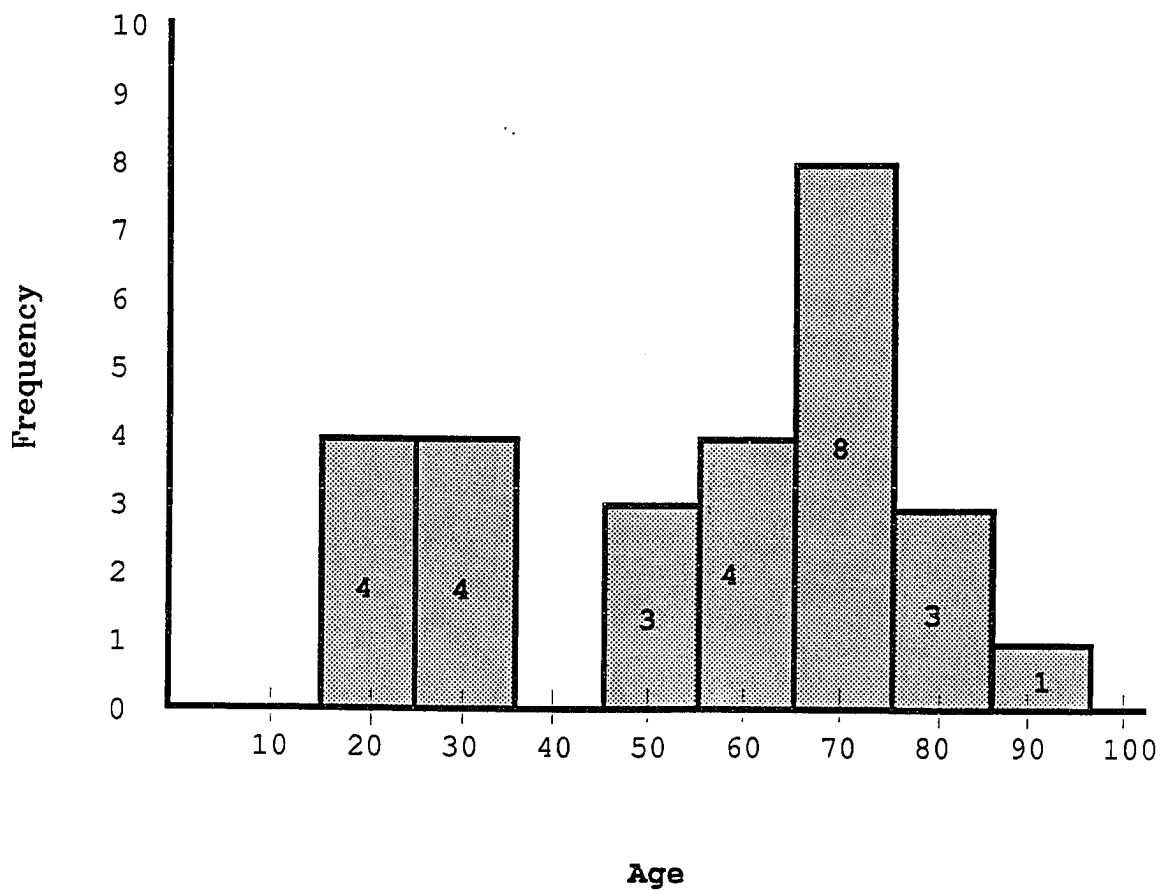


Figure 3. Frequency distribution of age.

The sample was distributed with 44% (12) subjects on a medical floor, 26% (7) subjects on a surgical floor, and 30% (8) subjects on a combination medical/surgical floor (Table 3). Race was distributed as follow: most were Caucasian at 81% (22) while 15% (4) were Black, and 4% (1) was a Native American (Table 3). The sample was composed of 67% (18) female subjects.

The first research question was "What is the relative ability (sensitivity) of the three scales to predict patients who develop pressure ulcers?" The Daly Scale and Norton Scale with a cutoff of 12 were each 25% sensitive (Table 4). In contrast, the Braden Scale and the Norton Scale with a cutoff of 14 were each 50% sensitive. The percentages are difficult to interpret due to the small sample size and the small number (4) of actual pressure ulcers. Twenty-five percent represents one pressure ulcer, while 50% represents two pressure ulcers.

The second research question was "What differences are there in predictability among the scales, based on over-prediction of pressure ulcer development?" The false positive or over-prediction of pressure ulcers differed with all three scales. The highest rate of over-prediction was 19% using the Braden Scale (Table 4). This represents 11 patients in this study. The Norton Scale with a cutoff of 14, ranked next with 14% which represents eight patients. The Daly Scale had a 7% over-prediction rate which represented four patients. The lowest rate of

Table 3

Distribution of Patients in Sample as to Floor, Race,
Gender, and Medical Diagnosis

<u>Demographics</u>	<u>Percent</u>	<u>Number</u>
<u>Floor</u>		
Medical	44%	12
Surgical	26%	7
Med-Surg	30%	8
<u>Race</u>		
Caucasian	81%	22
Black	15%	4
Native American	4%	1
<u>Gender</u>		
Female	67%	18
Male	33%	9
<u>Medical Diagnosis</u>		
CVA	11%	3
Pneumonia	7%	2
Diabetes	7%	2
COPD	11%	3
Chemical Cellulitis	7%	2
G.I. Bleed	7%	2
Other	48%	13

Table 4

Comparison of Validity of Three Rating Scales

<u>Characteristic</u>	<u>Daly</u>	<u>Braden</u>	<u>Norton</u> <u>*(14)</u>	<u>Norton</u> <u>+(12)</u>
Sensitivity	25%	50%	50%	25%
Specificity	93%	80%	86%	96%
Predictive value of a positive test	20%	15%	20%	33%
Predictive value of a negative test	95%	96%	96%	95%
False positive rate	7%	19%	14%	4%
False negative rate	75%	50%	50%	75%

* Norton with cutoff of 14

+ Norton with cutoff of 12

Definitions of Terms Using Larson Formula

Sensitivity - Percentage of those with pressure ulcers who were predicted.

Specificity - Percentage of those without pressure ulcers who were predicted.

Predictive value of a positive test - Percentage of those who were predicted to get pressure ulcers who did.

Predictive value of a negative test - Percentage of those who were predicted not to get pressure ulcers and who did not.

False positive rate - Percentage of those who were predicted to have pressure ulcers and did not develop them.

False negative rate - Percentage of those who were predicted not to develop pressure ulcers but did.

over-prediction was the Norton Scale with a cutoff of 12. (It over-predicted four percent (two patients).)

Most subjects had differing diagnosis: 11% (3) of the subjects had a diagnosis of CVA, 7% (2) of pneumonia, 7% (2) had diabetes, 11% (3) had COPD, 7% (2) had chemical cellulitis, and 7% (2) had GI Bleed (Table 3). These diagnoses were within the list of diagnoses with average length of stay of 6 days. The remaining 48% (13) of the patients each had a different diagnosis.

Of the 27 patients assessed and the 183 predictive assessments completed (61 for each scale), only three subjects developed pressure ulcers. One subject displayed a pressure ulcer on two consecutive observations. Two of the subjects who developed pressure ulcers were on a medical floor, while one was on a medical-surgical floor. Subjects who developed pressure ulcers were all female and tended to be older than 70 with medical problems (Table 5). These results were not surprising because numerous studies have supported these findings that older people are at greater risk of pressure ulcer development and that females tend to live longer than males. Also, medical patients generally have a longer hospital stay than do surgical patients; the older adults lose skin elasticity, may not be as mobile, and may have poorer nutrition than the younger population. Patients with a diagnosis of CVA are not mobile in the acute stages and are more prone to pressure from lack of movement. Patients with a diagnosis of pulmonary embolism are

Table 5

Comparison of Age, Diagnosis and Unit of Assignment
of Patients Who Exhibited Pressure Sores

<u>Patient</u>	<u>Floor</u>	<u>Age</u>	<u>Race</u>	<u>Gender</u>	<u>Diagnosis</u>
1	Med-Surg	82	White	Fe	CVA
2	Medical	94	White	Fe	CVA, CHF
3	Medical	76	White	Fe	Pulmonary Embolism

generally on bedrest in the acute stages. This also leads to lack of movement and pressure on the skin.

The Daly Scale

The Daly scale predicted that five pressure ulcers would develop. Of these five, only one actually developed a pressure ulcer. The one who developed a pressure ulcer wore heel protectors; however, the pressure ulcer developed on the right elbow which had no protection and disappeared by the next assessment day. Of the five observations that predicted pressure ulcer development which did not materialize, four of these observations occurred with one patient who wore protectors on both feet; the other patient had no protective devices.

Three pressure ulcers developed that were not predicted by the Daly Scale. One was a sheet abrasion of the right elbow observed on the second assessment. The sheet abrasion disappeared by the next assessment day. No protective devices were worn at this time. By the fourth assessment,

this subject was wearing heel protectors on both feet. The second and third pressure ulcers were observed on a different subject on the tip of the great left toe on two consecutive observations of the same subject. This subject had no protective devices and was observed for a total of four days.

Fifty-three observations (assessments) with the Daly Scale were true negatives; no pressure ulcers were predicted and no pressure ulcers were observed. Four observations were false positive (pressure ulcers were predicted which did not occur). Three observations were false negative; the subjects were not predicted to get pressure ulcers, but they did develop them. One observation was a true positive; one subject was predicted to get a pressure ulcer and actually did develop one (Table 6).

Sensitivity for the Daly Scale was calculated at 25%, specificity at 93%, predictive value of a positive test at 20%, predictive value of a negative test at 95%, false positive rate at 7%, and false negative rate at 75% (Table 4).

The Norton Scale

The Norton Scale predicted that 10 pressure ulcers would develop. Of those 10, two actually did develop pressure ulcers. One was a sheet abrasion of the right elbow which disappeared by the next assessment day. This prediction was classified as having little risk (score of 13 or 14). The other was a pressure ulcer to the right elbow.

