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**PRESSURE ULCERS IN A NEUROSCIENCE POPULATION: A SECONDARY
ANALYSIS OF PREVALENCE, SEVERITY AND CLINICAL RISK FACTORS**

By

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Thesis submitted to the School of Graduate Studies and Research
in partial fulfillment of the requirements for the
degree of Master of Science in Nursing

University of Ottawa

December 1999

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Abstract

Clients in health care settings have many complex problems, one of which may be the development of pressure ulcers. Specific patient populations, such as the neuroscience population, have been identified as high risk for pressure ulcer development due to the similarity of the clinical risk factors for pressure ulcers and those that hallmark neurological illness. However, the prevalence and severity of pressure ulcer development for neuroscience patients in tertiary settings is unknown. Understanding the extent of the problem is essential in planning prevention and treatment strategies.

The purpose of the study was to describe and compare, in a tertiary care setting, the prevalence and severity of pressure ulcers in the neuroscience population to a non-neuroscience population. This study was guided by a conceptual schema that provided a physiological basis for the development of pressure ulcers. The presence of contributory clinical risk factors was compared between the two populations. The neuroscience population included patients admitted to the neurology and neurosurgery services (40 bed unit) while the remainder of the hospital population comprised the non-neuroscience population. A secondary analysis method was used to compare data obtained from four annual pressure ulcer prevalence studies conducted from 1993-1996. The instruments used were the Demographic and Clinical Profile Form, a Prevalence Grid and the Braden Scale for Pressure Sore Risk. Trend analysis and yearly comparisons were conducted with a level of statistical significance set at $p = 0.05$ level with a clinically important difference of ten percent or greater.

Important differences were found between the neuroscience and non-neuroscience population. There was a significant decrease in the prevalence of all stage ulcers and stage 2 and higher ulcers in the neuroscience population over the four years. The neuroscience population had a higher proportion of patients with the clinical risk factors of sensory perception, moisture, activity, mobility, and friction/shear categories in 1993 - 1995, while the non-neuroscience population demonstrated higher clinical risk with nutrition.

Similarities found between the populations included advancing age, and a decrease in the severity and numbers of ulcers. The greatest area of concern for pressure ulcer development was the coccyx, sacrum and ischial tuberosity.

Study implications for practice include on-going risk assessment, especially in the elderly population, as well as skin, moisture, nutritional, and mechanical loading interventions that reduce or minimize the potential of pressure ulcer development. Implications for research include further development and testing of a new conceptual framework that incorporates assessment for pressure ulcer risk in the neuroscience population.

Acknowledgments

During my experience at graduate school, I have had the pleasure of working with many people who have guided and supported me. It is with fond regards that I acknowledge their support to achieve this worthwhile endeavor.

I am indebted to my thesis advisor Dr. Jo Logan who provided me with mentorship and support throughout this process. I am proud to have been your student. A heart-filled thank-you goes to committee member Dr. Margaret Harrison who has nurtured me in my thesis topic from both clinical and research perspectives. A special thanks goes to committee members Dr. Frances Fothergill-Bourbonnais for the encouragement and guidance during many of the thesis drafts, and to Dr. George Wells who kindly offered statistical support. The opportunity provided me through the nursing research fellowship at the Loeb Health Research Institute from the Neuroscience Programs of Excellence was instrumental in the tangible support provided to me during graduate school.

To my many friends from the Thesis in Progress Support (TIPS) group, a big thank-you for all your words of encouragement and sincere interest in my topic, even when you thought I had too much data! To my many friends that have been on hold for four years, I look forward to good times together and appreciate your solid friendship and patience.

Last but far from least, I acknowledge the love and support from my family who have been there to listen to me and understood my physical absence. Special love to my son Richard who has been very patient while his Mom's at school, as well as my mother Maxine who is proud of me no matter what I do.

Table of Contents

Abstract.....	ii
Acknowledgments.....	iv
List of Tables.....	vii
List of Figures.....	viii
Definition of Terms.....	x
Chapter One.....	1
Introduction.....	1
Statement of the Problem.....	4
Purpose and Objectives.....	6
Chapter Two: Conceptual Framework and Literature Review.....	8
Introduction.....	8
Conceptual Schema of Pressure Ulcer Development.....	9
Literature Review on Pressure Ulcer Development in Tertiary Settings	13
Clinical Risk Factors: Pressure	13
Clinical Risk Factors : Tissue Tolerance.....	18
Literature Review of Clinical Risk Factors in the Neuroscience	
Population	27
Pressure Ulcer Development: Prevalence, Incidence and Severity	37
Pressure Ulcer Development: Prevalence, Incidence and Severity of	
Pressure Ulcers in the Neuroscience Population.....	50
Chapter Three: Methods.....	56
Design.....	56
Secondary Analysis Methods.....	57
Study Variables.....	59
Setting and Sample.....	59
Instruments.....	61
Data Analysis	64
Ethical Considerations.....	68
Chapter Four: Results.....	69
Setting and Population.....	69
Characteristics of the Neuroscience and Non-neuroscience	
populations.....	71
Pressure Ulcers: Prevalence	74
Pressure Ulcers: Severity.....	77
Ulcer site occurrence.....	80
Clinical Risk Factors.....	83
Types of clinical risk factors.....	84
Chapter Five: Discussion.....	92
General Summary of Findings	92

Table of Contents

Prevalence.....	93
Clinical Risk Factors	96
A Neuroscience Pressure Ulcer Conceptual Framework.....	100
Implications for Practice.....	102
Implications for Advanced Practice Nurses.....	109
Implications for Research.....	114
Study Limitations.....	116
References.....	118
Appendices:.....	
A Pressure Ulcer Staging: A Literature Review	131
B Research Instruments:	132
Demographic and Clinical Profile Form.	
The Braden Scale for Predicting Pressure Sore Risk	
The Ottawa Civic Hospital (OCH) Prevalence Grid	
C The Agency for Health Care Policy and Research Pressure Ulcer Staging.....	133
D Ethics Approval:.....	134
Pressure Ulcer Prevalence Study Principle Investigator	
Ottawa Civic Hospital Nursing Research Committee.	
Ottawa Civic Hospital Ethics Committee	
E Pressure Ulcer Prevalence (PUP) Population Flow Charts:.....	135
1993	
1994	
1995	
1996	
F Technical Tables.....	136

List of Tables

Table 1	Summary of the Literature Findings on the Significant Clinical Risk Factors Found in Patients with Pressure Ulcers from Tertiary Settings.....	15
Table 2	Summary of the Literature Findings on the Significant Clinical Risk Factors Found in Neuroscience Patients with Pressure Ulcers from Acute and Rehabilitation Settings.....	31
Table 3	Summary of the Literature on Prevalence and Severity of Pressure Ulcers Conducted in Tertiary Settings.....	41
Table 4	Summary of the Literature on Incidence and Severity of Pressure Ulcers Conducted in Tertiary Settings.....	47
Table 5	Summary of the Literature on Prevalence, Incidence and Severity of Pressure Ulcers Conducted in the Neuroscience Population.....	51
Table 6	Pressure Ulcer Prevalence Study Methods: 1993-1996.....	60
Table 7	Clinical Risk Factors for Pressure Ulcer Development Descriptors From the <i>Braden Scale</i> , Using the Concept of Risk Versus No Risk.....	67
Table 8	The Neuroscience and Non-neuroscience Population from 1993-1996.....	70
Table 9	Numbers of Pressure Ulcers Found in the Neuroscience and Non-neuroscience Population.....	80
Table 10	The Major Similarities and Differences found between the Neuroscience and Non-neuroscience Population from 1993-1996.....	92

List of Figures

Figure 1	The Conceptual Schema for the Etiology of Pressure Ulcers.....	11
Figure 2	Factors in the Neurologically Impaired Patient that Contribute to the Risk of Pressure Area Damage.....	28
Figure 3	Median Ages of the Neuroscience and Non-neuroscience Population: 1993-1996.....	71
Figure 4	Age Categories in the Neuroscience Population from 1993 to 1996..	72
Figure 5	Age Categories in the Non- neuroscience Population from 1993 to 1996.....	73
Figure 6	Neuroscience Population Time in Hospital: 1993 - 1996.....	74
Figure 7	Non-neuroscience Population Time in Hospital: 1993 - 1996.....	75
Figure 8	Prevalence of All Stage Ulcers in the Neuroscience and Non-neuroscience Population from 1993 to 1996.....	76
Figure 9	Prevalence of Stage 2 and Higher Ulcers in the Neuroscience and Non-neuroscience Population from 1993 to 1996.....	77
Figure 10	Severity of Pressure Ulcers in the Non-neuroscience Population from 1993 to 1996.....	78
Figure 11	Comparison of Stage 1 Pressure Ulcers in the Neuroscience and Non-neuroscience Population from 1993 to 1996.....	79
Figure 12	Body Site Location of All Stage Ulcers in the Neuroscience Population.....	82
Figure 13	Body Site Location of All Stage Ulcers in the Non-neuroscience Population.....	82
Figure 14	Body Site Location of Stage 2 and Higher Ulcers in the Non-neuroscience Population.....	83
Figure 15	Proportion of Neuroscience and Non-neuroscience Population at Risk for Pressure Ulcer Development Based Upon the Braden Scale.	84

List of Figures

Figure 16	Proportion of Neuroscience and Non-neuroscience Population with the Clinical Risk Factor of Sensory Perception.....	86
Figure 17	Proportion of Neuroscience and Non-neuroscience Population with the Clinical Risk Factor of Moisture.....	86
Figure 18	Proportion of Neuroscience and Non-neuroscience Population with the Clinical Risk Factor of Activity.	87
Figure 19	Proportion of Neuroscience and Non-neuroscience Population with the Clinical Risk Factor of Mobility.	88
Figure 20	Proportion of Neuroscience and Non-neuroscience Population with the Clinical Risk Factor of Nutrition.	89
Figure 21	Proportion of Neuroscience and Non-neuroscience Population with the Clinical Risk Factor of Friction /Shear.....	90
Figure 22	Potential Clinical Risk Factors related to the Development of Pressure Ulcers in the Neuroscience Population (LJ) Framework....	102

Definition of Terms

The following definition of terms provides the reader with information regarding specific terminology used to describe pressure ulcers and their analyses.

Pressure Ulcer(s)

A pressure ulcer is defined as any lesion caused by unrelieved pressure resulting in damage to underlying tissue (AHCPR, 1992). Pressure ulcers usually occur over bony prominences and are graded or staged to classify the degree of tissue damage observed (AHCPR, 1992, International Association of Enterostomal Therapist, 1988; Shea, 1975).

Staging of Ulcers

A classification system that describes the physical characteristics of pressure ulcers based on evidence of tissue damage (AHCPR, 1992). The classification system used in research studies may have anywhere from four to seven descriptive stages. Since the publication of the AHCPR Clinical Practice Guidelines (1992), the classification system of four ulcer stages has been recommended and is now widely used in the research field. AHCPR (1992; 1994) recognizes the limitations of the use of the four pressure ulcer stages which does not include those ulcers covered with eschar, thus preventing accurate staging.

Prevalence

A cross-sectional count of the number of cases of interest at a specific point in time and includes all cases (AHCPR, 1992). It represents a proportion of the population with the condition and is reported as a percentage. Cases excluded from the study due to no risk must be reported (Frantz, 1997).

Prevalence of ulcers are reported as: all stage ulcers which include stage 1-4 and for this study includes stage X.

The number of cases with the condition on data collection day X 100

The number of cases included in the data collection
(Frantz, 1997)

Incidence

A count of the number of new cases that develop over a specified period of time (AHCPR, 1992). Incidence represents a proportion of the population and is reported as a percentage.

The number of at risk patients developing the condition per time period X 100

The number of at risk patients admitted per time period
(Frantz, 1997)

Severity of Pressure Ulcers

Severity of pressure ulcers includes the following categories:

- staging of ulcers - how many cases had which stage of ulcer. This is often reported as:
 - all stage ulcers (stage 1 - 4 and Stage X)
 - stage 2 and higher (stage 2 - 4 and Stage X).
- numbers of ulcers and sites of ulcers - the total number of ulcers from all the cases.
- body site prevalence - the total number of ulcers per body site.

Clinical Risk Factors

Factors that have been identified in the research literature as having a relationship with the formation of pressure ulcers. Risk is the probability that the condition of concern will or will not occur.

Shear

Force per unit magnitude of the area acting parallel to the surface of the body. This parameter is affected by the pressure, the coefficient of friction between the materials contracting each other, and how much the body interlocks with the support surface (AHCPR, 1992 p 57).

CHAPTER ONE

Introduction

In this chapter the problem of pressure ulcers as a health care concern is introduced. The rationale for the study is provided, and its contribution to addressing gaps in the literature is described .