Table 6

Comparison of True Positive, True Negative, False Positive and False Negative Scores of the Three Scales

<u>Characteristic</u>	<u>Daly</u>	<u>Braden</u>	<u>Norton</u> <u>*(14)</u>	<u>Norton</u> <u>+(12)</u>
True Positive	1	2	2	1
True Negative	53	46	49	55
False Positive	4	11	8	2
False Negative	<u>3</u>	<u>2</u>	<u>2</u>	<u>3</u>
	61	61	61	61

* Norton with cutoff of 14

+ Norton with cutoff of 12

This prediction was classified as high risk (less than 12). The patient with the sheet abrasion was observed a total of five days. The Norton Scale predicted pressure ulcers would develop on all five assessment days, but the abrasion was observed only on the second assessment day. The other predicted pressure ulcer was observed on the right elbow on the second assessment day only, but the Norton Scale predicted pressure ulcer development on the first, second and fourth assessment days on this patient.

The ten positive predictions involved four patients. One patient had five positive predictions while one pressure ulcer was observed; one patient had three positive predictions while one pressure ulcer was observed; two

patients had one each positive prediction while no pressure ulcer was observed (Table 6). Two pressure ulcers developed that were not predicted by the Norton 14 Scale. Those pressure ulcers were observed on the same patient on the tip of the left great toe on two consecutive assessments. No protective devices were used by this patient. The pressure ulcers were observed on the third and fourth assessment day.

The Norton Scale correctly classified 49 true negative observations; pressure ulcers were predicted not to occur and were not observed. Sensitivity for the Norton Scale with a cutoff of 14 was calculated at 50%, specificity at 86%, predictive value of a positive test at 20%, predictive value of a negative test at 96%, false positive rate at 14%, and false negative rate at 50% (Table 4).

If the cutoff point for the Norton Scale was changed from 14 to 12, the following would be true. Three pressure ulcers would have been predicted to occur, while one actually would have been observed and two would not have been observed. Using a cutoff point of 14, eight did not occur that were predicted. However, one more would have been missed with this scale. Four pressure ulcers actually were observed, but only one was predicted. In contrast, using a cutoff point of 12, one was observed while four were predicted. The total number of observations that were not predicted and did not occur with this scale (cutoff of 12) increased from 49 to 55 (Table 6).

The Braden Scale

The Braden Scale predicted that 13 pressure ulcers would develop. Of the 13 observations that were predicted to develop pressure ulcers, two did develop pressure ulcers while 11 did not. Of the two who did develop pressure ulcers, one had no protective device, while the other had heel protectors on both feet; the reddened area developed on the right elbow in the form of a sheet abrasion. Of the 11 patient observations who were predicted to get pressure ulcers and did not, four wore heel protectors, one had an eggcrate on the bed and six had no protective devices.

Two observations predicted pressure ulcers would not develop, but pressure ulcers did develop. These observations were consecutive observations on the same patient. No protective devices were worn by this patient. The pressure ulcer was observed on the tip of the left great toe. Forty-six assessments with the Braden Scale were true negative; no pressure ulcers were predicted and no pressure ulcers were observed (Table 6). However, 11 assessments were false positive (those pressure ulcers predicted which did not occur); two assessments were true positive (those pressure ulcers predicted which did occur); and two assessment were false negative (those pressure ulcers predicted not to occur which did occur). Sensitivity for the Braden Scale was calculated at 50%, specificity at 80%, predictive value of a positive test at 15%, predicted value

of a negative test at 96%, false positive rate at 19%, and false negative rate at 50% (Table 4).

The Braden and Norton 14 Scales were most sensitive (50%). Fifty percent of the patients who developed pressure ulcers were predicted. In contrast, the Daly and Norton 12 Scales were 25% sensitive (Table 3, Figure 9). The Norton 12 had the lowest rate of overprediction or false positive rate. Four percent of the patients who were predicted to get pressure ulcers did not. In contrast, the Braden Scale scored 19%, followed by the Norton 14 at 14%, and the Daly Scale at 7% (Table 4).

Past studies have found the Norton Scale to overpredict and the Braden Scale to be highly sensitive and specific. It must be noted that some of the differences of older studies may be attributed to advances in management and treatment of acute care populations. Patients now get out of bed sooner after surgery, length of stay is shorter, the older population is walked and sat in chairs several times a day, diseases are treated more aggressively and their lives are extended much longer than in the 1960's. In Norton's study of 250 hospitalized patients in 1962, 24% developed pressure ulcers. Of these 24%, the incidence of pressure ulcers was 54% among those who died. The subjects in this recently completed study were all expected to live and their conditions were expected to improve.

CHAPTER 5

Discussion

A reliable and valid tool (scale) to predict risk of pressure ulcers is necessary in prevention of pressure ulcers. This type of tool could save the patient pain and costly treatment, save time for staff, and be cost efficient for the institution. The tool itself must be simple to use and cost effective. Assessments using the three tools compared in this study are a part of routine nursing care. The Norton Scale is the simplest of the three with five categories and four simple, one word defining characteristics for each category. The Braden Scale is more complicated with six categories and with defining characteristics that are more specific. Consequently, it is more time consuming to use. The Daly Scale has eight categories, the most of the three scales. Although it has specific defining characteristics, the Daly Scale is the most time consuming to use of the three scales.

If accurate predictions can be made with a valid and reliable tool, preventive measures can be taken. In 1989, in the facility where this research was completed, the following items and prices shown in Table 7 were in use. Many times use of an eggcrate mattress or heel/elbow protectors is sufficient to prevent pressure ulcer development. The thin, frail elderly, however, may need frequent position changes and a special air bed that keeps the body free of pressure. When a pressure ulcer develops,

Table 7

Cost Comparison of Preventive Measures

DEVICE	*COST
Eggcrate mattress	\$ 28.61
Wheelchair cover pad (eggcrate)	12.96
Elbow/heel protectors	15.08
Soft-Care mattress	160.00
Ken-Air bed per day	100.00
Fluid-Air bed per day	125.00

* example in 1989 in hospital where study was taken

treatment plus one or more of the items in Table 7 may be used. Other preventive measures (eggcrate mattress at \$29, wheelchair cover pad [eggcrate] at \$13, elbow and heel protectors at \$15, and soft care mattress at \$160) are one-time charges unless they become soiled and need replacing or repair. None of the subjects in this study used the special beds (Table 8).

The Daly Scale predicted that 4 patients would develop pressure ulcers who did not (Figure 4, cell C). In dollar terms, it would have cost the hospital \$400 per hospital stay (4 days) for a Ken-Air bed or \$500 per hospital stay (4 days) for a Fluid-Air bed if one of these preventive measures were utilized (Table 8). These are unnecessary charges as the patients did not develop pressure ulcers.

Fifteen percent of this sample was false positive (overpredicted).

The Braden Scale overpredicted pressure ulcer development by 11 patients more than the other two scales (Figure 4, cell C). The cost outcomes of this prediction are extremely high at \$1100 for 11 days for a Ken-Air bed and \$1375 for 11 days for the Fluid-Air bed (Table 8).

Table 8

Comparison of Cost Per Day of Instituting Aggressive Measures of Prevention for False Positive Predictions in This Study

	Ken-Air Bed	Fluid-Air Bed
	<u>\$100 per day</u>	<u>\$125 per day</u>
Daly	4 x \$100 = \$ 400	4 x \$125 = \$ 500
Braden	11 x \$100 = \$1100	11 x \$125 = \$1375
Norton (14)*	8 x \$100 = \$ 800	8 x \$125 = \$1024
Norton (12)+	2 x \$100 = \$ 200	2 x \$125 = \$ 250

* Norton cutoff of 14

+ Norton cutoff of 12

The Norton Scale with a cutoff point of 14, fell between the Daly Scale and the Braden Scale with 8 overpredictions (Figure 4, cell C). The cost of using the Norton Scale would have been \$800 for 8 days for the Ken-Air bed and \$1024 for 8 days for the Fluid-Air bed (Table 8).

	A	B
TP		FN
	C	D
FP		TN

		<u>Daly</u> Actual				<u>Braden</u> Actual				
		Yes	No			Yes	No			
Predicted	Yes	1	A		B	2	A		B	Yes
	No	4	C		D	11	C		D	No
		<u>Norton(14)*</u> Actual				<u>Norton(12)+</u> Actual				
		Yes	No			Yes	No			
Predicted	Yes	2	A		B	1	A		B	Yes
	No	8	C		D	2	C		D	No

Sensitivity $\frac{A}{A + B} =$

Specificity $\frac{D}{C + D} =$

Figure 4. Calculation of sensitivity and specificity for scales predicting skin breakdown.

In contrast, the Norton Scale with a cutoff of 12 overpredicted only 2 patients. Contrary to previous studies, the Norton Scale over-predicted less than Daly, Braden and Norton with a cutoff of 14. Differences in some studies, especially the Daly, may be a function of design. The Daly study was a retrospective study. Data for the risk assessment all came from the patient's chart. For this current study the skin assessment was actual and all pressure ulcers were stage 1. The Daly study and the Braden study may have documented deeper pressure ulcers, all recorded on the chart. Cost of the Norton Scale would have been \$200 for 2 days for a Ken-Air bed and \$250 for 2 days for a Fluid-Air bed (Table 8).