Clients in tertiary health care settings have many complex health problems, one of which may be the development of pressure ulcers. A pressure ulcer is defined by the National Pressure Ulcer Advisory Panel (NPUAP) as "localized area of tissue necrosis that tends to develop when soft tissue is compressed between a bony prominence and an external surface for a prolonged period of time" (p. 25). The problem of pressure ulcers is complex and is related to many factors. Clinical risk factors such as impaired mobility and activity, decreased sensory perception, incontinence and malnutrition have been identified as contributing directly and indirectly to the development of pressure ulcers (Berlowitz & Wilking, 1989; Bergstrom, Braden, Laguzza, & Holman, 1987; Braden, 1997; Sparks, 1992). Non-clinical factors have also been identified and include the susceptibility of individuals related to circumstances of illness, personal beliefs and values, socioeconomic variables and the ability to participate in their health care (Olshansky, 1994, Oot-Giromini et al., 1989, Sebern, 1996). Pressure ulcers complicate client recovery (Allman et al., 1986, Allman, 1989), prolong hospitalizations (Dallman et al., 1995; Meehan, 1990; National Pressure Ulcer Advisory Panel, 1989), prevent the patient moving along the expected health trajectory, increase health care costs (Xakellis & Frantz, 1996) and lengthen the time away from friends, family and personal life activities. Allman (1989) found the risk of death among geriatric patients increased

fourfold when a pressure ulcer develops and six-fold when a ulcer does not heal.

Increased length of stays have also been reported in patients with ulcers, thus impacting health care resources (Allman, 1997; Stotts, Deosaransingh, Roll, & Newman 1998).

Frantz, Bergquist, and Specht (1995) report treatment costs per patient to average slightly over \$600.00 per year in U.S funds, while Xakellis and Frantz (1996) found stage 3 and 4 ulcers to cost up to \$10,000, including treatment and nursing time. A study conducted for the Agency of Health Care Policy and Research (AHCPR) reported the total national cost of pressure ulcer treatment was estimated to exceed \$1.355 billion U.S. per year (Miller & Delozier, 1994). Once at home, the patient and caregiver may lack knowledge and skill in the management of pressure ulcers (Baharestani, 1994). The importance of predicting, preventing and treating pressure ulcers is essential in order to decrease human suffering, shorten length of stays and utilize health care dollars appropriately.

The maintenance of skin integrity is an important indicator of the quality of care a patient receives (Harrison, Logan, Joseph, & Graham, 1998) and is influenced by the complex interplay of individual, clinical and organizational factors. The involvement of numerous disciplines, the variety of approaches used to predict, prevent and treat pressure ulcers, and the organizational support given to this health care problem, all contribute to the complexity of prevention and management of pressure ulcers.

Pressure ulcers are a prominent health care concern in all patient care settings (Agency for Health Care Policy and Research, 1992, 1994; Langemo et al., 1991) and transcend all health care sectors. The magnitude of the problem has been identified from prevalence and incidence studies conducted in a variety of health care facilities and community settings. The prevalence of pressure ulcers from general health care settings has ranged

from 4.7% (Allman et al. 1986) to 32.1 % (Allcock, Wharrad & Nicolson, 1994). The incidence of pressure ulcers has ranged from 2.7% (Gerson, 1975) to 41.7% (Pieper, Sugrue, Weiland, Sprague, & Heiman 1998). Variation in prevalence and incidence is related to many factors, including the type of facility, the underlying medical condition, age of the persons involved as well as the quality of the study (Yarkony, 1994).

Concern regarding pressure ulcers has been expressed by practitioners both at local and national levels. The National Pressure Ulcer Advisory Panel (NPUAP), formed in the United States in 1987, is an independent, non - profit organization dedicated to the prevention and management of pressure ulcers. The first National NPUAP consensus conference identified the many issues of assessment and management of pressure ulcers. Following this conference, the Agency for Health Care Policy and Research (AHCPR), commissioned by the United States government, identified pressure ulcers as one of seven health care concerns that required an in-depth study to develop evidence-based practice recommendations for practitioners, researchers, and policy makers. The development of Clinical Practice Guidelines, defined as "systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical conditions" (AHCPR, 1992, p ii), provide direction and a standard of care for this complex problem. The publication of the clinical practice guideline *Prediction and Prevention of Pressure Ulcers* (AHCPR, 1992) and the subsequent publication *Treatment of Pressure Ulcers* (AHCPR, 1994) reflect the "current state of knowledge, as set out by the health care literature, regarding the effectiveness and appropriateness of procedures and practices designed to predict, prevent and treat pressure ulcers" (p. 13).

Statement of the Problem

The *Clinical Practice Guidelines* (AHCPR 1992 and 1994) provide a foundation for research based practice, however gaps remain in the knowledge of pressure ulcer development. For example, research findings (AHCPR, 1994) have demonstrated that specific sub-populations are at greater risk. Richardson and Meyer (1981) found a 60% prevalence in quadriplegic patients, while Versluisen (1986) found a 66% incidence rate in elderly patients admitted for femoral fracture. Bergstrom, Demuth and Braden (1987) found a 33% incidence rate in critical care patients while Robnett (1986) found a 41% prevalence rate in an intensive care setting. Both the prevalence and incidence rates in the mentioned groups, reflect a higher percentage of patients with pressure ulcers than seen in other health care populations. Determining the prevalence, severity, and specific clinical risk factors associated of pressure ulcer development in selected vulnerable populations remains an important research direction.

Neuroscience clients are potentially at greater risk for pressure ulcer development than other hospital clients. Many of the clinical risk factors identified as contributing to pressure ulcer development are clinical characteristics that hallmark neurological illness (Allman, 1989; Braden & Bergstrom, 1987, 1994; Jiricka, Ryan, Carvalho, & Bukvich, 1995). These factors include changes in level of consciousness, cognitive, perceptual and communicative problems, decreased mobility, sensory impairments, difficulty in maintaining nutrition, and incontinence (AHCPR Guideline, Post-Stroke Rehabilitation, 1995; Johnson, 1994; Salzberg et al. 1996). Many neurological conditions are commonly diagnosed and treated in tertiary care settings. The neurological outcome of head injury, spinal injury and stroke depend on the severity of the illness and the recovery process.

Patients with altered or limited neurological recovery may continue to exhibit clinical risk factors such as sensory perceptual changes, impaired mobility and activity, incontinence and poor nutrition, to name a few. Due to the similarity between clinical factors of neurological disease and the risk factors for pressure ulcer development, the neurological patient is at clinical risk throughout the course of the illness.

A hospital admission in a tertiary setting due to neurological illness is an entry point where one can examine the similarities between the clinical risk factors of neurological illness and the clinical risk factors for pressure ulcer development. Knowledge of the extent of clinical risk in the neurological population in tertiary settings is crucial to determine which factors are amenable to nursing action. Given the similarities of neurological and pressure ulcer risk, the neurologically impaired population may be particularly vulnerable to pressure ulcer development.

Descriptive information on prevalence, severity, and clinical risk factors has not been reported on pressure ulcer development in the neuroscience population from tertiary settings. Current prevalence and incidence studies tend to report overall hospital rates. A few specific neurological groups have been described, namely patients with strokes and spinal cord injuries. Pressure ulcer information on clients with stroke (Berlowitz & Wilking, 1989), and spinal cord injury reflect a variety of client settings such as rehabilitation sites (Hunter et al., 1992; Rodriguez & Garber, 1994) veteran homes (Salzberg et al. 1996) and community living (Garber, Rintaala, Rossi, Hart, & Fuhrer, 1996). Little is known about the prevalence, severity and clinical risk factors of pressure ulcers in a neuroscience population in a tertiary settings. Applying the information from neuroscience patients in chronic or rehabilitation health settings may not be appropriate to

determine the needs of the neuroscience population in an acute care setting. Without a clear description of the neuroscience population, prevention and treatment aspects may remain generic in nature and not meet the required needs.

Purpose and Objectives

A secondary analysis of data, from a four year period, was undertaken to describe and compare the extent of pressure ulcers in a neuroscience and non-neuroscience in-patient population from a tertiary care setting. The purpose of the study was to describe the neuroscience population and determine if differences existed between the two populations.

The study objectives were to:

1. Determine the prevalence rate of pressure ulcers in an inpatient tertiary care neuroscience population and compare it to a non-neuroscience population.
2. Determine the severity of pressure ulcers in an inpatient tertiary care neuroscience population and compare it to the non-neuroscience population.
3. Compare the sites of pressure ulcer occurrence in the neuroscience population and the non-neuroscience population.
4. Compare the presence or absence of clinical risk factors in the neuroscience population and the non-neuroscience population.
5. Compare the type of clinical risk factors that contribute to pressure ulcer development in the neuroscience and the non-neuroscience populations.

In summary, pressure ulcers continue to be a complex health care problem across all health care sectors. Due to the complexity of the problem, Clinical Practice Guidelines (AHCPR, 1992, 1994) have been developed to assist the practitioner and client in

applying evidence-based care. Measures to maintain skin integrity and monitor pressure ulcers have become an important priority in assessing the quality of care patients receive in hospital. Within the hospitalized environment certain populations such as the neuroscience population, may be at high risk for pressure ulcer development. Information on the prevalence, severity, and clinical risk factors of pressure ulcers in the neuroscience population is lacking and specific research questions have been established in this study to determine the nature and extent of the problem. The information obtained from this research will specifically aid in planning nursing interventions and provide decision-makers with information that will contribute to organizational planning for this population.

The next chapter will focus on the conceptual framework that has been reported in the literature and is used in this study. Following that, the findings from the literature review on prevalence, severity and the clinical risk factors will be presented.

CHAPTER TWO

Conceptual Framework and Literature Review

This chapter includes the conceptual framework and the literature review. A conceptual schema used in defining the etiology of pressure ulcer development is presented. The empirical findings on the prevalence, severity, and clinical risk factors that contribute to pressure ulcer development that have been reported in acute tertiary settings and in particular the neuroscience population are discussed.

Introduction

The definition of a pressure ulcer has developed over time (AHCPR, 1992; Braden & Bergstrom, 1987; NPUAP, 1988; Shea, 1975). Skin ulceration due to pressure and shear has been frequently referred to as decubitus ulcers, bed sores, ischemic ulcers, and pressure sores. While Braden and Bergstrom (1987) used the term "pressure sore" to denote a lesion on any skin surface that occurs as a result of pressure and includes reactive hyperemia as well as blistered skin, broken or necrotic skin, the National Pressure Ulcer Advisory Panel (NPUAP) defined a pressure ulcer as a localized area of tissue necrosis that tends to develop when soft tissue is compressed between a bony prominence and an external surface for a prolonged period of time (NPUAP, 1989). More recently the AHCPR Clinical Practice Guideline (1992, 1994) defined a pressure ulcer as "any lesion caused by unrelieved pressure resulting in damage of underlying tissue" (p. 7). Pressure ulcer is the most appropriate term, which denotes the principle etiological factor that results in the sloughing of necrotic tissue, causing an ulceration (Yarkony, 1994).

A literature review of prediction and prevention of pressure ulcers spanning from 1987 to 1999 was undertaken in English through the following databases: Cumulative Index to

Nursing and Allied Health Literature (CINAHL), Medline, Healthstar and the Cochrane Collaboration Library. Search words used were pressure ulcer, pressure sore, decubitus ulcer, prevalence, incidence and risk factors. The reference lists of the relevant studies were also used to identify additional research articles. The search was conducted on studies that focused on 1) the clinical risk factors of pressure ulcers in general and the neuroscience population specifically; and 2) prevalence, incidence and severity of pressure ulcers in tertiary settings and in the neuroscience population. This population includes patients who may have been admitted to the neurology service for a medical treatment as well as patients admitted to neurosurgery for surgical treatment. This latter group includes patients with head and spinal cord injuries. Collectively, this group will be referred to as the neuroscience population. The conceptual framework of Braden and Bergstrom (1987) was selected from the literature to guide this study and organize the literature review. It is widely used in North America and provides a basis for risk assessment suggested in the AHCPR Guidelines (1992, 1994) and other international guidelines (CREST, 98).