Of the 27 subjects in the study, six used protective devices during the study. Of these six, two subjects developed pressure ulcers (subjects 1 and 2, Figure 5). Subject 1 wore heel protectors on the fourth and fifth assessment days only, but developed a pressure ulcer on the second assessment day in the form of a sheet abrasion on the right elbow. Both the Norton Scale and the Braden Scale predicted pressure ulcer development on all five assessment days, while the Daly Scale predicted that no pressure ulcers would develop. Subject 1 may be looked at in two ways. The Norton and Braden Scale overpredicted, while the Daly Scale was more specific, or heel protectors did aid in prevention of pressure ulcers on the heels at a cost of \$15. Subject 2, who wore heel protectors on all four assessment days, had

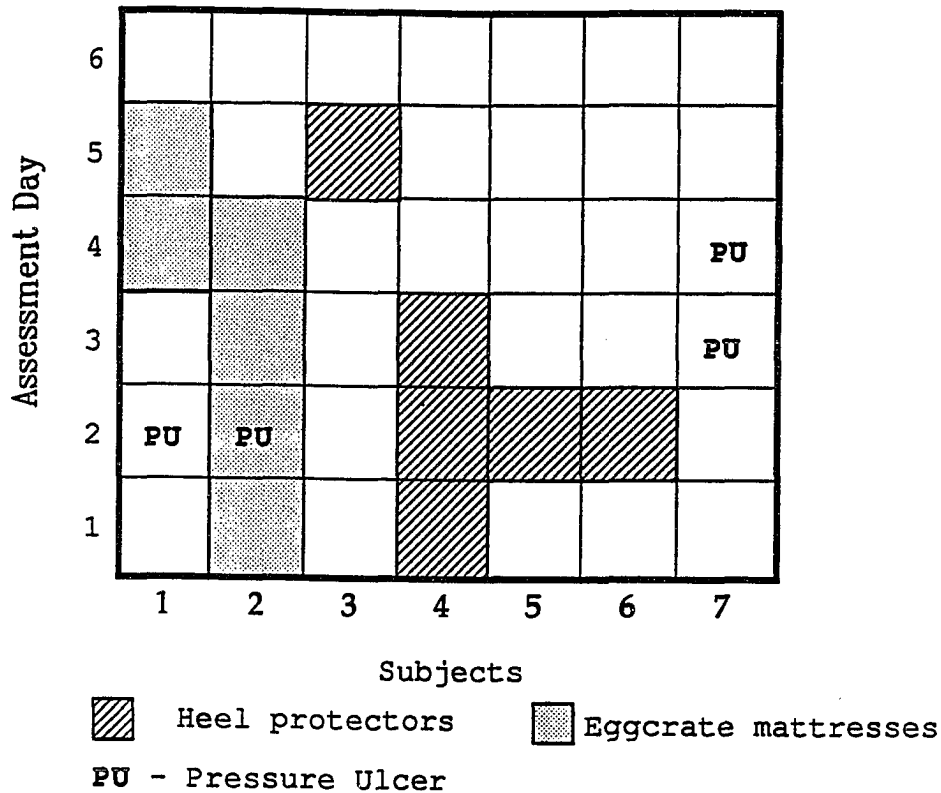


Figure 5. Subjects who developed pressure ulcers and the protective devices used on specific assessment days.

a pressure ulcer on the right elbow on the second assessment day only. This subject was predicted to develop a pressure ulcer by all three scales. Heel protectors may have prevented pressure ulcers on the heels at a cost of \$15. An elbow protector may have prevented the sheet abrasion at a cost of \$15.

Subjects 3, 4, 5 and 6 all used eggcrate mattresses during the study (Figure 5). None of these subjects developed pressure ulcers. Subject 3 was predicted to

develop a pressure ulcer by the Daly Scale on the third assessment day only and by the Braden Scale on the third and fourth assessment days only, while the Norton Scale predicted no pressure ulcer development. The eggcrate mattress was used on the fifth assessment day. No pressure ulcers developed. By the fifth assessment day, when the eggcrate mattress was first used, all three scales predicted no pressure ulcer development. Another \$29 in savings could have been realized by subject 3. The Daly Scale and the Norton Scale predicted that pressure ulcers would not develop on subject 4, while the Braden Scale predicted pressure ulcer development on the first assessment only. The eggcrate mattress may not have been necessary for a savings of \$29. Subject 5 used an eggcrate mattress on the second assessment day, however, all 3 scales predicted that pressure ulcers would not develop and they did not. A savings of \$29 could have been realized for subject 5. Subject 6 was predicted not to get pressure ulcers by all three scales and did not. Another savings of \$29 could have been realized by using one of the predictive tools. A total of \$116 could have been saved by these four subjects/hospital/taxpayers as a result of using one of the predictive tools.

Subject 7 did not wear protective devices or use an eggcrate mattress. A pressure ulcer did develop on the tip of the left toe on the third and fourth assessment days. Neither an eggcrate or heel protectors would have prevented

this ulcer, however, a foot cradle may have at no cost to the subject. The Daly Scale predicted a pressure ulcer on the third assessment day, the Braden Scale predicted a pressure ulcer on the third and fourth assessment days, while the Norton Scale predicted that no pressure ulcer would develop. This pressure ulcer may have been prevented by using the Daly Scale or the Braden Scale.

Of the three subjects who developed pressure ulcers, one was on a Medical-Surgical floor and two were on a medical floor. Medical patients usually have a longer length of stay than surgical patients. The ages of all three subjects were above the mean (59.5) and the median (65) for the sample. Figure 6 illustrates the fact that all patients who developed pressure ulcers were older. The numbers, however, were insufficient to test the statistical relationship between the variables of age and pressure ulcer development. Pressure ulcers are expected to occur in the elderly more so than the younger population due to loss of fat pads from the extremities, loss of tissue elasticity, decreased immune system, poor nutrition, and they are generally less mobile with multiple medical diagnoses.

All three subjects who developed pressure ulcers were Caucasian. The sample was composed of 81% (22) Caucasian subjects, while 19% (5) subjects were non-Caucasian. All three subjects were female and above the median age (65) (Figure 7). The sample was composed of 67% (18) females and 33% (9) males. Older women generally outlive older men so

Pressure Development

		No	Yes
Age	Below Median	13	0
	Above Median	10	3

Figure 6. Relationship of pressure development to age.

		Gender	
		Fe	M
Age	Below Median	0	0
	Above Median	3	0

Median Age = 65

Figure 7. Comparison of the gender and age of subjects who developed pressure ulcers.

that a greater population of females than males would be hospitalized because there are more of them.

Summary and Conclusion

The Norton Scale with five categories is the simplest of the three scales to use. It requires the least amount of staff time to complete, but the categories are open to interpretation. While the Daly and Braden Scales are more specific, both require more time to complete. All categories on these two scales have qualifying characteristics. The Daly Scale is the most complex with eight categories, while the Braden Scale has six categories.

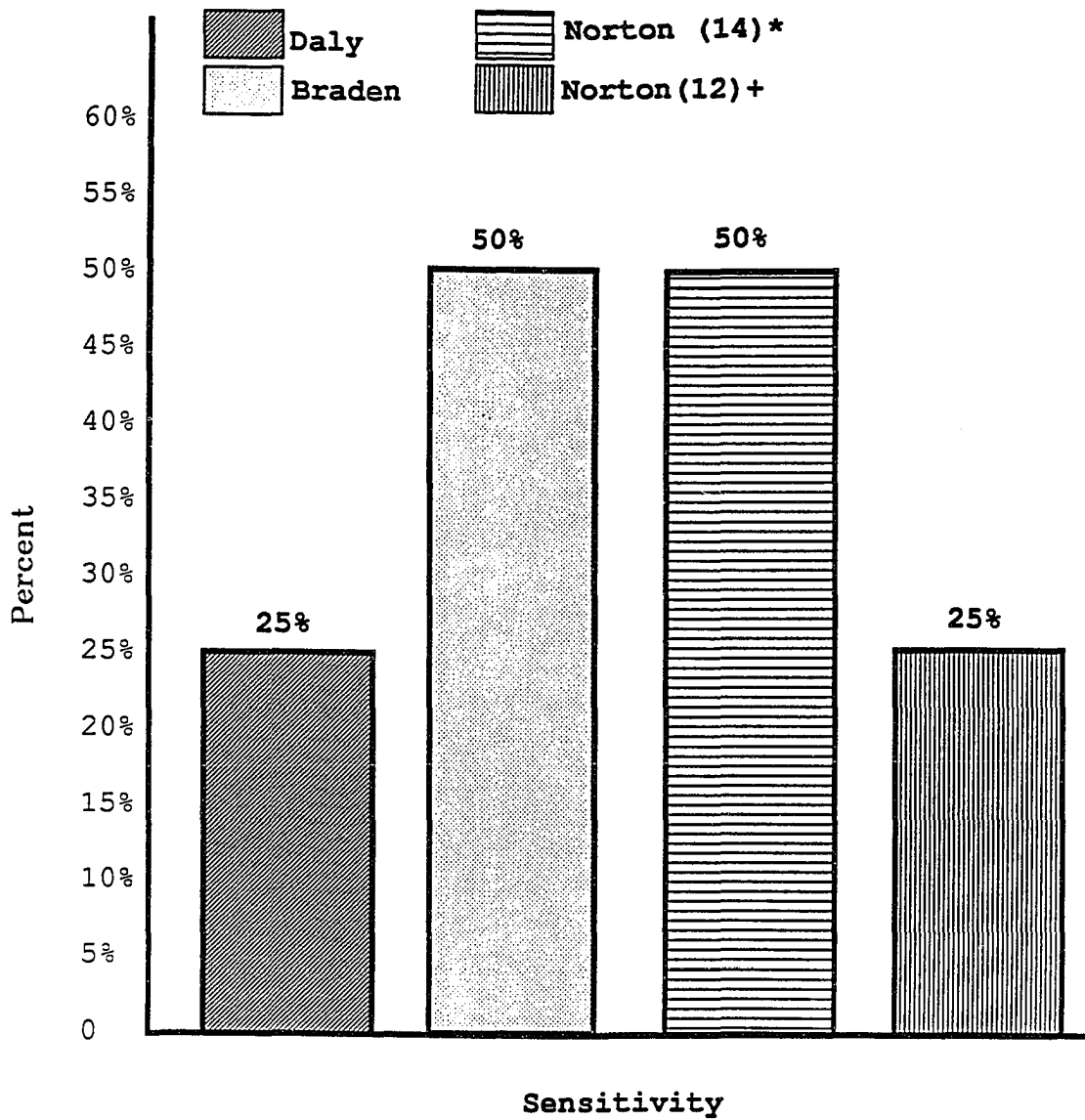
The Braden Scale and the Norton 14 Scale were equally sensitive at 50% (Figure 8). That is, 50% of the subjects with pressure ulcers had a positive test using the Braden and Norton 14 Scales. The Daly Scale and the Norton 12 Scale were also equally sensitive at 25%, but only half as sensitive as the Braden and Norton 14.