Conceptual Schema of Pressure Ulcer Development

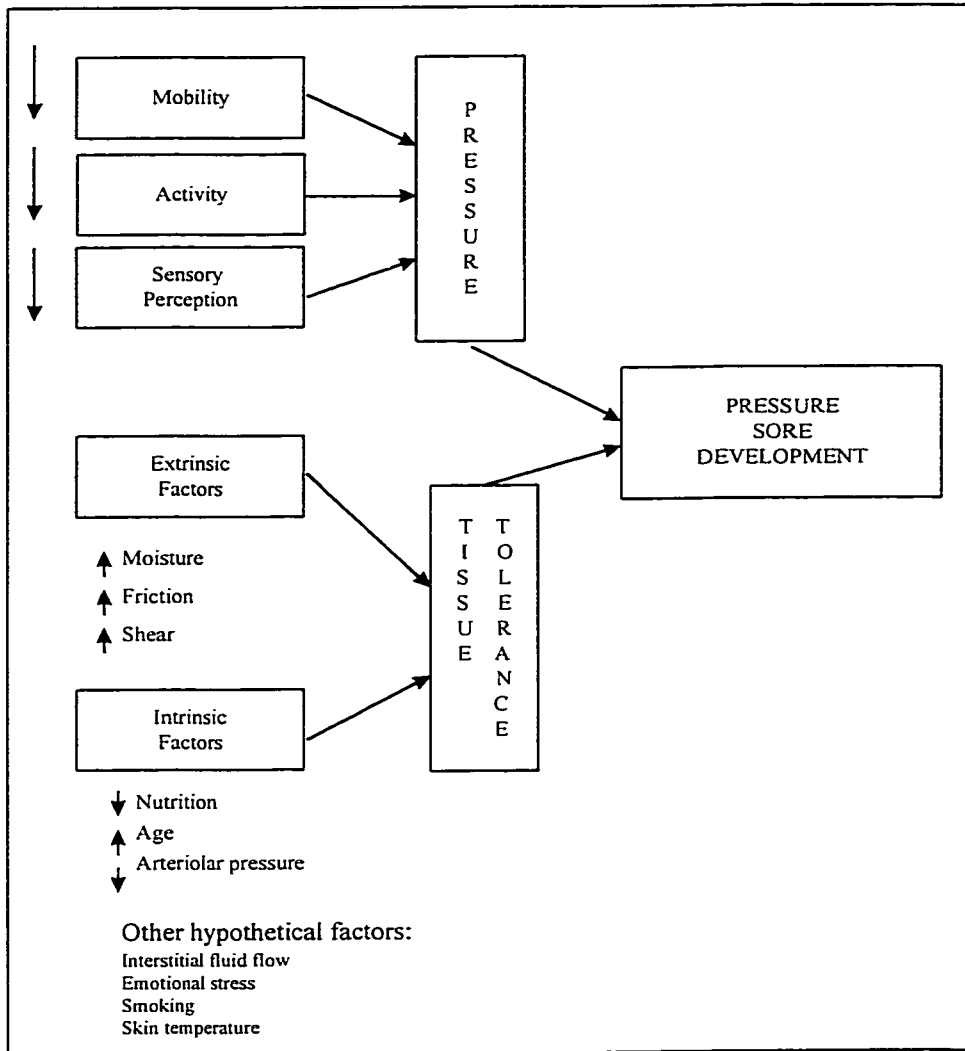
Braden and Bergstrom (1987) conceptualized the critical determinants of pressure ulcers in a conceptual schema representing previous scientific findings along with their hypothesis on the etiology of pressure ulcers. The conceptual schema was introduced as a system that would identify the current thinking regarding pressure ulcers, and identify knowledge gaps, which required further study.

The ability to prevent pressure ulcers lies in the identification of clinical risk factors that support pressure ulcer development. Braden and Bergstrom (1987) posited two key

constructs related to pressure ulcer development: pressure and tissue tolerance. Pressure is the major causative factor in pressure ulcer formation and incorporates the intensity of pressure and the duration that the pressure is applied (Byrant, 1992). Clinical factors contributing to pressure are sensory perception problems resulting in the inability to respond to pressure, and impaired mobility and decreased activity therefore providing limited relief of pressure. The state of the tissue and the ability to tolerate or withstand pressure is the other crucial aspect. Tissue tolerance was related to nutrition, moisture friction and shear that would ultimately affect the tissue's ability to withstand pressure. The component of unrelieved pressure with the subsequent transmission from the skin surface to the underlying dense bone, compressing all intervening tissue, was important for laying the foundation of the physiological ideology supporting Braden and Bergstrom's conceptual framework for pressure ulcer development.

Braden and Bergstrom (1987) posited that other hypothesized factors may also contribute to pressure ulcer development. These other factors were interstitial fluid flow, emotional stress, smoking and skin temperature (Figure 1). Through observation and empirical studies, the mechanisms of pressure ulcer development became more knowledge - based. The ability to determine the relationship, if any, to specific factors, lay in the ability to consistently identify them in individuals with and without pressure ulcers and to be able to predict those patients who would develop ulcers.

Figure 1. A conceptual schema for the study of the etiology of pressure sores which accounts for the relative contribution of the duration and intensity of pressure and tissue tolerance for pressure.



From: B. Braden and N. Bergstrom (1987). A conceptual schema for the study of the etiology of pressure ulcers. *Rehabilitation Nursing* 12(1), 8-12,16.

Conceptual Framework Strengths

The clinical factors identified in the model were organized into relationships of pressure and tissue tolerance. The framework was visually simple and clinically useful, and allowed a number of clinical factors to be presented in a logical approach.

The conceptual schema described broad categories in which new identified findings could also be added. Researchers are provided with the potential of a predictive model to study both single and multivariate relationships in pressure ulcer formation. As new etiological findings are discovered and tested, the relationship between the clinical factors and pressure ulcer formation will contribute to further knowledge about prevention and treatment.

The conceptual framework led to the development of an operational risk assessment tool called the *Braden Scale for Predicting Pressure Sore Risk* (Bergstrom, Braden, Laguzza, & Holman, 1987; Bergstrom, Demuth, & Braden, 1987). The purpose of the risk assessment tool was to identify patients at risk for pressure sores, thus operationalizing the conceptual schema for clinical practice. The *Braden Scale* has been used as a clinical and research tool in a variety of populations as well as in various health care settings (Baldwin & Ziegler, 1998; Bergstrom, Demuth, & Braden, 1987; Bergstrom, Braden, Boynton, & Bruch, 1995; Bostrom, et al., 1996, Capobianco & McDonald, 1996; Gawron, 1994; Goodridge, et al., 1998; Harrison, Wells, Fisher, & Prince, 1996; Jiricka, Ryan, Carvalho, & Bukvich, 1995; Kemp, Keithley, Smith, & Morreale, 1990; Salvadalena, Snyder, & Brogdon, 1992). One of the successes of the *Braden Scale* lies in the ability to portray the essence of the conceptual schema and the etiological nature of the clinical risk factors identified for pressure ulcer development. The clinical risk factors depicted in the conceptual schema were operationalized into clinical subscales with measurable attributes.

Conceptual Framework Limitations

Braden and Bergstrom's model (1987) outlines clinical risk factors that contribute to pressure and tissue tolerance. Qualifying the context of pressure (such as increased pressure) and tissue tolerance (decreased tissue tolerance) was omitted from their model reducing clarity.

Braden and Bergstrom (1987) acknowledged that further work will be required in developing new hypotheses in the relationship of clinical factors and the risk of pressure ulcer development. The hypothetical factors will require further testing. To date, the relationship of stress and pressure ulcer development has been published (Braden, 1998).

The Braden and Bergstrom model is a generic model for the development of pressure ulcers and is not designed specifically for any specialized patient populations. Additional clinical risk factors may well need to be included in a model to address the characteristics of these subpopulations. To date, none have been added.

Literature Review on Pressure Ulcer Development in Tertiary Settings

This next section reviews the clinical risk factors that lead to pressure ulcer development. The clinical risk factors presented are organized according to the conceptual framework used for this study (Braden & Bergstrom, 1987). Studies conducted in tertiary settings are presented, followed by those specific to the neuroscience population.

Clinical Risk Factors: Pressure

Pressure ulcer formation is a complex process and cannot be attributed to any one factor, although it is universally accepted that the process begins with pressure (Shea, 1975; Young, 1997). The pressure load is usually a force external to the body,

perpendicular to the skin, and parallel to a bony surface (Byrant, 1992). The combination of external force and a bony surface causes compression of blood vessels and results in tissue hypoxemia and ultimately tissue necrosis (Margolios, 1995). Based on early studies (Daniel, Priest & Wheatly, 1981; Groth, 1942; Kosiak, 1959), Braden and Bergstrom (1987) concluded that the intensity of pressure on skin and underlying muscle and the duration of the pressure were important clinical factors to assess. Conditions that contribute to prolonged and intense pressure are mobility, activity, and sensory perception (Braden & Bergstrom, 1987).

The summary of the literature findings on the significant clinical risk factors found in patients with pressure ulcers from tertiary settings are presented in Table 1. In this table, studies that were conducted from 1989 - 1999 are reported and are organized by their design including single and multi - site studies. Significant findings of the clinical risk factors, information on the sample size, and length of follow-up are included.

Mobility.

The concept of mobility is related to the ability to change, control and maintain body position. Pressure related sensation normally causes an alteration in movement in order to relieve the sensation. When mobility is impaired, the ability to respond to pressure sensation is compromised. Prolonged and intense pressure coupled with decreased ability to move increases the likelihood of pressure ulcer development. Mobility continues to be an important clinical risk factor associated with pressure ulcer development. While Allman, Goode, Patrick, Burst & Bartloucci (1995) and Makleburst and Magnan (1994) found impaired mobility led to the development of pressure ulcers in incidence studies conducted over 8 weeks to 2 years, Bostrom et al. (1996) found the Braden Scale

Table 1

Summary of the Literature Findings on the Significant Clinical Risk Factors Found in Patients With Pressure Ulcers from Tertiary Settings.

Author, Setting Sample	Findings
<i>Prevalence studies</i>	
Meehan (1990) n = 34,987	Females > risk than males Advancing age - over 50% of ulcers found in the 70-89 year age group
Fisher et al. (1996) n = 1,020	Men had 2X the number of ulcers Percentage of risk according to the <i>Braden Scale</i> in the ulcer group: sensory perception - 38.9%; moisture - 46.7%; activity - 82.8%; mobility - 61.9%; nutrition - 66.8%; friction/shear - 63.1%
Gawron (1995) tertiary setting n=440	Total mean Braden score = 14.5 Mean Braden scores in : sensory perception = 3.1; activity = 2.0; mobility = 2.4; moisture = 3.0 nutrition = 2.1; friction/shear 1.8
<i>Incidence studies</i>	
Berlowitz & Wilking (1989) n = 185 3 week follow-up	Stroke/apoplexy, bed or chair-bound, altered level of consciousness, some assistance with activities of daily living, diabetes, upper extremity contracture, lower extremity contracture, and increased age <i>Multivariate analysis:</i> stroke, bed-or-chair bound, impaired nutrition
Bianchetti et al. (1993) n = 92; hospital 8 weeks follow up	Urinary and fecal incontinence, altered consciousness, impaired cognitive function, poor functional status, time spent in bed, poor nutritional status
Allman et al. (1995) n = 286; tertiary setting 8 weeks follow-up	Risk factors for the development of stage 2 and greater ulcers: independent factors: age = 75yrs, dry sacral skin, non-blanchable erythema, previous pressure ulcer, immobility, fecal incontinence, depleted triceps skinfold, lymphopenia, and ↓body weight <i>Correlated factors:</i> fecal incontinence with immobility, ↑ age with ↓ body weight, ↓ body weight with depleted triceps skinfold <i>Multivariate analysis:</i> nonblanchable erythema; lymphopenia, immobility, dry sacral skin and ↓ body weight
Perneger et al. (1998) tertiary n = 907, 844, 801 N= 2,373 one observation time following admission	Female, increased age, surgical intervention, hospitalized for fracture, Norton score of 16, reduced appetite, nasogastric tube or intravenous nutrition <i>Multivariate analysis:</i> Increased age, surgical intervention, hospitalized for fracture, Norton score of 16, reduced appetite, nasogastric tube or intravenous nutrition
Makleburst & Magnan (1994) tertiary care n = 2,189 2 years	Age, impaired mobility, fecal incontinence, malnutrition, decreased mental status, peripheral vascular disease, urinary incontinence, diabetes mellitus, metastatic cancer, spinal cord injury, multiple sclerosis <i>Logistic regression:</i> fecal incontinence, impaired mobility, malnutrition, decreased mental status

Table 1 cont'd
Summary of the Literature Findings on the Significant Clinical Risk Factors Found in Patients With Pressure Ulcers from Tertiary Settings.

Author, Setting Sample	Findings
<i>Multi-site incidence studies</i>	
Langemo et al. (1991) multi-site n=190 3X per week for 2 weeks	Braden score of 15 most sensitive in acute care setting, activity level with time spent in bed (> 23 hrs).
Bergstrom et al. (1996) n = 843; 6-12 month follow-up	Females > males, white race > black race, cardiovascular disease most significant predictor of pressure ulcers
Pieper (1998) N = 694 2 months	Advancing age, ↑ number of medical diagnosis, ↑ LOS, ↓ hemoglobin & serum albumin, ↑ white blood cell counts, lower total Braden scores and lower mean scores in the six subscales.
Goodridge et al. (1998) n = 330 bi-weekly x 3 months	Patients with PU had greater number of medical diagnosis. Average # of medical diagnosis -5.86 Average Braden score immediately prior to PU development was 2 points lower (17.42) when comparing acute and long term setting Acute care had lower Braden scores in subjects with PU than no PU (18.1) Mean scores of the Braden subscales of nutrition, activity, mobility and friction/shear were associated with PU development.
Bostrom (1996) n = 112	Braden subscale score of mobility was found to be predictive of risk in patients who developed ulcers (n = 9) while total Braden score or remainder subscale scores
<i>Specialized Settings</i>	
Jiricka et al. (1995) n = 85; ICU 2 week follow-up	Increased length of stay, white race, multiple surgeries, sensory perception and moisture (Braden scale), mental status, mobility, moisture, friction and shear and circulation Braden score of 11 had highest sensitivity and specificity <i>Multiple regression:</i> sensory perception and moisture, moisture and circulation
Baldwin (1998) ICU setting n= 36	Longer LOS a predictor of pressure ulcers The total mean Braden score and the mean score of the sensory perception subscale were consistently lower in the ulcer group. A risk cut-off score of 10 in this study provided highest sensitivity and specificity Nutritional uptake versus intake in critically injured patients
Kemp (1990) n = 125 elective cardiac surgery patients	Older age; long OR time, low pre-op Braden scores; intraoperative hypotension. Braden score not useful in prediction

subscale of mobility to be predictive of patients who developed ulcers in multi-site studies.

Activity.

The concept of activity relates to the overall frequency of major position changes, thus pressure relief is completely achieved during the activity time. Although some patients had the ability to move or re-adjust their position frequently, the literature found some patient groups such as spinal cord injured (Bennett, Kavner, Lee, Trainor & Lewis, 1984) or patients with arthritis, cancer or debilitated states (Manley, 1978) spent a high percentage of their time confined to a wheelchair or bed. Major position changes with the accompanying relief of pressure were limited. The coccyx and trochanter were vulnerable to skin breakdown, as they were not normally weight sustaining surfaces like the heels. In combination with limited activity and limited mobility, the risk of pressure ulcer development was more pronounced. Although patients such as paraplegics could adjust position through mobility efforts, their *activity* throughout the day remained limited. Impaired mobility and activity were identified as significant clinical risk factors in tertiary settings (Allman et al., 1995; Berlowitz & Wilking, 1989; Bianchetti et al., 1993; Goodridge et al., 1998; Jiricak et al., 1995; Makelburst & Magnan, 1994; Pieper et al. 1998).

Sensory perception.

The concept of sensory perception is related to the diminished ability to perceive or respond to discomfort. In Braden and Bergstrom's conceptual schema, the concept of sensory perception incorporated intact spinal cord and normal consciousness. Perceiving sensory alterations such as pain related to intense pressure depends on the intactness of numerous sensory receptors in the skin, muscles, and joints; peripheral and central

sensory tracts. Loss of cutaneous sensation interferes with the perception of ischemic pain and the cue to shift positions (Bennett, Kavner, Lee, Trainor & Lewis, 1984). Sensory perception is also related to the conscious level and the ability to interpret pressure sensation. Patients with a decreased level of consciousness, as in the case of cerebral hemorrhage, narcotic poisoning, catatonia, prolonged anaesthesia and excessive doses of tranquilizers, may or may not perceive pain and cannot respond by repositioning or requesting assistance to reposition (Anderson & Kvorning, 1982; Seiler & Stahelin, 1979).

The clinical risk factor of sensory perception was found to be significant by Gawron (1995), Berlowitz & Wilking (1989), Bianchetti et al., (1993), Makelburst & Mangan (1994), Jiricka et al. (1995) and Baldwin & Zielger (1998). Healthy adults with intact sensory perception, regularly shift their weight in response to the discomfort associated with capillary closure and tissue hypoxia caused by high interface pressures (Bryant, 1992). The combination of the ability to distinguish pressure, the ability to move, and to be active contribute to the prevention of pressure ulcers.

Clinical Risk Factors: Tissue Tolerance

Braden and Bergstrom (1987) posit tissue tolerance as a second key factor in their conceptual schema of pressure ulcer development. In certain situations it was believed that when tissue tolerance for pressure was reduced, pressure sores might develop at a lower threshold of pressure within a shorter duration of time. Based on this hypothesis, factors that affected tissue tolerance were categorized into extrinsic and intrinsic factors. Extrinsic factors were external environment factors such as moisture, friction and shear that affect the skin and the underlying tissue tolerance for pressure ulcer development.

Intrinsic factors were those that “influence the architecture and integrity of the skin’s supporting structures and/or the vascular and lymphatic system that serves the skin and underlying structures” (Braden & Bergstrom, 1987). Any physiological factor that adversely affects the architecture and integrity of these supporting structures diminishes the ability of the soft tissues to absorb and distribute the mechanical load and therefore tolerate pressure (Braden & Bergstrom, 1987). Factors that were identified as affecting the integrity and architecture of the skin were decreased nutrition, increased age, low arteriolar pressure, and other factors such as interstitial fluid flow, emotional stress, smoking, and skin temperature (Andersen & Kvorning, 1982; Kosiak, 1959; Krouskop, 1983; Natow, 1983; Seiler & Stahelin, 1979; Williams, 1972).

Extrinsic factors - moisture.

Skin exposure to moisture through perspiration, urinary and fecal incontinence and drainage from fistulas or wounds was postulated to potentiate the development of pressure ulcers through mechanisms of maceration. Contribution from Andersen and Kvorning’s study (1982) supported this clinical factor in which moisture was deemed to be an active causative factor in 147 patients with pressure ulcers. The skin, when exposed to moisture, could further develop cellulitis, skin rashes, and skin infections, which could also make the skin more susceptible to breakdown (Elliot, 1982). While incontinence has been identified in numerous studies, (Allman et al., 1995; Bianchetti et al., 1993; Gawron, 1994; Jiricak et al., 1995 & Makleburst & Magnan, 1994), Makleburst and Magnan (1994) reported that the odds of developing a pressure ulcer with both the clinical risk factors of fecal impairment and immobility increased 37 times.

Extrinsic factors - friction.

Braden and Bergstrom incorporated friction as an extrinsic factor based on Dinsdale's (1974) work on paraplegic swine where skin ulceration was produced at much lower pressure following the application of friction. Pressure ulcers increased in the presence of pressure application and friction, with more ulcers appearing after repeated measures of friction. Braden and Bergstrom (1987) postulated that patients might experience friction during position changes if unable to lift themselves or be lifted sufficiently. Frequent episodes of friction, in conjunction with patients who are agitated or spastic and who are confined to bed or chair, as well as friction caused by restrictive devices in the orthopaedic population may lead to the development of pressure ulcers.

Extrinsic factors - shear.

Tissue tolerance may also be affected through the mechanism of shear forces. Shear forces are initiated when the surface skin remains stationary against the support surface or bed and the skeletal mass slides against the tissues due to a perpendicular force. The suspected mechanism for tissue injury is related to deformation and destruction of the vascular bed as it passes between the deep fascia and superficial fascia (Riechel, 1958; Newell, Thornburgh & Fleming, 1970). Dinsdale's (1974) study demonstrated that while friction contributed to pressure ulcers through mechanical forces applied to the epidermis, shear forces were "more disastrous than vertical forces" (p 151) and impacted the vascular bed with subsequent ischemic processes initiated. At the time of Braden and Bergstrom's conceptual development, research was sparse examining shear, however studies that examined pressure tolerance in paraplegics and geriatric patients found these subjects developed greater shearing forces than normal subjects (Bennett, 1984). Friction

and shear factors that promote pressure ulcers were found to be significant in a number of studies (Gawron, 1995; Jiricaka et al., 1995; Makleburst & Magnan, 1994).

Intrinsic factors - nutrition.

Numerous studies that cited a variety of nutritional deficiencies frequently related to pressure ulcers contributed to the Braden and Bergstrom model. These were hypoproteinemia (Moolten, 1972; Vasile & Chaitin, 1972; Hunter & Rajan, 1972), ascorbic acid deficiency (Hunter & Rajan, 1972) and lack of trace minerals (Prasad, 1982) which contributed to a decrease in the quality and integrity of the components of soft tissue, particularly collagen. Lowered serum albumin levels (Vasile & Chaitin, 1972) and, blood cell hemoglobin concentrations (Moolten, 1972) were also found by Braden and Bergstrom (1987) to be present with pressure sores, although the findings were from retrospective studies of patients with existing pressure sores.

Other nutritional studies looked at the role of vitamin C and zinc and their contribution in the pathogenesis of pressure ulcers. Vitamin C supports the formation and maintenance of collagen, which is an important structure of blood vessels, fibrous tissues and hard tissue such as bone and cartilage. Studies found that healthy persons on a vitamin C deficient diet had delayed wound healing and decreased resistance to skin tearing (Bartlett, Jones, & Ryan, 1942; Irwin & Hutchins, 1976; Ringsdorf & Cheraskin, 1982). Similarly, Taylor, Rimmer, Day, Butcher, & Dymock, (1974) found that when the blood concentration of vitamin C was elevated through dietary measures, the rate of pressure sore healing was increased at a rate not seen in the control group. The role of zinc was also considered crucial in the synthesis and degradation of carbohydrates, lipids, protein

and nucleic acids. It was hypothesized that dietary levels of zinc may contribute to the quality of collagen, an important connective tissue protein responsible for tensile strength in wound healing (Prasad, 1982).

The role of impaired nutrition in the development of pressure ulcers has been documented however the measurement of nutrition has varied. In critical care settings Baldwin & Zielger (1998) questioned the nutritional *uptake* of patients versus the nutritional intake that is normally measured. Studies in tertiary settings found poor inadequate nutrition to be significantly related to the population with pressure ulcers (Allman et al., 1995; Baldwin & Ziegler, 1998; Berlowitz & Wilking, 1989; Bianchetti et al., 1993; Fisher et al., 1996; Gawron, 1995; Goodridge et al., 1998; Jiricak et al., 1995; Makelburst & Magnan, 1994; Perneger, Heliot, Rae, Borst, & Gaspoz, 1998; Pieper 1998).

Intrinsic factors – age.

Advancing age as outlined in the conceptual framework by Bergstrom and Braden (1987), was identified in numerous studies in many health settings. The recognition of advancing age within a tertiary settings has been identified as an important clinical trend (Allman, 1995, Barczak, Barnett, Jarczyński Childs, & Bosley, 1997; Bergstrom, Braden, Kemp, Champagne, & Ruby, 1996; Fisher et al., 1996; Kemp et al., 1990; Makleburst & Magnan, 1994; Meehan, 1989; Perneger et al., 1998; Pieper et al., 1998). Barczak et al., (1997) found the 71-80 year age group was the predominant group with pressure ulcers in four U.S. national surveys while Perneger et al. (1998) found that patients 90 years of age or older had a 5-fold increase in the risk of developing a pressure ulcer compared with younger adults. Pressure ulcers among the elderly continue to be of concern, especially as

age-related skin changes, immobility, nutritional factors, hypoalbuminemia, fecal incontinence and presence of a fracture are common in this population (Allman, 1989).

Aging appears to jeopardize tissue tolerance as a result of decreased elastin, and the cohesion between the epidermis and the dermis commonly seen in the elderly (Bryant, 1992). Among this age group, tissue ischemia may occur at a lower intensity of pressure because of the transfer of a mechanical load from the supporting structures to the underlying tissue thereby affecting the vasculature. Bennet (1984) found that the median rates of pulsatile skin blood flow volumes for paraplegic patients and hospitalized geriatric patients to be only one third of normal patients, demonstrating the magnitude of the effects of aging and subsequent skin changes. Manley (1978) and Andersen and Kvorning (1982) also found a relationship between increasing age and increasing incidence of pressure ulcers, further supporting the schema proposed by Braden and Bergstrom (1987).

Intrinsic factors –arteriolar pressure.

The relationship of low arteriolar pressure (diastolic blood pressure less than 60 mm Hg) and the skin's tolerance to external pressure was determined by Braden and Bergstrom (1987) to be important based upon work done by Seiler and Stahelin (1979), Moolton (1972), and Gosnell, (1973). A lower external force, when applied to the skin, could overcome the skin's tissue tolerance when systolic and diastolic blood pressures were low. Inversely, Larsen, Holstein, and Lassen (1979) found that subjects who were hypertensive could withstand higher external pressure before reaching vascular occlusion than subjects who were normotensive. Individual factors such as dermal tissue and capillary autoregulation lessens the effect of external pressure. Dermal tissue consists of a

mesh of collagen and elastin fibers which gives skin its strength and extensibility through stretch and recoil mechanisms. Capillary autoregulation increases the internal capillary pressure when faced with external pressures. The duration of the applied pressure and the intensity are thought to be significant factors as a high intensity pressure over a short time or conversely a lower pressure applied over a long time ultimately affect the tissue. The ability for the skin and blood vessels to respond to pressure is dependent on the state of the tissue which is individually dependent on a variety of factors (Young, 1997). Kemp et al. (1990) found cardiac surgical patients who developed ulcers, had intraoperative hypotension and were unable to effectively maintain local perfusion in light of pressure and decreased tissue tolerance.