Specificity was high for all three scales (Figure 9). The range was from 80% to 96%. Specificity is the proportion of subjects without pressure ulcers who have a negative test. The Norton (12) Scale was the most specific at 96%. The Daly Scale was 93% specific, while the Norton (14) Scale was 86% specific, and the Braden Scale was least specific at 80%.

Scores for false positive rate were lowest for the Norton (12) Scale at 4% (Figure 10). False positive is the proportion of subjects predicted to get pressure ulcers who did not. The rate for the Daly Scale was 7% while the Norton (14) Scale was 14% and the Braden Scale was highest with 19%.

The Braden Scale and the Norton (14) Scale scored equally at 50% for false negative rate (Figure 11). False negative rate is the proportion of subjects who were predicted not to get pressure ulcers who did. The Daly Scale and the Norton (12) Scale also scored equally, but at 75%.

The Norton (12) Scale scored highest for a predictive value of a positive test at 33% (Figure 12). Predictive value of a positive test is the proportion of subjects with

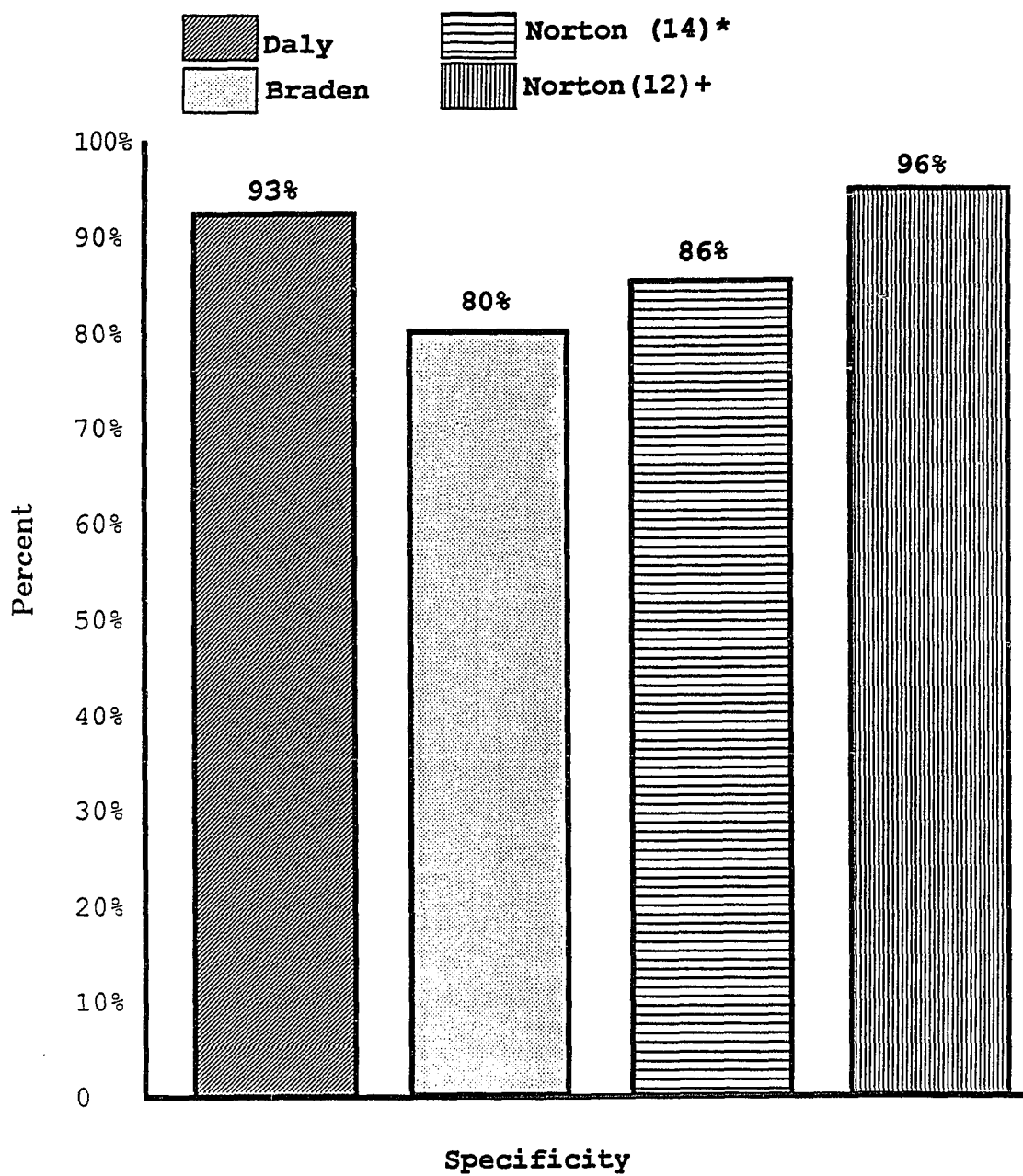


The proportion of subjects with pressure ulcers who have a positive test.

* Norton 14 - cutoff point

+ Norton 12 - cutoff point

Figure 8. Comparison of sensitivity.

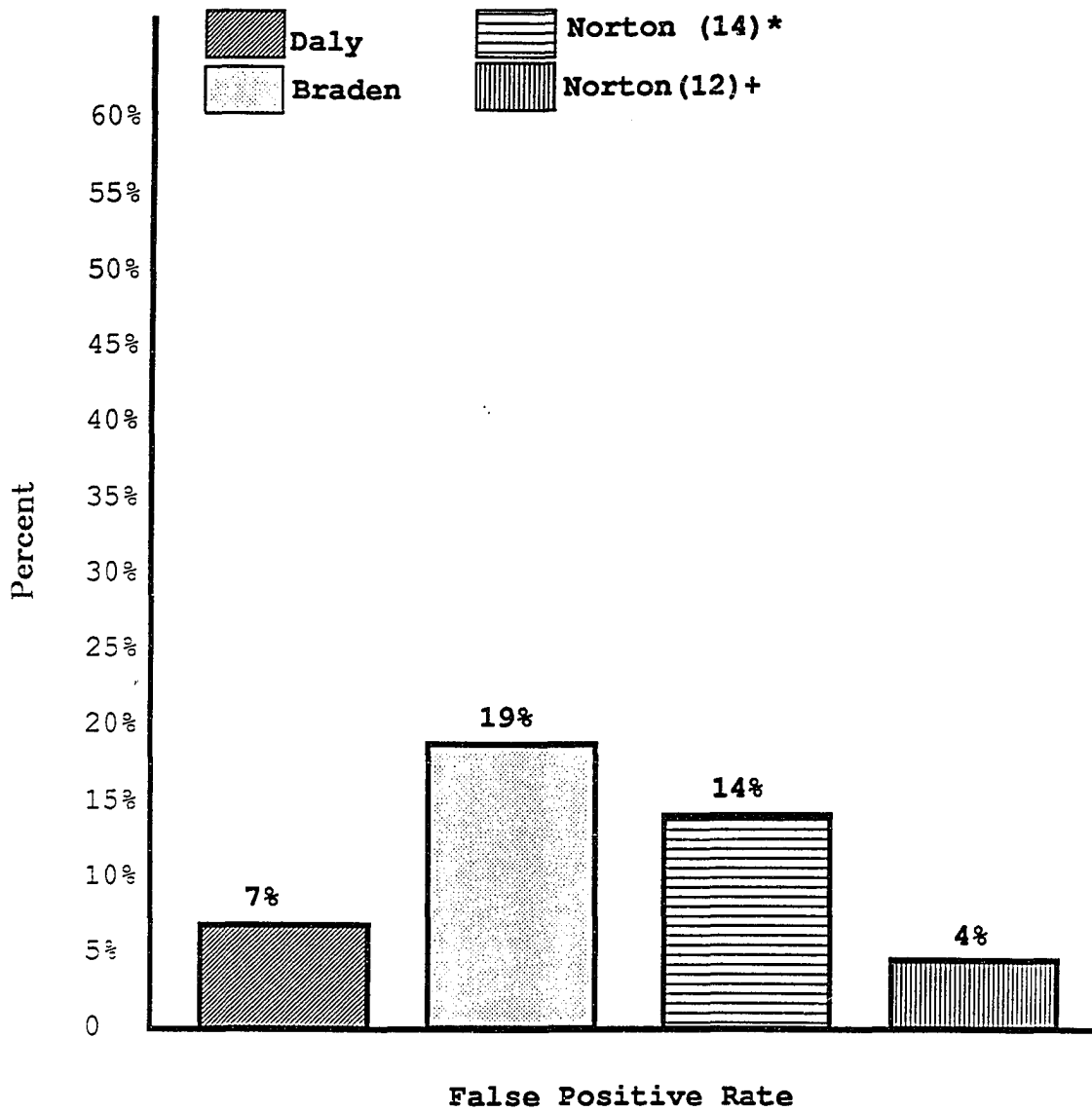


The proportion of subjects without pressure ulcers who have a negative test.