Pressure ulcer development –other factors.

Braden and Bergstrom (1987) hypothesized that other clinical factors such as emotional stress, skin temperature, interstitial fluid flow and smoking were considered to play a role in pressure ulcer development but were not directly included in the conceptual schema. A recent study by Braden (1998) supports the relationship of stress, cortisol levels and pressure ulcer development, however there have been no further changes to the conceptual schema at this time.

Other clinical risk factors that have been found in patients with ulcers, include co-morbid diseases, gender and race differences, and length of stay. The relationship of these factors to the presence of co-morbid diseases and the intrinsic influence on pressure ulcers were found in several studies (Bergstrom, Braden, Kemp, Champagne, & Ruby, 1996; Goodridge et al., 1998; Makelburst & Megan, 1994; Pieper et al., 1998). For

example, Goodridge (1998) in studying a population of elderly (> 65 years) patients with ulcers, found that the average number of medical diagnoses to be 5.86. Co-morbid diseases included cardiovascular and peripheral vascular disease as well as stroke, diabetes mellitus, metastatic cancer, spinal cord injury and multiple sclerosis.

A few studies found gender and race differences. Bergstrom et al. (1996) found more females than males developed pressure ulcers and white subjects had more ulcers than blacks even when stage 1 was eliminated from analysis. Fisher et al. (1996) found the male gender to be statistically significant in the development of stage 2 and higher ulcers in two large tertiary care settings. In dark-skinned clients, Barczak (1997) found a significantly higher prevalence of full-thickness ulcers and a low prevalence rate of stage 1 ulcers. The difficulty in detecting stage 1 ulcers in dark-skinned individuals however has been recognized (Henderson et al. 1997).

The relationship between the development of pressure ulcers and length of agency stay was founded on the premise that patients who required longer hospital stays were more debilitated and therefore more susceptible to pressure ulcers. Goodridge et al. (1998) found the mean number of days to ulcer development was 18.5 days in patients who were admitted to medical and geriatric units. Baldwin et al. (1998) found the average length of time to first pressure ulcer was 9 days (range 1 to 20) in patients admitted with traumatic critical injuries, with 64% of the patients developing a pressure ulcer within the first two weeks of hospitalization. Perneger et al. (1998), conducted three cross-sectional surveys (n = 2,373), found that pressure ulcers of stage 1 and greater would develop in about 4% of patients admitted to a general hospital and that on any given day, about every 10th

hospitalized patient had a pressure ulcer. The differences between the numbers were based on the fact that patients who have long hospital stays are over-represented in cross-sectional surveys and are at increased risk for a pressure ulcers (p. 1943).

Use of the Braden Risk Assessment Scale for Determining Clinical Risk

Several studies from tertiary settings utilized the *Braden Assessment Scale for Pressure Sore Risk* for quantifying the degree of clinical risk in the development of pressure ulcers (Baldwin & Ziegler, 1998; Bergstrom, et al., 1987; Bergstrom, et al., 1995; Bostrom, et al., 1996, Capobianco & McDonald, 1996; Gawron, 1994; Goodridge, et al., 1998; Harrison, et al., 1996; Jiricka, et al., 1995; Kemp, et al., 1990; Pieper et al., 1998; Salvadalena, et al., 1992). The *Braden Assessment Scale for Pressure Sore Risk* consists of six mutually exclusive subscales that examine the clinical risk factors that contribute to pressure ulcer development as identified by the conceptual framework (Braden & Bergstrom, 1987). The clinical factors of sensory perception, activity, mobility, incontinence, nutrition and friction /shear are organized into subscales with each subscale ranked from 1 to 4 with the exception of the combined category of friction and shear category which is ranked 1 to 3. The *Braden Scale* has an overall risk score derived from the six subscales that are scored from 1 (most at risk) to 3 or 4 (least at risk) for a maximum of 23 points. Studies found in the literature used either a total score or subscale mean scores when examining those patients with and without pressure ulcers.

When examining the total Braden Scale score in the ulcer population, Bostrom (1996) and Kemp et al. (1990) did not find the total score to be associated with pressure ulcer development. Conversely, Pieper et al. (1998), Goodridge et al. (1998), and Baldwin and Ziegler (1998) found the total Braden Scale score was lower in the ulcer population,

although different cut off scores were used to determine risk. When examining the subscale scores, Pieper et al. (1998) found all of the six subscale scores were lower in the ulcer population while Goodridge et al. (1998), Jiricka et al. (1995) and Baldwin and Ziegler (1998) found only some of the subscale scores to be significantly lower in the ulcer population. When using the Braden Scale for predicting pressure ulcers, Salvadalena, et al., (1992) and Harrison et al., (1996) found accuracy of the *Braden Scale* prediction for pressure ulcers low.

Summary of literature on clinical risk factors in the general population.

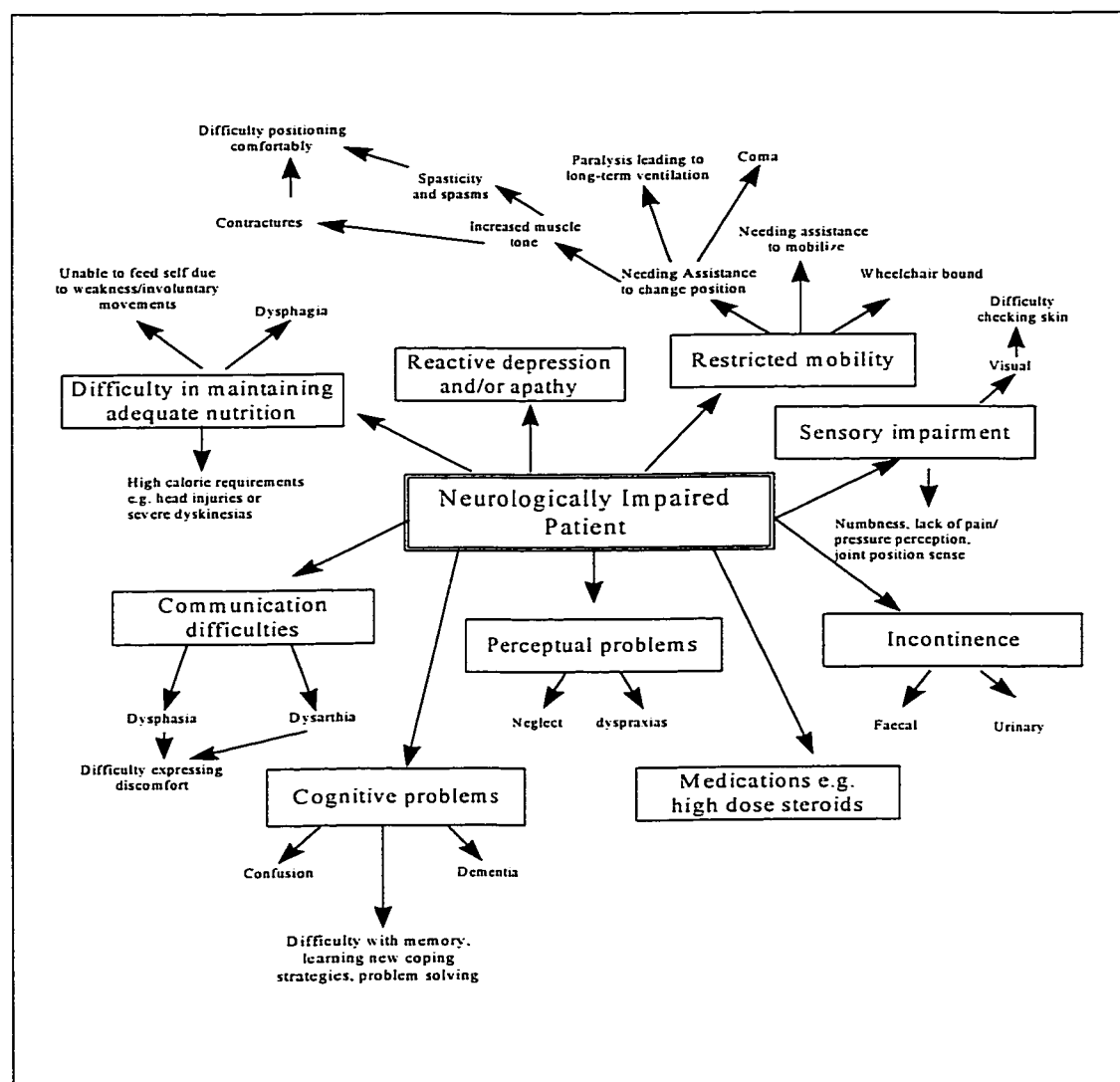
In summary, Braden and Bergstrom's conceptual schema proposed that increased pressure and decreased tissue tolerance supported the development of pressure ulcers. Clinical factors that contributed to pressure were decreased mobility, activity and sensory perception, whereas increased moisture, friction and shear, age, decreased nutrition and arteriolar pressure affected tissue tolerance. Numerous prevalence and incidence studies, conducted in single, multi-site and specialized settings demonstrated that these clinical risk factors were found in patients who developed pressure ulcers. Race, gender, co-morbidity and length of hospital stay were also found to be additional factors that are thought to lead to pressure ulcers.

Literature Review of the Clinical Risk Factors in the Neuroscience Population

The literature review conducted in the neuroscience population revealed a framework that outlined the risk factors in the neurologically impaired patient that contributed to pressure ulcers (Johnson, 1994). However Johnson (1994) had not outlined the relationships of the risk factors in the neurological patient and their contributory relationship to pressure ulcer development (Personal communication, December, 1998).

Although the framework (Figure 2) outlined many clinical risk factors including perceptual and communication difficulties and emotional states, the diagram lacked a causal relationship to pressure ulcers, unlike the Braden and Bergstrom model and for this reason, was not used in this study.

Figure 2. Factors in the Neurologically Impaired Patient that Contribute to the Risk of Pressure Area Damage



From Johnson, J. (1994). Pressure area risk assessment in a neurological setting. *British Journal of Nursing* 3 (18), 927.

Information on the clinical risk factors specific to the neuroscience population were obtained from studies primarily conducted on spinal injured patients, residing in spinal injury centers (including acute and long-termed injured patients), veteran homes and community treatment areas. No studies from tertiary settings on the neuroscience population per se were found. Early studies have demonstrated that patients with quadriplegia and paraplegia have both a high prevalence and incidence rate of pressure ulcers (Bennett et al., 1984; Richardson & Meyer, 1981). It would seem reasonable then to study the clinical risk factors present in this subpopulation in a tertiary centre to determine the relationship to pressure ulcer development.

The literature findings on the significant clinical risk factors found in the neuroscience population with pressure ulcers are presented in Table 2. While most of the studies reported are from the spinal injured subpopulation, a few studies were found in other client groups with neurological illness. The health care settings of the spinal injured group are varied and reflect a subpopulation studied along different points of time in the trajectory of their condition. Table 2 also reflects the variety of clinical risk factors studied in order to identify the relationship to subsequent pressure ulcer development. The clinical factors remain varied and continue to support the complex nature of pressure ulcer development.

Studies that examined the clinical risk factors for pressure ulcer development in the neuroscience population tended to differ in design from the studies conducted in tertiary settings. The clinical risk factors from tertiary settings were obtained through prospective prevalence and incidence studies. While a few studies examining the clinical risk factors in the neuroscience population were prospective (Lehman, 1995; Sanada et al., 1997;

Rodriguez & Garber, 1994) most were retrospective in design using chart audits and medical records to determine the clinical risk factors attributed to pressure ulcer development (Curry & Casady, 1992; Fuhrer, Garber, Rintala, Clearman, & Hart, 1993; Hammond, Bozzaco, Steins, Buhner, & Lyman, 1994; Niaz, Salsberg, Byrne, & Viehbeck 1997; Raney, 1989; Rochon et al., 1993; Salzberg et al., 1996; Schubert & Heraud, 1994; Vial & Sarrias, 1991). Due to the retrospective nature and the inability to control potential confounding variables, information obtained using this method may have suffered from decreased construct validity.

Mobility, activity and sensory perception

The relationship of activity and mobility, the level of spinal injury and whether the spinal injury was complete or incomplete were risk factors identified by several studies (Curry & Casady, 1992; Fuhrer et al., 1993; Niazi et al., 1997; Rochon et al., 1993; Salzberg et al., 1996; Vial & Sarrias; 1991). In spinal injured patients, the preservation of sensation is important in the ability to cue an individual to change position. When sensation is not intact, then regular position changes are essential. In spinal injured patients, the combination of inability to perceive sensation and pressure, and the inability to mobilize and maintain activity levels heighten the predisposition to pressure ulcer development. Rochon et al. (1993) found that the odds of developing a pressure ulcer, given little or no movement, increased the likelihood by almost six times. The level of spinal cord functioning has been implicated in pressure ulcer development due to the lower level of functioning, decreased sensory ability to feel pressure, and the loss of ability to make small but crucial mobility changes as seen in quadriplegia. Curry and Cassady (1992), Salzberg et al. (1996), Rochon et al. (1993), Niaiz et al. (1997), Vial and

Table 2.

Summary of the Literature Findings on the Significant Clinical Risk Factors Found in Neuroscience Patients With Pressure Ulcers from Acute and Rehabilitation Settings.

Author, Setting Sample	Findings
<i>Acute spinal injury centers</i>	
Curry & Cassady (1992) study 1 n = 19 study 2 n = 49 Spinal Cord Center retrospective review over 5 years	Study 1 - complete spinal cord injury; paraplegia, immobilization > 8 hrs Study 2 - immobilization > 6 hrs (Note: study 2 included study 1 patients)
Hammond et al. (1994) Spinal Cord Center n = 410	Previous history of pressure ulcer, surgical repair of pressure ulcer, new spinal cord injury, long-standing spinal cord injury (>10 years), and the use of condom catheters.
<i>Rehabilitation & Veteran Centers</i>	
Salzberg et al. (1996) Veterans Center spinal injured pop. n = 219	Risk factors that met the 4 inclusion criteria for the new scale: level of activity; mobility; complete SCI; urine incontinence or constantly moist; autonomic dysreflexia or severe spasticity; age (yrs); tobacco use/smoking; pulmonary disease; cardiac disease; diabetes or glucose >110mg/dl; renal disease; impaired cognitive function; hospital or home residence; albumin <3.4 or total protein <6.4; hematocrit <36.0% (HGB <12.0)
Rochon et al. (1993) Spinal injured pop. Veteran Center n = 364 2 years	Risk factors significantly associated with development of pressure ulcers: Frankel grade A and B - Odds Ratio (OR) 5.7; low albumin - OR 4.9, low hemoglobin- OR 2.5; 60 yrs & >- OR 1.9; Comorbidity risk factors: a CIRS-OR 3.7; b Charlson Index -OR 2.2; c Seven or greater ICD-9CM codes -OR 4.2.
Hunter (1992) Rehabilitation Center n = 40 (prevalence) n = 40 (incidence)	Prevalence :Mean <i>Braden Scale</i> score in ulcer group -14 (range 11-19). Incidence: Good skin practices may have prevented all ulcers as incidence was 0%
Niazi (1997) Veterans Medical Center n = 176	Smoking an independent risk factor for recurrence of pressure ulcer, including a longer history of smoking. Patients with lowest level of activity had highest recurrent rate. Patients with cardiovascular disease an diabetes were 1.8 times more likely to suffer a recurrent ulcer. Younger patients had less recurrence rate than older individuals

a Cumulative Illness Rating Scale (CIRS) -a scale to measure co-morbidity and evaluates 13 body systems independently using a 4 point scoring system.

b The Charlson Index - a co-morbidity index that assigns weights of 1,2,3 or 6 to a series of pre-defined medical conditions.

c International Classification of Diseases, Ninth Revision, Clinical Modification = ICD, 9 CM

Table 2

Summary of the Literature Findings on the Significant Clinical Risk Factors Found in Neuroscience Patients With Pressure Ulcers from Tertiary and Rehabilitation Settings.

Author, Setting Sample	Findings
Vial (1991) Rehabilitation Center n = 884	Increased # and seriousness of ulcers with age, esp. > 40 yrs; higher ulcers in males (75%) compared to females (25%); complete paraplegia highest (60.82%) than other neurological levels ; Frankel A category significant in patients with pressure ulcers; Significant relationship found between pressure ulcers & alcoholism, mental disorders and malnutrition. Patients from General hospitals had higher number of serious ulcers; patients who had higher re-occurrence rate had greater severity of pressure ulcers.
Rodriguez & Garber (1994) Rehabilitation Center n = 60 2 years	Ulcer group had ↑ urinary secretion of glu-gal Hyl and appearance of stage 2 ulcer
<i>Intra-operative setting</i>	
Sanada (1997) Spinal and abdominal surgery n = 24	All spinal patients developed pressure ulcers; all prone patient developed ulcers including if OR time was < 4 hrs.
<i>Community setting</i>	
Fuhrer et al. (1993) Community living n = 140 (100 males and 40 females)	Patients with ulcer had significantly more surgeries, less voluntary movement and lower FIM score. Blacks had more severe ulcers (Grade 3 & 4) than whites
Garber et al. (1996) community living n = 23	Self-detection of ulcers in both paraplegics and quadriplegics > 90%. 90% of stage 2 and higher ulcer were detected while only 39% of stage 1 ulcers were detected. Patients with stage 1 & 2 ulcers had higher accuracy in staging their own ulcers than patients with severe ulcers. Patients who took immediate action when detecting an ulcer were more likely to practice other preventative behaviours. Patients who did not take immediate action in detecting an ulcer, did not take appropriate action either. Patients who took appropriate action to prevent ulcers also practiced regular preventative techniques.
Lehman (1995) Community n = 29	Higher # of paraplegics versus quadriplegia; higher prevalence of male; Co-morbidities- anemia, COPD, pulmonary complications, spasticity, hypertension, history of pressure ulcers, chronic urinary tract infections, urinary complications, bowel complications, chronic anemia
<i>Other Patients with Neurological Disease</i>	
Raney (1989) Private referral center ALS: n = 28 MS: n = 33	Similarities: Race, gender, mobility; activity impairment, alert, communicative, difficulties with elimination problems, use of corticosteroids, family support, home placement. Differences: ALS: older (stat. sig.), ↑ nutritional deficits, ↑ respiratory. & cardiovascular disorders, ↓ art. BP. MS: less sensory intact, ↑ neurologic/psychological disorders.

Table 2.

Summary of the Literature Findings on the Significant Clinical Risk Factors Found in Neuroscience Patients With Pressure Ulcers from Tertiary and Rehabilitation Settings.

Author, Setting Sample	Findings
Schubert & Heraud (1994) n = 20 Group 1 (no risk) n = 10 Group 2 (at risk)	Group 2 patients had an inability to recover a satisfactory blood flow in comparison to Group 1 during supine 0° and 45° positions. Parkinson patients higher risk due to no spontaneous movements in comparison to patients with stroke.

Sarrias (1991) found that a higher level of spinal injury was related to pressure ulcer development while Lehman (1995) found that significantly more patients with paraplegia compared to quadriplegia developed ulcers when examined from a community setting.

Activity and mobility limitations were also found as clinical risk factors by Raney (1989) in patients with Amyotrophic Lateral Sclerosis (ALS) and Multiple Sclerosis (MS). Berlowitz and Wilkings (1989) found that odds ratio of having a pressure ulcer increased in patients who were bed/chair-bound by 2.4 and that slight decreases in mobility increased the odds ratio to 5.0. in stroke patients in a chronic care facility. In patients with decreased levels of consciousness, Berlowitz and Wilkings (1989) found that the odds of developing a pressure ulcer were 4.1. These studies demonstrated the combined and synergistic effects of decreased mobility and activity and ability to respond to the sensation of pressure also contribute to pressure ulcer development in the neuroscience population.

The relationship of immobility, caused by lack of muscle innervation and other clinical risk factors such as friction/shear and arteriolar pressure have also been studied. Despite surgery as a frequent treatment in selected cases of head and spinal trauma,

hemorrhagic strokes, and central nervous system neoplasms, the literature is sparse related to the clinical risk factors of immobilization attributed to length of time during operative procedures. For example, Sanada et al. (1997) studied changes in skin blood flow and length of time exposed to pressure in patients undergoing spinal and abdominal surgery. Patients who subsequently developed ulcers had decreased skin blood flow within one hour of the surgical procedure as well as lower skin blood flow during the application of pressure caused by prone positioning during surgery. In a non-operative setting, Schubert and Heraud (1994) also measured skin blood flow in elderly patients and found that the risk group (stroke n = 9 and Parkinson n = 1) showed an inability to recover satisfactory blood supply to the sacral region following the effects of pressure and shear during supine and 45° head of bed elevation for time periods of 30 minutes.

Moisture

There is a direct relationship between the loss of bladder and bowel control and the development of pressure ulcers. For example, Salzberg et al. (1996), Hammond et al. (1994), Lehman (1995) and Raney (1989) found urinary incontinence, urinary complications and bowel disturbances higher in the patients who developed ulcers. Bowel and bladder control is complex and is related to both brain, spinal cord and local mechanisms. In the neuroscience population, altered brain and spinal cord functioning contribute to the loss of bladder and bowel functioning.

Nutrition

Adequate nutrition in the neuroscience population may be complicated by physiological aspects such as caloric needs, level of consciousness, and cranial nerve dysfunction as well as psychosocial aspects such as depression and mentation. Studies

that looked at the clinical risk factor of nutrition in relation to the neuroscience population and the development of pressure ulcers were few. Vial and Sarrias (1991) found a combination of malnutrition, alcoholism and mental disorders to be significant in spinal injured patients who had developed pressure ulcers in a rehabilitation centre. Raney (1989) also found nutritional deficits to be significant in a small sample of patients with (ALS), demonstrating the combined effects of motor neuron pathology in the spinal cord and subsequent motor paralysis affecting chewing and swallowing mechanisms.

Demographic characteristics

The clinical risk factor of age was not as prominent in the neuroscience population compared to studies reported from tertiary settings and may be due to the predominance of younger spinal-injured individuals. Rochon et al. (1993), Salzberg et al. (1996), and Vial and Sarrias (1991) however found that older spinal-injured patients had a higher risk of developing pressure ulcers including recurrent ulcers (Niazi et al., 1997). A higher proportion of male patients were found to have pressure ulcers however, as more spinal injuries occur in males, there tended to be a gender bias in the spinal - injured population who had developed pressure ulcers. Fuhrer et al. (1993) using a community sampling technique found that a higher proportion of blacks compared to whites had more severe ulcers. It is unclear whether the detection of early stage ulcers in dark skinned individuals was a factor. Patients with spinal injuries who live in community settings may also be affected by the economic and supportive issues which possibly contribute to pressure ulcer development.

Co-morbid diseases

The presence of co-morbid diseases and the relationship to pressure ulcer development was also found in the spinal injured population studied. Salzberg et al. (1996) noted the presence of pulmonary, cardiac, renal disease and diabetes mellitus to be significant and therefore included these factors in developing a risk assessment scale. Rochon et al. (1993) found that spinal injured patients were as least three times greater at risk for developing a pressure ulcer in the presence of other influencing diseases. Other medical factors such as low albumin, protein, hemoglobin, and hematocrit were also found to be risk factors in the spinal injured (Salzberg et al., 1996; Rochon et al., 1993).

Niazi et al. (1997) studying the risk of pressure ulcer recurrence found that patients with a smoking history, especially greater than 16 years, had a higher recurrence rate than non-smokers. The size and the grade of the first ulcer and the patient's activity level were significant in influencing the recurrence rate. The highest incidence rate of the recurrent ulcers were found on the opposite side of the body, demonstrating the relationship of increased pressure and tissue tolerance in pressure ulcer formation.

The time to ulcer development was not well defined in the neuroscience population. Hammond et al. (1994) found the mean time for pressure ulcer development post injury was 15-24 months with a large range of less than one year or greater than 10 years.

Use of the Braden Risk Assessment Scale for Determining Clinical Risk

The literature review in the neuroscience population found one study that utilized the *Braden Assessment Scale for Pressure Sore Risk* for quantifying the degree of clinical risk towards the development of pressure ulcers. Hunter (1992), conducting both a prevalence and incidence study in a rehabilitation center found a mean *Braden Scale*

score of 14 in the group of spinal injured patients who developed pressure ulcers. A cut off score of 16 and below was originally identified as indicating patients at risk for pressure ulcer development (Bergstrom et al., 1987).

Summary of Literature on Clinical Risk Factors in Neuroscience Population

In summary, a variety of clinical risk factors in the neuroscience population have been reported. Spinal cord injury patients continue to be the most prevalent subgroup studied with respect to the clinical risk factors related to pressure ulcer development. Clinical risk factors identified were decreased mobility, activity, sensory perception, moisture, nutrition and friction/ shear. Other clinical risk factors found included age, gender, length of stay, and co-morbid conditions. Time of ulcer development was quite varied while the risk of ulcer re-occurrence was increased especially with respect to smoking history and presence and stage of first ulcer. This next section reviews studies on pressure ulcer occurrence.