* Norton 14 - cutoff point

+ Norton 12 - cutoff point

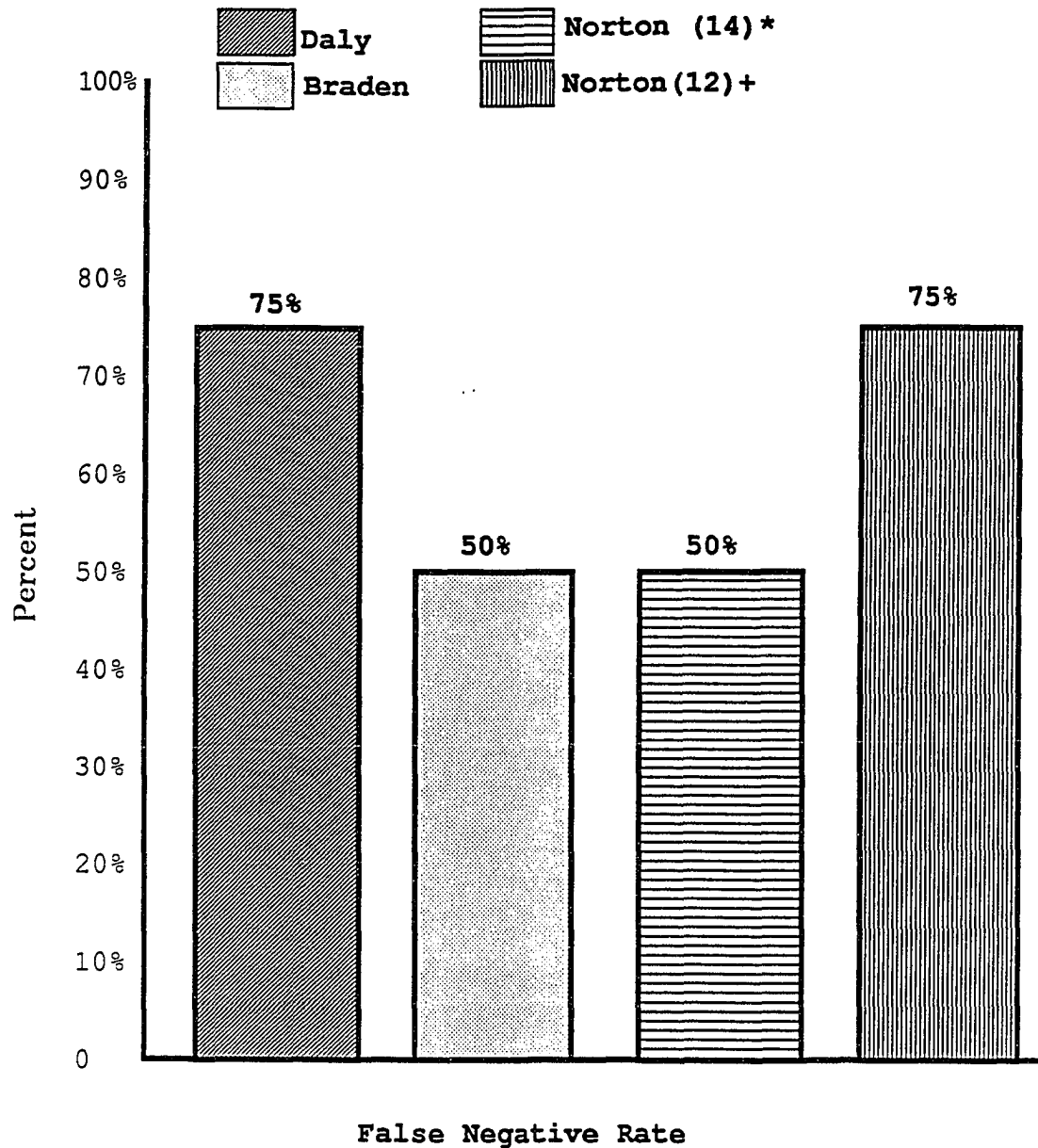
Figure 9. Comparison of specificity.



Proportion of subjects predicted to get pressure ulcers who did not.

- * Norton 14 - cutoff point
- + Norton 12 - cutoff point

Figure 10. Comparison of false positive rate.

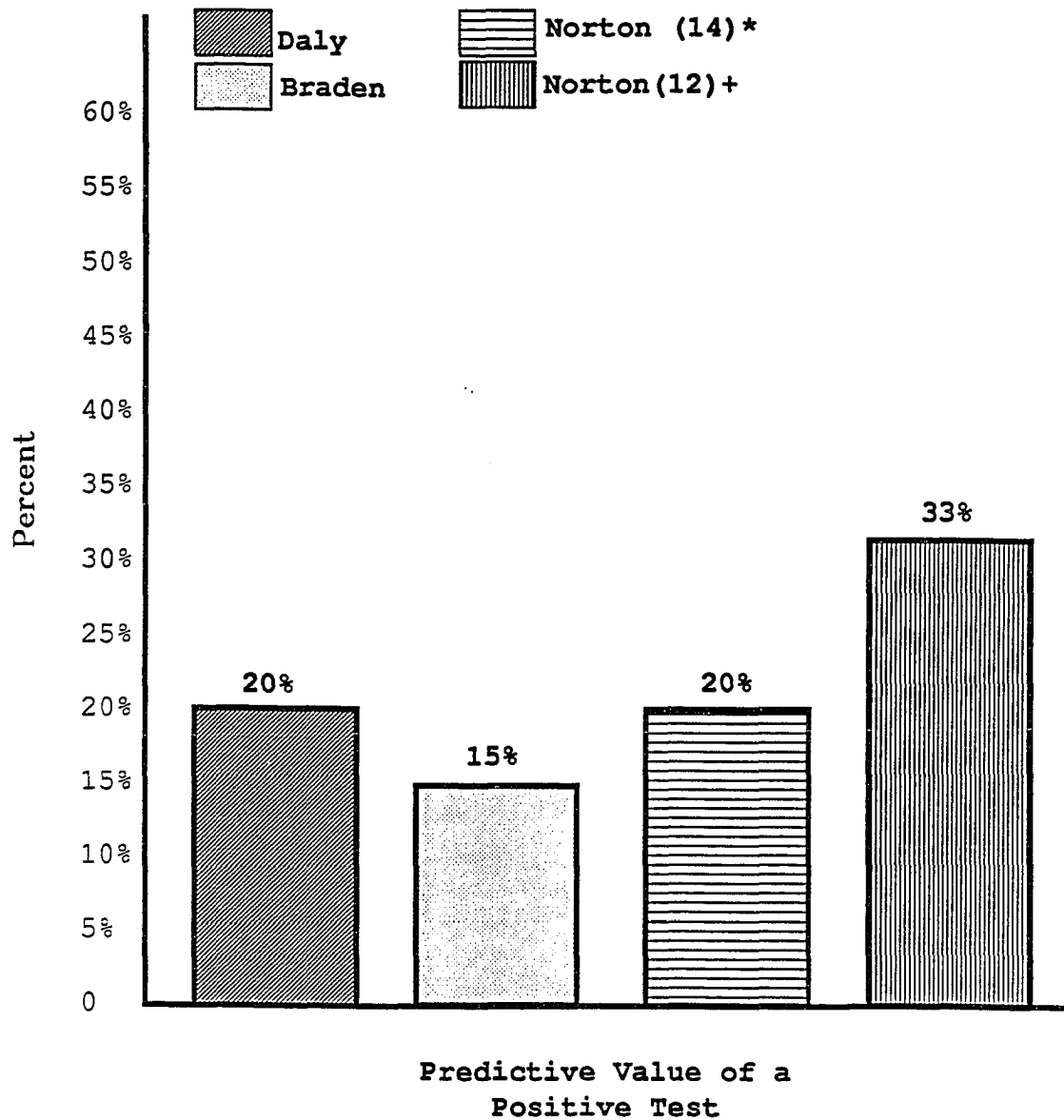


Proportion of subjects who were predicted not to get pressure ulcers who did.

* Norton 14 - cutoff point

+ Norton 12 - cutoff point

Figure 11. Comparison of false negative rate.



Proportion of subjects with a positive test who have pressure ulcers.

* Norton 14 - cutoff point

+ Norton 12 - cutoff point

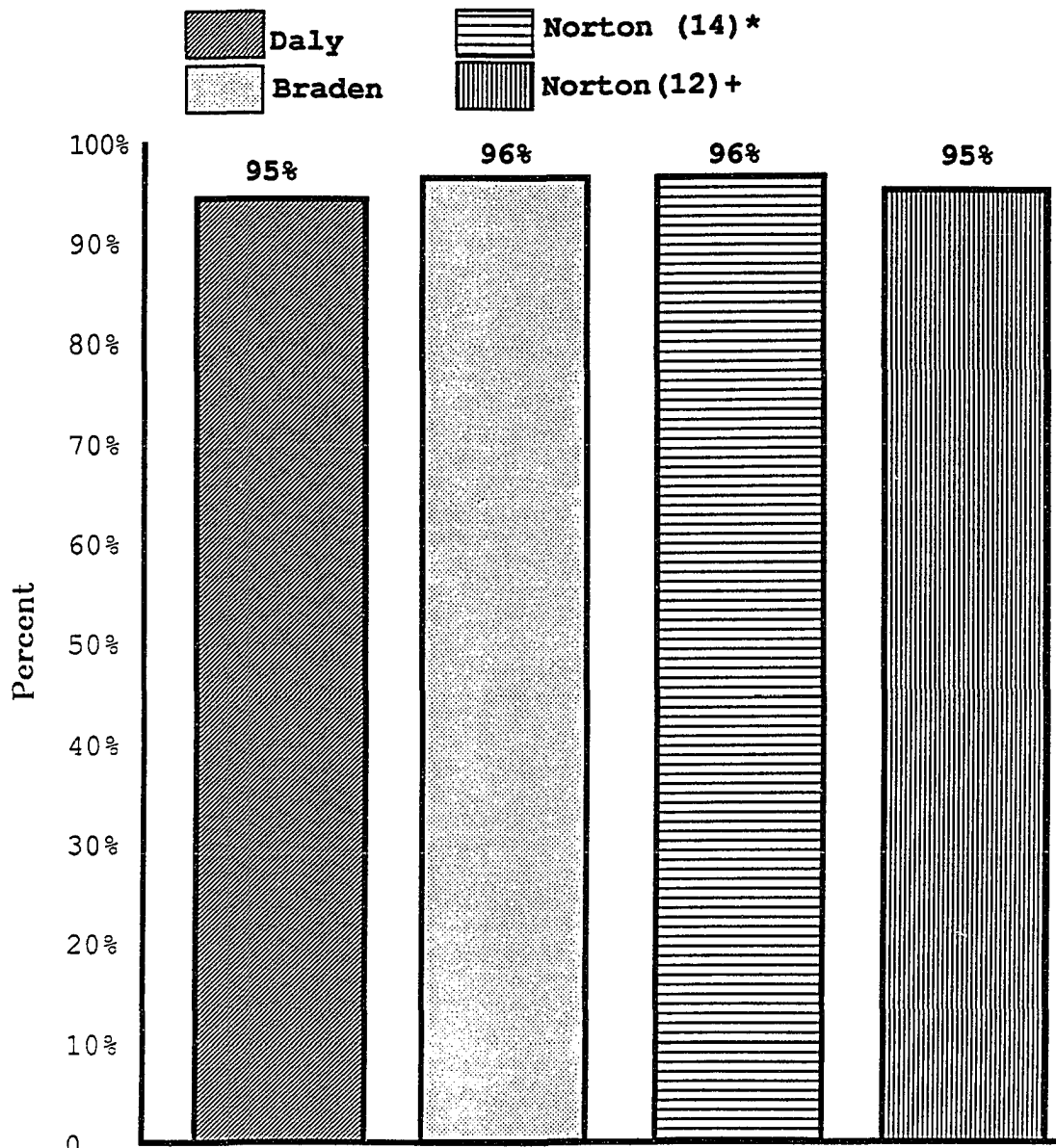
Figure 12. Comparison of predictive value of a positive test.