Pressure Ulcer Development: Prevalence, Incidence and Severity

Pressure ulcers are measured through prevalence and incidence studies (AHCPR, 1992). Prevalence and incidence studies provide measurable, longitudinal, event-specific, quality outcome indicators (Gallagher, 1997). Both prevalence and incidence yield proportional information calculated from a numerator and denominator fraction. Prevalence and incidence cases represent numbers of people who have pressure ulcers and not the number of pressure ulcers itself. One person with one ulcer is considered a case as well as one person with several ulcers. Prevalence and incidence studies incorporate the information on severity of pressure ulcers which are typically assessed through the staging of ulcers and the numbers of ulcers. Pressure ulcers are given a stage

based upon erythema of the skin or depth of the ulcer. Literature findings have revealed that numerous staging classifications have been used (Appendix A). Prior to the existence of a staging classification system, ulcers were described as being either present or absent. Early classification systems tended to be author based, with ulcers described according to their appearance (Allman et al., 1986; Gerson, 1972). Other advantages of staging include the improvement of accurate reporting of prevalence rates and severity of ulcers and comparability of data collection from similar settings.

Ulcer severity is also reported in terms of the numbers of ulcers present per patient. Specific ulcer stages and the numbers of ulcers are often reported on particular body sites. Patients with numerous pressure ulcers, especially when combined with the higher ulcer stages are a measure of the seriousness of the problem.

Prevalence and Severity Studies

Published prevalence and incidence studies conducted in tertiary settings from 1990 to 1998 are described. The literature on pressure ulcers is extensive and for the purpose of this study, findings on prevalence and incidence rates in tertiary settings and neuroscience populations will be reported. Studies that were conducted to evaluate specific therapies or treatments are not included in this review. The magnitude of pressure ulcers however was clear as numerous studies had been conducted across a variety of health care settings, including tertiary sites, nursing homes, rehabilitation settings and community care environments. Information obtained was deemed essential to determine the extent of the problem with the intent to identify treatment approaches and evaluate outcomes. Studies pertaining specifically to the neuroscience population will then be presented.

The variation in the prevalence rates reflects the extent of the problem in the specific setting as well as the study designs, staging criteria and methods used to capture the information. The low prevalence rate (4.7%) found by Allman et al.(1986) may be reflective of the absence of reporting stage 1 and stage X ulcers and the indirect assessment methods used in determining the prevalence rate. There also may have been selection bias in determining the study population as only patients deemed at risk were assessed rather than the total population. Some early studies also reflected information obtained from retrospective chart audits where incomplete or inaccurate documentation provided less than ideal information on prevalence rates.

Studies conducted in the early to late 1990's (Allcock, 1994; Barczak et al., 1997; Dealey, 1991; Fisher et al., 1996; Grawon, 1995; Harrison et al., 1996; Makleburst & Magnan 1994; Meehan, 1990; O'Brien, Wind, van Rijswijk, & Kerstein, 1998; O'Dea, 1993, 1996) demonstrated the use of improved research designs with trained survey teams collecting patient data on risk and outcome in a uniform manner across single or multiple sites. In these studies, prevalence rates ranged from 12% (Grawon, 1995) to 32.1% (Allcock et al. 1994). Table 3 presents the literature findings on prevalence rates conducted in single, multisite and national studies and includes the staging criteria used as well as the seriousness of the ulcers and particular body area location.

Prevalence studies in Table 3 reflect the variety of staging classifications used in tertiary settings. Formal staging classifications systems such as the one developed by NPUAP and adopted by AHCPR assisted clinicians and researchers in describing the severity of pressure ulcers with respect to their depth. While several studies used the NPUAP staging classification, other studies, especially British based studies (Allcock et

al., 1994; Dealey, 1991 and O'Dea, 1993, 1996) used other staging criteria to describe tissue depth, thus making the comparability of ulcer severity more difficult.

Most studies included stage 1 ulcers (non-blanchable erythema) into the overall calculation of the prevalence and incidence rates, however O'Dea, (1993, 1996) excluded this particular category due to concerns regarding accurate assessment especially in dark-skinned individuals. Exclusion of stage 1 ulcers lowers the reported prevalence and incidence rate, and also excludes the proportion of patients that could benefit the most from early detection and subsequent preventative techniques. Studies that included a stage X category in the calculation of prevalence and incidence rates (Barczak et al., 1995; Harrison et al., 1996; Fisher et al., 1996; Makleburst & Magnan, 1994; Meehan, 1994) demonstrated that the extent of the pressure ulcer problem was not solely limited to visualizing the depth of tissue destruction.

The definition of the study group and how the information was analyzed also varied. Almost all prevalence and incidence studies excluded the obstetrical and neonatal population because of the unlikely risk of pressure ulcer development, while a few studies chose to exclude patients with mental or psychiatric illness.

Large multi - site studies were conducted in an attempt to understand the extent of the problem across multiple health care sectors. While some studies were conducted in similar tertiary settings (O'Brien et al., 1998; Fisher et al., 1996; O'Dea, 1993) other studies (Foster, Frisch, Denis, Forler, & Jago, 1992) partnered with a variety of tertiary to community healthcare settings, thus providing a composite view of pressure ulcers across

Table 3.

Summary of the Literature on Prevalence and Severity of Pressure Ulcers Conducted in Tertiary Settings

Author	Staging	Prevalence	Severity of Ulcers	Body Site
<i>Single studies</i>				
Grawron (1995) university medical center n = 440	AHCPR staging, including eschar	12% including stage I ulcers	Stage 1 - 27% Stage 2 - 44% Stage 3 - 9% Stage 4 - 0% Stage Unknown - 19%	Coccyx, ischial and heels most common sites
Makleburst & Magnan (1994) n = 2,189	NPUAP	12.3%	270 patients developed 570 ulcers; Stage 1 - 29.8% Stage 2 - 37.5% Stage 3 - 14.7% Stage 4 - 10.7% Stage X - 7.1% One ulcer - 53%; >1 ulcer - 47%; Ulcers per patient 1-16	Pelvic girdle = 69.3%; Below pelvic girdle = 21.5% Above pelvic girdle = 9.3%
Allcock, et. al. (1994) n = 714	7 stages	All stage ulcers - 32.1% Stage 2 ≥ - 19.7%	Stage 1 - 44% Stage 2 - 29% Stage 3 - 21% Stage 4 - 5% Stage 5 - 1% Stage 6 - 0% Stage 7 - 2%	Feet - 42% Sacrum - 34% Arms - 15%
Harrison et al. (1996) n = 738	NPUAP Included Stages 1A & 1B Stage X	All stage ulcers - 29.7% Stage 2 = - 13.6%	Stage 1 - 54% Stage 2 - ≥ 46%	Not reported
<i>Multi-site studies</i>				
Foster et al. (1992) n = 2,384	NPUAP	25.7%	Stage 1 - 57.2% Stage 2 ≥ - 42.8%	Not reported
Fisher et al. (1996) n = 1,020	NPUAP Included Stages 1A & 1B Stage X	All stage ulcers - 23.9%; Stage 2 ≥ - 10.1%	Stage 1 A - 39.6% Stage 1 B - 23.9% Stage 2 - 23.1% Stage 3 - 3.5% Stage 4 - 1.1% Stage X - 8.8 % 11% of patients had 2 or more ulcers 15% of ulcers developed prior to admission	Coccyx/sacrum - 28.2% Elbow - 14.1% Heel - 13.6% Toe - 10.9% Ankle - 10.6%
O'Dea (1993) n = 3,213	4 stages	Mean rate = 18.6 Range - 14.4- 22.8%	No ulcer - 34% Ulcers - 66%	Not reported
O'Dea (1996) n = 11,050	4 stages	All stage ulcers - 14.4% Stage 2 ≥ - 9%	No ulcer - 41% Ulcers - 59%	Not reported

Table 3 cont'd
 Summary of the Literature on Prevalence and Severity of Pressure Ulcers Conducted in Tertiary Settings

Author	Staging	Prevalence	Severity of Ulcers	Body Site
<i>Serial studies</i>				
Dealy (1991) three prevalence studies prior to skin program implementation n = 399	5 stage	8.7% pre	Stage 1 = 37.5% Stage 2 - 39.1% Stage 3 - 10.9% Stage 4 - 4.7% Stage 5 - 7.8%	Sacral -42.1% Heel -18.8%
n = 396	5 stage	5.1% pre	Not reported	Not reported
n = 381	5 stage	8.19% pre	Not reported	Not reported
Dealey (1994) n = 406	5 stage	7.5%	Grade 1 = 23.9% Grade 2 = 32.6% Grade 3 = 30.4% Grade 4 = 8.7% Grade 5 = 4.4% 32 patients had 47 ulcers	Sacrum = 56.5% Heel = 6.5%
O'Brien et al. (1998) 1993 n = 313	NPUAP	All stage ulcers - 18% Stage 2 = - 13%	56 patients had 101 ulcers Stage 2 - 46%	Sacrum -43% Leg - 12% Heel - 9%
n = 331		All stage ulcer - 10% Stage 2 = - 7%	34 patients had 48 ulcers stage 1 - 48% stage 2 - 29%	Sacrum - 42% Ankle - 6%
n = 315		All stage ulcer - 10% Stage 2 = - 8%	30 patients had 64 ulcers stage 1 - 20% stage 2 - 47%	Sacrum - 28% Buttocks- 21% Heel/Ankle - 20%
<i>National studies</i>				
Meehan (1990) First national prevalence study n = 34,987	IAET staging	9.2%	Stage 1 - 39% Stage 2 - 39% Stage 3 - 14% Stage 4 - 8% Stage X - not reported	Sacrum -38% Heel- 19% Trochanter for most severe ulcers
Meehan 1994 Second national prevalence study n = 31,530	NPUAP staging	National 11.2%	Stage 1 - 38% Stage 2 - 37% Stage 3 - 11% Stage 4 - 7% Stage X - 8% 3487 patients had > 1 ulcer	Sacrum -36% Heel- 30%
<i>National studies</i>				
Barczak et al. (1997) Third national prevalence study 1993 177 hospitals n = 33,063	AHCPR including eschar stage	11.1%	Stage 1 - 38% stage 2 - 36% Stage 3 - 9% Stage 4 - 7% Stage X - 9%	Sacrum (36%) Heel (30%)

Table 3 cont'd
Summary of the Literature on Prevalence and Severity of Pressure Ulcers Conducted in Tertiary Settings

Author	Staging	Prevalence	Severity of Ulcers	Body Site
National studies				
Barczak (1997) Fourth national prevalence study -1995 265 hospitals n = 39, 874	AHCPR including eschar stage	National prevalence - 10.1% Individual hospitals- 1.4% - 36.4%	Stage 1 - 35% Stage 2 - 39% Stage 3 - 10% Stage 4 - 7% Stage X - 9%	Sacral (39%) Heel (28%)

the continuum of care. Multi - site studies conducted in comparable tertiary settings have the potential to provide important information on patient population characteristics, delivery of care models and resource allocation to the prevention and treatment of pressure ulcers. Multi-site studies across the continuum of care, especially in one geographical area, can provide valuable information on the overall extent of the problem from a regional perspective and identify potential or actual gaps in the health care delivery model.

Literature findings also demonstrated that single institutions conducted serial prevalence studies in order to determine trends in pressure ulcer prevalence, and review the impact of quality improvement initiatives. While Dealey (1991) reported the results of three point prevalence rates conducted within a six month period prior to the implementation of pressure-relieving equipment, O'Brien (1998) studied patient characteristics, documentation practices and treatment measures in two year intervals starting in 1993.

National studies were conducted to examine the problem of pressure ulcers. Although no national Canadian studies have being completed, Meehan (1990) conducted the first of

four national prevalence studies in the United States of America. The prevalence rate of 9.2% reflected a pressure ulcer problem from 142 active treatment hospitals, including teaching, community, private and government institutions who volunteered for the study. This well designed and implemented study demonstrated that there was a statistically significant increase in the more serious ulcers in hospitals with greater than 500 beds. Three further U.S. national prevalence studies were conducted in 1991, 1993 and 1995 (Meehan, 1994; Barczak et al., 1997), with acute care hospital participation ranging from 2 - 5% of potential participating sites. Over the four years, a total of 603 different American hospitals from 45 states participated with 139,454 patients. Studies conducted produced the following national prevalence rates: 11.2%, 11.1% and 10.1% (Barczak et al., 1997). Although Barczak felt there had been improved health care changes over the seven years, including the increased awareness of the problem of pressure ulcers through the publication of the AHCPR Clinical Practice Guidelines, there appeared to be little change in prevalence rates from 1989 to 1995. This may reflect factors such as higher patient acuity, age of the population, reduction in clinical staff, less attention to pressure ulcer prevention and reduced quality of care (Barczak et al., 1997).