a positive test who have pressure ulcers. The Daly Scale and the Norton (14) scored equally well at 20%, while the Braden Scale had the lowest score at 15%.

All scales performed well (Figure 13) for a predictive value of a negative test (proportion of subjects with a negative test who do not have pressure ulcers). The Braden Scale and the Norton (14) Scale each scored 96%, while the Daly Scale and the Norton (12) Scale scored 95%.

Contrary to previous studies (Goldstone and Goldstone, 1979, 1982; Roberts and Goldstone, 1979) which showed the Norton Scale to overpredict at 40% and 43% respectively, this study found the Norton 12 Scale to overpredict by only 4%. In contrast, the Braden Scale overpredicted by 19%, the Norton 14 by 14%, and the Daly Scale by 7%. The Norton 14 Scale and the Braden Scale were most sensitive at 50% each. Previous studies showed the Braden Scale to be 83-100% sensitive. The Norton 12 was most specific at 96%. Previous studies showed the Daly Scale to be 100% specific (Ira, 1985), while in this study it was only 86% specific. Differences in this study and in previous studies may be due to design as well as charting skills, especially in the retrospective studies.

To summarize, the Braden Scale and the Norton 14 Scale were equally sensitive at 50%. Both scales predicted 50% of those patients who developed pressure ulcers. The Norton 12 was most specific. The Norton 12 predicted 96% of the patients would not develop pressures sores and they did not.



Predictive Value of a Negative Test

Proportion of subjects with a negative test who do not have pressure ulcers.

* Norton 14 - cutoff point

+ Norton 12 - cutoff point

Figure 13. Comparison of predictive value of a negative test.

The Norton 12 also had the lowest false positive rate. The Norton 12 predicted 4% of the patients would get pressure ulcers who did not. The Braden Scale and the Norton 14 Scale scored equally with the lowest false negative rate. The Braden and Norton 14 predicted 50% of the patients who were predicted not to get pressure ulcers but did. The Norton 12 scored highest at 33% for predictive value of a positive test (patients with a positive test who have pressure ulcers), while all three scales scored high at 95% and 96% for predictive value of a negative test (patients with a negative test who do not have pressure ulcers). More of the patients who actually develop pressure ulcers will be identified using the Braden and Norton 14 Scales. The Norton Scale is the easiest to use and may be completed in less time than the Braden or Daly Scales. The Norton 12 Scale is most cost effective in terms of time and rate of overprediction. The Norton 14 and the Braden Scales are equally effective in identifying patients with pressure ulcers who were predicted to develop them (sensitivity).

The objective of a reliable and sensitive tool is to predict who is at risk to develop pressure ulcers and then intervene with the most cost effective measures. Each facility needs to set its own cutoff point. In order to attain and maintain quality nursing care, assessment and evaluation, reassessment and reevaluation are essential.

Clinical Implications

No instrument (scale) is perfect. Some are more comprehensive than others and thus take more time to complete while others are simple, but require more interpretation. Skill of the data collector is important especially with the simpler tool because of the need for interpretation. Data collectors for this study each had more than five years of experience in nursing and each was a clinical coordinator at the time of this study.

Each data collector was asked to evaluate the tool that was used. Comments about the Daly Scale were that the scale was easy to understand and follow. A weakness of the tool was that needed information was not always available in the chart, i.e., a chem profile was not always done, therefore albumin was not available. The data collector found it difficult to obtain some information from the chart alone and concluded that it would have been helpful to have actually cared for the patient. This data collector also questioned whether a patient's history might have been considered useful especially in relation to cardiac status.

The evaluator of the Norton Scale found it simple and easy to use. It was a quick assessment covering major points that would help indicate a potential risk for skin breakdown. A weakness of this tool was that it left a great deal of room for interpretation by the data collector. Changes suggested by this evaluator would be to include an

assessment of clinical indicators such as BUN, creatinine and albumin.

The evaluator of the Braden Scale felt it took a minimal amount of time to complete, and that the categories were complete and inclusive. It was felt that it was a good tool for ambulatory patients. Weaknesses of the tool were that it did not incorporate lab values, that it was task oriented and did not include enough depth. Some categories left this evaluator wondering if the scale was rated correctly: mobility was difficult to decide from reading the chart as was sensory perception and friction and shear. Much of the information was not found on the chart and was difficult to assess without seeing the patient or interviewing the caregivers. Another weakness was that there was not an area to indicate whether or not a preventive measure was already in use. It was suggested that more defining characteristics be added. This evaluator would use the Braden Scale if adopted.

Each data collector evaluated only the tool that was used. The data collectors were familiar only with the tools used by each one. Therefore, this is not a comparison of the tools with respect to depth or ease of use, but of predictive validity.

Limitations and Recommendations

In view of the small sample size used, N=27, it was difficult to adequately test the predictive validity of the tools. Another limitation of this study was the low

incidence of pressure ulcers. A sample of 100 to 150 subjects might have been preferable. An extended care facility may also be a more appropriate setting in which to conduct this type of study. The extended care population is generally older with a longer length of stay. The patients in an extended care facility generally have multiple medical diagnoses, are less mobile and have decreased tissue tolerance to pressure. Many more assessments may be made due to the longer length of stay. The participants in this study were assessed a minimum of one time and a maximum of five times, a limitation of this study. Incidence of pressure ulcers (4) was too low to test statistically. Because of the small sample size, demographics including blood pressure, temperature, medications, laboratory tests, height and weight were not analyzed in relation to the development of pressure ulcers.

Selection bias may have occurred as there is no way of accurately predicting a patient's length of stay. The raters were given their tools three weeks prior to the beginning of the study so that they could use the tool and familiarize themselves with the tool, and thus eliminate the threat of instrumentation.

Recommendations include replicating this study in an extended care facility with a sample size of 100 to 150 subjects. The same procedure is recommended; that is, a different person would be assigned to rate each scale and an independent person would assess skin condition. It might be

advisable to change the cutoff point of the Norton Scale from 14 to 12 to reduce the number of false positive ratings. Another recommendation would be for each data collector to visit, interview and assess each subject (except skin assessment) to clarify ambiguous categories on the scales or gather information missing from the chart. Interviewing the primary caregiver would also be useful for clarification, however, this would add additional time for completion of each assessment.

The hospitals and extended care facilities vary in the ages of clients and length of stay. Extended care facilities have a population of older adults whereas acute care institutions' populations are inclusive of all age groups. Acute care institutions are more likely to use the special beds (e.g., Ken-Air, Clinitron) whereas extended care facilities are more likely to use eggcrates and heel protectors in prevention and treatment. Hospitals are generally more aggressive in treatment of pressure ulcers and they have more treatment options available than extended care facilities.

The tool that is chosen by each institution should have categories that are clearly defined and understood by the data collectors. It may make a difference if an RN, LPN or other trained personnel are using the tool. The categories of each tool need to have a relationship to the development of pressure ulcers. A study of sensitivity and specificity is recommended so that a cut-off point is established that

corresponds to the actual number of pressure ulcers that develop. A suitable tool would be cost effective to use and be in the client's best interest. A suitable tool would also have low to no false positives to be cost effective and no false negatives in which the clients are missed and they do develop pressure ulcers.

REFERENCES

REFERENCE LIST

- Abbey, J. (1985). Commentary. Western Journal of Nursing Research, 7, 75-79.
- Agency for Health Care Policy and Research. (1990, February). Nursing advisory panel for guideline development: Summary. Rockville, MD.
- Bereck, K. (1975). Etiology of decubitus ulcers. Nursing Clinics of North America, 10(1), 157-169.
- Bergstrom, N., Braden, B., Laquzza, A., & Holman, V. (1987) The Braden Scale for predicting pressure sore risk. Nursing Research, 36, 205-210.
- Bergstrom, N., Braden, B., Laquzza, A., & Holman, V. (1985) The Braden Scale for predicting pressure risk: Reliability studies. Nursing Research, 34, 383.
- Bergstrom, N., Demuth, P., & Braden, B. (1987). A clinical trial of the Braden Scale for predicting pressure sore risk. Nursing Clinics of North America, 22(2), 417-428.
- Braden, B. & Bergstrom, N. (1987). A conceptual schema for the study of the etiology of pressure sores. Rehabilitation Nursing, 12, 8-12.
- Braden, B. & Bergstrom, N. (1989). Clinical utility of the Braden Scales for predicting pressure sore risk, Decubitus, 2(3), 44-51.

- Brown, M., Boosinger, J., Black, J. & Gaspar, T. (1985).
Nursing innovation for prevention of decubitus ulcers
in long term care facilities. Plastic Surgical
Nursing, 57-64.
- Daechsel, D. & Conine, T. (1985). Special mattresses:
Effectiveness in preventing decubitus ulcers in chronic
neurological patients. Archives of Physical Medicine &
Rehabilitation, 66, 246-248.
- Daly, S. (1985). The Daly Scale. Unpublished manuscript.
- Fawcett, J. (1984). Neuman's systems model. Analysis and
evaluation of conceptual models of nursing (pp.
145-174). Philadelphia: F. A. Davis Company.
- Fitzpatrick, J. & Whall, A. (1983). The Betty Neuman
health care system model. Conceptual models of
nursing: Analysis and application (pp. 203-219).
Bowie, Maryland: Prentice-Hall Publishing and
Communications Company.
- Goldstone, L., & Goldstone, J. (1982). The Norton Score:
An early warning of pressure sores? Journal of
Advanced Nursing, 7, 419-426.
- Gosnell, D. (1973). An assessment tool to identify
pressure sores. Nursing Research, 22(1), 55-59.
- Gosnell, J. (1987). Assessment and evaluation of pressure
sores. Nursing Clinics of North America, 22(2),
399-416.

- Griffith-Kenney, J. & Christensen, P. (1986). Neuman's health-care systems model. Nursing process: Application of theories, frameworks and models (pp. 25-27). St. Louis: The C. V. Mosby Company.
- Ira, P. (1987). The Sensitivity, Specificity and Predictive Value of Three Pressure Sore Risk Scales. Unpublished manuscript.
- Kosiak, M. (1959). Etiology and pathology of ischemic ulcers. Archives of Physical Medicine & Rehabilitation, 40, 62-69.
- Kosiak, M. (1961). Etiology of decubitus ulcers. Archives of Physical Medicine & Rehabilitation, 42, 19-29.
- Larson, E. (1986). Evaluation validity of screening tests. Nursing Research, 35(3), 186-188.
- Linares, H., Mawson, A., Suarez, E., & Biundo, J. (1987). Association between pressure sores and immobilization in the immediate post-injury period. Orthopedics, 10(4), 571-573.
- Lincoln, R., Roberts, R., Maddox, A., Levine, S., & Patterson, C. (1986). Use of the Norton pressure sore risk assessment scoring system with elderly patients in acute care. Journal of Enterostomal Therapy, 13, 132-138.
- Maklebust, J., Mondoux, L., & Siegreen, M. (1986). Pressure relief characteristics of various support surfaces used in prevention and treatment of pressure ulcers. Journal of Enterostomal Therapy, 13, 85-89.

- Neuman, B. (1974). The Betty Neuman health care systems model: A total person approach to patient problems. In J. P. Riehl and C. Roy. Conceptual Models for Nursing Practice. New York: Appleton-Century-Crafts.
- Neuman, B. (1980). The Betty Neuman health care systems model: A total person approach to patient problems. In J. P. Riehl and C. Roy. Conceptual Models for Nursing Practice (2nd ed.). New York: Appleton-Century-Crafts.
- Norton, D., McLaren, R., & Exton-Smith, A. (1962). Pressure sores, in an investigation of geriatric problems in hospitals. London: The National Corporation for the Care of Old People.
- Pajik, M., Craven, G., Cameron-Barry, J., Shipps, T., & Bennum, N. (1986). Investigation of the problem of pressure sores. Journal of Gerontological Nursing, 12, 11-16.
- Roberts, B. & Goldstone, L. (1979). A survey of pressure sores in the over sixties on two orthopaedic wards. Intern Journal Studies, 16, 355-364.
- Sather, W., Allen, S. & George, J. (1977). Pressure sores and the spinal cord injury patient. Drug Intelligence and Clinical Pharmacy, 2, 154-169.
- Tepperman, P., Zwireck, C., Chiarcossi, A., & Jimenez, J. (1977). Pressure sores: Prevention and set-up management. Postgraduate Medicine, 62, 83-89.

APPENDICES

APPENDIX A

Norton Scale: Pressure Sore Risk Assessment Scoring System

Date _____ Evaluator _____

Rm. Number _____

Patient Assessment Form

Patient Number/ Code	PHYSICAL CONDITION		MENTAL CONDITION		ACTIVITY		MOBILITY		INCONTINENT		TOTAL SCORE
	Good	4	Alert	4	Ambulant	4	Full	4	Not	4	
	Fair	3	Apathetic	3	Walk/help	3	Sl limited	3	Occasional	3	
	Poor	2	Confused	2	Chairbound	2	V limited	2	Usually Urine	2	
	V Bad	1	Stupor	1	Bed	1	Immobile	1	Doubly	1	

Source: Norton D., McLaren R., Exton-Smith, A. (1962).
 Pressure sores in an investigation of geriatric nursing
 problems in hospitals, London: The National
 Corporation for the Care of Old People.

Total score is determined by adding the individual scores
 for the five components.

APPENDIX B

Pressure Sore Risk Assessment Scoring System (Norton Score)*

Physical Condition	4	Mental State	4	Activity	4	Mobility	4	Incontinence	4
Good	4	Alert	4	Ambulant	4	Full	4	Not	4
Fair	3	Apathetic	3	Walks with help	3	Slightly limited	3	Occasionally	3
Poor	2	Confused	2	Chairbound	2	Very limited	2	Usually urinary	2
Very bad	1	Stuporous	1	Bedfast	1	Immobile	1	Double	1

* Reproduced from Norton D. McLaren R. Exton-Smith AN: An investigation of geriatric nursing problems in hospitals. Edinburgh, 1975. Churchill Livingstone. (Original work published in London, 1962, National Corporation for the Care of Old People.)

Total score is determined by adding the individual scores for the five components.

GENERAL CONDITION--Encompasses current medical condition and physical health (Consider nutritional status, tissue integrity, muscle bulk, and condition of skin.)

Good = stable medical condition, appears healthy and well nourished

Fair = generally stable medical condition, appears fairly healthy

Poor = unstable medical condition, appears unhealthy

Very Bad = critical medical condition, appears acutely ill

MENTAL STATUS--Encompasses level of consciousness and orientation

Alert = oriented x 3, aware of surroundings

Apathetic = oriented x 2-3, dull affect, passive

Confused = oriented x 1-2, conversation inappropriate at times

Stuporous = generally unresponsive, lethargic

ACTIVITY--Degree to which subject is ambulatory

Ambulant = able to walk independently, includes cane/walker

Walks with help = unable to walk without human assistance

Chairbound = walks only to chair, limited to chair by condition and/or physician's orders

Bedfast = confined to bed due to condition and/or physician's orders

MOBILITY--Degree to which controls and moves extremities

Full = moves and controls all extremities at will, independent in moving

Slightly limited = able to control and move extremities, but some degree of limitation, needs assistance to change position

Very limited = unable to change position without help, offers minimal assistance with moving, paralysis, contractures

Immobile = No ability to move, unable to change position

INCONTINENCE--Degree to which subject has control of bowel/bladder

Not = total control of bowel and bladder (exceptions: with diagnostic tests), has Foley catheter and no bowel incontinence

Occasionally = has had 1 to 2 episodes of urine/feces incontinence in 24 hours (not related to laxatives/enemas), has condom catheter, has Foley catheter but has inconsistent stools

Usually urinary = has had 3 to 6 episodes of urinary incontinence or diarrheal stools in past 24 hours

Double = never able to control bowel and bladder function, has 7 to 10 episodes in 24 hours

Source: Lincoln, R., Roberts, R., Maddox, A., Levine, S., & Patterson, C. (1986). Use of the Norton Pressure Risk Assessment Scoring System with elderly patients in acute care. Enterostomal Therapy, 13, 132-138.

APPENDIX C

Calculating Sensitivity and Specificity

1a. FORMULA				1b. EXAMPLE: Does the patient have a urinary tract infection?				
TEST				NURSE ASSESSMENT				
Reference ("gold") standard	Yes	Yes a	No b	Urine culture	Yes	17	9	26
	No	c	d		No	1 18	20 29	21 47
a = True positives (TP) b = False negatives (FN) c = False positives (FP) d = True negatives (TN)								
TERM	DEFINITION			FORMULA	EXAMPLE			
Sensitivity	Proportion of those with the condition who have a positive test			$a/a+b$ (TP/TP+FN)	17/26 = 65.4%			
Specificity	Proportion of those without the condition who have a negative test			$d/c+d$ (TN/FP+TN)	20/21 = 95.2%			
Predictive value of a positive test	Proportion of those with a positive test who have the condition			$a/a+c$ (TP/TP+FP)	17/18 = 94.4%			
Predictive value of a negative test	Proportion of those with a negative test who do not have the condition			$d/b+d$ (TN/FN+TN)	20/29 = 69.0%			
False positive rate (1-Specificity)	Proportion of those without condition who have a positive test			$c/c+d$ (FP/FP+TN)	1/21 = 4.8%			
False negative rate (1-Sensitivity)	Proportion of those with the condition who have a negative test.			$b/a+b$ (FN/TP+FN)	9/26 = 34.6%			

Source: Larson, E. (1986). Evaluating validity of screening tests. Nursing Research, 35(3), 186-188.

PLEASE NOTE

Copyrighted materials in this document have not been filmed at the request of the author. They are available for consultation, however, in the author's university library.

APPENDIX E

DALY SCALE

Date _____ Evaluator _____
 Patient Number/Code _____ Rm. Number _____

GOOD - 4 FAIR - 3 POOR - 2 VERY BAD - 1

<u>Physical condition:</u> (ADL - level of assistance required)	<u>Fully active:</u> Able to perform own ADL.	May be assisted by physical condition, but functions independently. Rate of completion of ADL may be slowed.	Requires assistance to complete some ADL.	Totally dependent on others for ADL.	
<u>Mental condition:</u> (Speed and content of response - TFF)	<u>Alert</u> Oriented to time, place and person. Responds appropriately to stimuli.	<u>Withdrawn</u> Oriented to time, place and person on repeated questioning. Responds appropriately to stimuli, but response is slow or delayed.	<u>Disoriented</u> Partial or intermittent orientation to time, place and person. Responds to stimuli appropriately only part of the time.	<u>Stuporous</u> Totally disoriented or unresponsive.	
<u>Activity level:</u> Ambulation - distance and independence.	<u>Ambulatory</u> Fully ambulatory. May use device to assist.	<u>Walk/Help</u> Walks with assistance of person and/or device, i.e., braces, crutches, walker.	<u>Chair</u> Walks only to chair with help or is confined to wheelchair.	<u>Bedfast</u> Confined to bed/ cardiac chair during entire 24 hours.	
<u>Mobility:</u> Amount and control of body movement.	<u>Full</u> Can control and move extremities at will; may need device, but can lift, turn, pull, balance and sit up at will.	<u>Slightly limited</u> May or may not control and move extremities, but requires help to change position.	<u>Very limited</u> Offers minimal assistance in helping to change position. Requires extensive assistance.	<u>Immobile</u> Does not assist self in any way to change position.	
<u>Moisture containment of skin.</u>	<u>No</u> Total control of urine and feces.	<u>Occasionally</u> Occasionally incontinent of urine or indwelling catheter in place. Occasional stool incontinence.	<u>Usually (urine)</u> Often incontinent of urine; occasional incontinence of stool. Diaphoresis.	<u>Urine & stool</u> Usually incontinent of both urine and feces. Extreme diaphoresis.	
<u>Nutrition/Fluid:</u>	Weight within normal limits. Normal skin turgor. Serum albumin 3.8 or greater.	Stable underweight. Stable overweight. Skin dry/flacid. Urine SG = 1.010-1.015. Scanty urine output. Serum albumin 3.5-3.8.	10% weight loss over 6 months. Obese. Serum albumin 3.0-3.5. Scant urine output with no renal disease.	Emaciated/losing weight rapidly (>10%/6 months) Scant urine output with no renal disease SG 1.020 or greater. Serum albumin <3.0.	
<u>Presence of disease with inherent potential for alteration in skin condition.</u>	No vascular disease, DM., neuropathy, or other disease contributing to dermal ulcer. Normal sensation.	Controlled D.M. Beginning vascular disease. Stage I Ulcer(s) present on bony prominences. Brown pigmentation around ankles with stasis dermatitis.	Brittle D.M., neuropathy, advanced vascular disease. Stasis or arterial ulcers. Stage II ulcer over bony prominences. Edema of ankles and feet (3+).	Stage II or greater ulcer over bony prominences. Massive body edema. Burns or grafts posteriorly. Lack of sensation below waist.	
<u>Cardiovascular state</u>	Hgb, Hct WNL for age, sex. No interventions required to maintain blood pressure.	Hgb 10-12 gms. No interventions required to maintain blood pressure.	Hgb 10-12 gms. Requires vasoactive drugs to maintain adequate blood pressure.	Hgb < 10 gms. Requires vasoactive drugs to maintain adequate blood pressure.	

Total Score _____

APPENDIX F

Verbal Script

Hello, my name is Sharon Marini. I am doing a study about skin problems as part of my masters thesis. The purpose of the study is to find a way of knowing which patients may develop pressure ulcers before they get them.

I would like you to help me in this study. If you agree to be a part of the study, your skin will be looked at by me every two to three days for a maximum of six times. The exam will take less than 10 minutes. I will look at areas of your skin that usually get pressure ulcers. Three other R.N.'s will review your chart and may ask you some questions.

If you do not want to be a part of the study, that is all right. If you want to be part of the study, I will ask you to sign a consent form. Your name will not be used in the study. You may leave the study at any time without explanation. Do you have any questions that you would like to ask me now? Thank you.

APPENDIX G

Informed Consent Form

The research study has been explained to me. I understand that the purpose of the study is to find a way of knowing which patients are likely to get pressure ulcers before they get them.

I further understand that:

My skin will be looked at every two to three days by one nurse.

My chart will be reviewed by three nurses.

My participation is voluntary.

I am free to drop out of the study at any time without it influencing the care I receive.

My name will not be used in the study, all information is confidential.

Although I see no risk of injury to me, there will be no reimbursement, compensation or free medical care offered by Grand Valley State University or Memorial Medical Center should injury occur.

I will receive a copy of this signed consent form.

I have discussed this study with Sharon Marini and my questions have been answered to my satisfaction. Any further questions I have may be answered by calling Sharon at (219) 277-5966.

I have read and understand the description of this study and my rights as a subject. On the basis of the above statements, I agree to participate in this study.

Patient's Signature

Date

Researcher's Signature

Patient's code number

_____ check here if copy is left with patient.

APPENDIX H

PRESSURE SORE DATA COLLECTION QUESTIONNAIRE

NURSE IV: DEMOGRAPHIC DATA

Subject's Rm # _____ Subject Code _____

1. Type of Unit _____
2. Date of Admission:
 - a) To Agency _____
Month Day Year
 - b) To Study _____
Month Day Year
3. Age _____
4. Race (check one):
 White American Indian Oriental
 Black Hispanic Other (specify)
5. Sex (check one):
 Male
 Female
6. Height _____ ft. _____ inches or _____ cm.
7. Weight _____ (circle: lbs. or kg.)
8. Primary Diagnosis _____
Secondary Diagnoses _____

10. Smoker (check one):
 Yes
 Formerly
 Never

NB 9/25/88
Reprinted with permission of Nancy Bergstrom

APPENDIX I

PRESSURE SORE DATA COLLECTION QUESTIONNAIRE
NURSE IV: MONITORING AND SKIN PROTECTION TOOL

Subject's Rm # _____ Subject Code _____

12. DATE OF OBSERVATION: _____

Observation:

13. Lowest diastolic blood pressure _____

14. Highest body temperature _____

15. Steroid therapy (yes/no) _____

16. Serum albumin (g/dl) _____

17. Lymphocyte count (%) _____

18. WBC count (&) _____

19. Skin Protection Interventions (yes/no/or as specified):

1) Specify mattress/pad (specify _____) _____

2) Specify bed (specify _____) _____

3) Sheepskin _____

4) Elbow protectors _____

5) Heel protectors _____

6) Occlusive dressing _____

7) Calf pad _____

8) Turning (record frequency) _____

9) Other (specify) _____

9/25/88

APPENDIX J

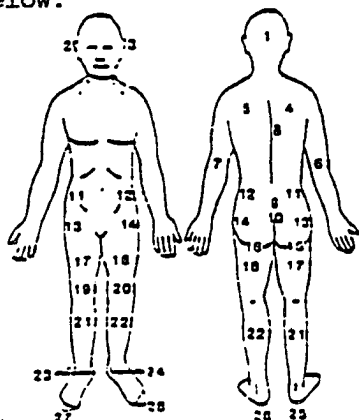
Subject's Rm # _____ Subject Code _____

1. DATE OF OBSERVATION:

2. Assessment Site*

				<u>Skin Condition</u>		
	<u>Stage</u>	<u>Size</u>	<u>Depth</u>	<u>Stage</u>	<u>Size</u>	<u>Depth</u>
1) Back of head.....	_____	_____	_____	_____	_____	_____
2) Right ear.....	_____	_____	_____	_____	_____	_____
3) Left ear.....	_____	_____	_____	_____	_____	_____
4) Right scapula.....	_____	_____	_____	_____	_____	_____
5) Left scapula.....	_____	_____	_____	_____	_____	_____
6) Right elbow.....	_____	_____	_____	_____	_____	_____
7) Left elbow.....	_____	_____	_____	_____	_____	_____
8) Vertebrae (upper-mid).....	_____	_____	_____	_____	_____	_____
9) Sacrum.....	_____	_____	_____	_____	_____	_____
10) Coccyx.....	_____	_____	_____	_____	_____	_____
11) Right iliac crest.....	_____	_____	_____	_____	_____	_____
12) Left iliac crest.....	_____	_____	_____	_____	_____	_____
13) Right trochanter (hip)....	_____	_____	_____	_____	_____	_____
14) Left trochanter (hip).....	_____	_____	_____	_____	_____	_____
15) Right ischial tuberosity..	_____	_____	_____	_____	_____	_____
16) Left ischial tuberosity...	_____	_____	_____	_____	_____	_____
17) Right thigh.....	_____	_____	_____	_____	_____	_____
18) Left thigh.....	_____	_____	_____	_____	_____	_____
19) Right knee.....	_____	_____	_____	_____	_____	_____
20) Left knee.....	_____	_____	_____	_____	_____	_____
21) Right lower leg.....	_____	_____	_____	_____	_____	_____
22) Left lower leg.....	_____	_____	_____	_____	_____	_____
23) Right ankle (inner/outer)..	_____	_____	_____	_____	_____	_____
24) Left ankle (inner/outer)..	_____	_____	_____	_____	_____	_____
25) Right heel.....	_____	_____	_____	_____	_____	_____
26) Left heel.....	_____	_____	_____	_____	_____	_____
27) Right toe(s).....	_____	_____	_____	_____	_____	_____
28) Left toe(s).....	_____	_____	_____	_____	_____	_____
29) Other (specify).....	_____	_____	_____	_____	_____	_____

*Assess each site and record each observation time. Mark site(s) on figure below.



Stage Key

- Stage 0 No redness or breakdown
- Stage 1 Erythema only: redness does not disappear within 15 min.
- Stage 2 Break in skin such as blisters or abrasions
- Stage 3 Break in skin exposing subcutaneous tissue
- Stage 4 Break in skin extending through tissue and subcutaneous layers, exposing muscle or bone

NB 9/25/88

Reprinted with permission of Nancy Bergstrom