Severity of ulcers reported in the prevalence studies conducted in tertiary settings demonstrated that over 50% of the ulcers were classified as either stage 1 or 2 with stage 4 ulcers accounting for 10% or less with respect to severity. This information supports that continued risk assessment, ulcer surveillance and early preventive approaches are needed to maintain the hold on ulcer severity and prevent more serious ulcers from developing. The coccyx, sacrum and heel appeared to be the most vulnerable body areas and was consistent across all tertiary settings. These body areas affected demonstrate the

effect of supine or sitting positions and the possibility of friction and shearing mechanisms and their contributory effect on pressure ulcer development.

Incidence and severity studies.

The incidence rate is the rate at which new cases of the disease or problem occurs in a population (Baumgarten, 1998). Pressure ulcers which develop while in hospital is thought to reflect the nosocomial problem (Gallagher, 1997). Incidence represents a longitudinal count of the number of cases over a specific period of time which will vary, depending on the design of the study and the resources and funding available to maintain surveillance. Because incidence measures the new occurrence of the problem based on risk, cases with the existing disease or problem would not be counted in the calculation of incidence (Baumgarten, 1998). The numerator represents the new cases that have occurred over the denominator of all susceptible people present at the beginning of the time period (Frantz, 1997).

The literature on incidence studies was analyzed for the purpose of understanding the nosocomial problem of pressure ulcers and their seriousness. Table 4 outlines the literature findings of the incidence rates found in a variety of health care settings as well as the staging criteria used including the severity of ulcers found and the body site location.

Incidence rates varied from 2.7% (Gerson, 1972) to 41.7% (Pieper et al., 1998) and reflected similar issues seen in prevalence studies with respect to study design, staging criteria used and methods employed to obtain data. The length of time the data was collected and how often varied in the incidence studies and may have been attributed to the resources allocated to investigate the reasonable time to ulcer development. Large

scale incidence studies conducted in tertiary settings as well as serial incidence studies were not reported in the literature.

Incidence rates have been reported on specific populations such as patients undergoing surgery (Aronovitch, 1998; Kemp et al., 1990), cardiac surgery (Papantonio, Wallop, & Kolodner, 1994; Ratliff & Rodeheaver, 1998) and patients in specific settings such as a intensive care units (Jiricka et al., 1995) or admitted following acute trauma (O'Sullivan et al., 1997). Incidence findings from these studies are found in Table 4 and demonstrate a wide range of rates.

O'Sullivan (1997) and colleagues found a very low incidence rate when examining retrospectively, all patients who developed pressure ulcers following an acute traumatic injury. The possible causes for pressure ulcers were categorized into time of position change greater than 2 hours, equipment related ulcers i.e. splints and casts, and pressure ulcers developing from multiple causes. Management of acute trauma including fluid resuscitation and interventions given for anemia, nutrition and infection were felt to contribute to the low rate found. Jiricka et al., (1995) and Baldwin et al., (1998) however found high incidence rates (56% and 30% respectively) of pressure ulcers when following critically injured patients until death or discharge in an intensive care setting. The higher rates seen in both these studies are most likely related to the seriousness and extent of injury and the necessity of an ICU admission. Although Baldwin et al. (1998) found that neurological injuries made up the majority of cases, an age cut-off of 60 years was used, thereby excluding potential neurological and other system injuries that can occur in an older age group.

Table 4

Summary of the Literature on Incidence and Severity of Pressure Ulcers Conducted in Tertiary Settings

Author	Staging	Incidence	Severity of Ulcers	Body Site
<i>Single site</i>				
Clark & Watts (1994) n = 8,935 52 weeks	4 stage system (David)	All stage ulcer -4.03% Stage 3 ≥ - 0.19	29/306 developed multiple sores; 10.9% incidence rate per 100 admissions on orthopaedic unit	Sacrum -76.3% Heels- 18.2%
Allman et al. (1995) n = 286 tertiary setting 8 weeks	NPUAP	12.9%	Stage 2 - 89.2% stage 3 - 10.8%	Coccyx -40.5% Ishial - 35.0% Sacrum - 10.8%
Schue & Langemo (1998) rehab n = 150 males 1 year	NPUAP	6%	stage 1 - 24% Stage 2 - 57% stage 3 - 15% stage 4 - 4%	Sacrum 46% Heel-ankle- 44% Trochanter -6%
<i>Multi-site studies</i>				
Gerson (1972) n = 5,648 3 hospital sites 4 months	None	2.7%	---	---
Langemo (1991) Multi-site study n = 190	NPUAP staging	Overall -9% Acute care - 14% Skilled care- 28% Rehab/ hospice-0%	Total of 14 ulcers among 11 acute care patients; stage 1 = 8 ulcers; stage 2= 6 ulcers; 1 patient had 4 ulcers	
Goodridge et al. (1998) 2 tertiary (n = 222) and long-term care facilities (n = 108) 3 months	Not reported	Overall - 9.7% acute setting - 10.36% long-term care setting - 8.0%	One ulcer - 73.8% Two ulcers - 11.9% Three ulcers & > - 14.4% 15/32 ulcers developed in the first week, 75% developed in the first month. Highest stage of ulcers: all stage ulcers - 57.1% stage 2 ≥ -31%	Sacrum/coccyx most frequent site (27%) with heel (20.3%) next highest.
Pieper (1998) multisite; 5 acute care, rehabilitation site & home care agency N= 694 2 months	AHCPR	41.7 % 71 patients had 174 pressure. 71% of ulcers were identified on admission while 29% were institution acquired	Stage 1-34 ulcers Stage 2 -69 ulcers Stage 3- 24 ulcers Stage 4- 22 ulcers	Most common sites of pressure ulcers were sacrum-coccyx , (L) trochanter, and heels

Table 4 cont'd
Summary of the Literature on Incidence and Severity of Pressure Ulcers Conducted in Tertiary Settings

Author	Staging	Incidence	Severity of Ulcers	Body Site
<i>Specialized settings</i>				
Baldwin (1998) n = 36 Intensive Care Unit; Bi-weekly assessment	NPUAP	30.6%	Stage 1-28% Stage 2- 62% Stage 3- 0% Stage 4-5% Unstageable- 5% patients developed 21 ulcers	Coccyx - 23% Heels -19% Elbows- 14% Scapula -14%
Jiricka et al., (1995) n = 85 Intensive Care Unit	Not reported	56%	Stage 1 - 54% Stage 2 > - 46%	Not reported
Kemp (1990) n = 125 Intra-operative	IAET	12%	15 patients developed 232 ulcers	Elbows, heels and sacrum most common
Lewicki (1997) n= 337	AHCPR	4.7%	Stage 1-13 ulcers; Stage 2- 5 ulcers; 4 ulcers were not staged, incl. eschar. 16 patients developed 22	Ulcers located on heels, gluteal folds, sacrum, scapula, toes & ankles
Papantonio, Wallop, & Kolodner (1994) n= 136 Cardiac surgery setting	IAET; Grade 1 included purple ecchymotic appearance in addition to erythemia.	27.2% *	Stage 2 - 43%; while 57% progressed to stage 2/3. Severe ulcers appeared sooner. 14% of stage 1 ulcers appeared in 18 hrs 63% of stage 2/3 ulcers appeared within 18 hrs and 43% developed by 72 hrs.	Study focused on sacral ulcers only
Aronovitch (1998) n = 1,128 Intraoperative	Burn-like lesion appearing hours to 3 days post-operatively ; with ecchymosis and blistering in 2-6 days	8.5% where operative time was >3 hrs	Stage 1 - 76% Stage 2 - 16% Unstageable ulcers -8% Average patient had 1.2 ulcers	Sacrum/coccyx - 39% Heel -36%
Ratliff & Rodeheaver, (1998) n=100 ; cardiac surgery	AHCPR	8%	Stage 1-50% Stage 2-50%	Not mentioned

* Incidence reflects sacral ulcers only.

Table 4 cont'd
Summary of the Literature on Incidence and Severity of Pressure Ulcers Conducted in Tertiary Settings

Author	Staging	Incidence	Severity of Ulcers	Body Site
<i>Specialized settings</i>				
O'Sullivan et al., (1997) n=7,492 acute trauma cases	Not mentioned	0.4%	Not mentioned	Coccyx- 23% Sacrum -16% Occiput- 9% Chin - 9% Ankle - 9%

Summary Of Prevalence, Incidence And Severity Of Pressure Ulcers In Tertiary Care

In summary, both prevalence and incidence rates have been reported on pressure ulcers in North America and Europe over the last decade. Prevalence rates have ranged from 4.7% (Allman et al., 1986) to 32.1% (Allcock et al., 1994) in tertiary settings while incidence rates have ranged from 2.7% (Gerson, 1975) to 41.7% (Pieper et al., 1998). Both prevalence and incidence rates analysed reflect the diverse populations studied within the tertiary care setting. Studies that were conducted across multiple settings often report both overall prevalence or incidence rates as well as individual site rates. Methodological limitations of prevalence and incidence studies can be described as problems with the comparability of various sample populations; inclusion or exclusion criteria of the sample, multiple sources of data extraction, diverse study designs and methods, and the numerous staging classifications used.

The literature review however demonstrated that tertiary settings, concerned with the problem of pressure ulcers, supported improved practices in pressure ulcer management in a variety of ways. The adoption of a risk assessment scale, the educational preparation in terms of type and amount given to staff, the establishment of survey nurses and the establishment of a skin program demonstrated continued efforts to reduce the prevalence, incidence and severity of pressure ulcers.

Pressure Ulcer Development: Prevalence, Incidence and Severity in the Neuroscience

Population

A literature review was undertaken to look at prevalence and incidence studies of pressure ulcers in the neuroscience population. There was a predominance of research conducted with patients who had suffered a spinal cord injury. Literature on other neuroscience subgroups was sparse. Patients with ALS, MS (Raney, 1989), Parkinson's disease (Baharestani, 1994) and stroke (Berlowitz & Wilking, 1989) were identified in the literature as developing pressure ulcers although some studies (Baharestani, 1994) did not identify rates. No studies were found in looking at the neuroscience population as a component of a tertiary care in-patient setting. A summary of prevalence and incidence rates, severity and body site location are found in Table 5.

Patients who have suffered a spinal cord injury have been cited by the AHCPR Guidelines (1992) to have the highest prevalence of pressure ulcers. Reasons for this are numerous and are related not only to the lack of sensory and motor innervation, but the changes the spinal injury has on other body systems. The literature findings on prevalence and incidence studies were conducted in rehabilitation centers (Hunter et al., 1992; Rodriquez & Garber, 1994) veteran homes (Salzberg et al., 1996) and community living (Fuhrer et al., 1993; Garber et al., 1996). Prevalence and incidence rates cited in this population were also reported in terms of anatomical area; whether the injury was complete or incomplete; and whether the patient was quadriplegia or paraplegia. Prevalence studies found in this population during the specific literature review period from 1990 to 1998 were few, with prevalence rates ranging from 21% (Guttenwicht, 1995) to 33% (Fuhrer, 1993). Guttenwicht (1995) studied acutely injured patients

Table 5 Summary of the Literature on Prevalence, Incidence and Severity of Pressure Ulcers Conducted in Neuroscience Population

Author	Staging	Prevalence	Incidence	Severity of Ulcers	Body Site
Stotts (1988) n =387 elective patients for cardiac and neurosurgical procedures; 3 week follow-up	Shea		17%	Used a severity scale score to evaluate ulcers. Ulcer severity ranged from 1-3	(L) knee and (R) malleous
Vial & Sarrias (1991) Rehabilitation Center n = 884	Stage 1-4 (Enis & Sarmiento)	30%		1.5 pressure ulcers per patient	Ishial region - 28% sacral -21% trochanter- 20.3%
Hunter et al. (1992) Rehabilitation Center prevalence n =40 incidence n =40 over 4 weeks	Shea	25%	0%	Two patients had 2 ulcers; Stage 1-5 ulcers Stage 2- 4 ulcers Stage 3- 3 ulcers	Sacral ulcers - 5 Elbows -3 (R) & (L) malleous -1 each and heels -1 each
Fuhrer (1993) Community n=140	Shea	33%		46 patients had 93 ulcers Stage 1 -34%* Stage 2 - 37.9% Stage 3 or 4 - 27.5%	Pelvic area - 60.9% lower extremity- 29.9%
Rochon et al (1993) n= 364	NPUAP		22.3%	Not reported	Not reported
Hammond et al. (1994) Acute and long term spinal unit n=410 weekly over 18 months	AHCPR with the exclusion of stage 1		7.5%	Stage 2 - 80 ulcers stage 3 or > - 1 ulcer. Ten patients accounted for 47 ulcers; 25 patients had > 1-2 ulcers; Five patients developed ulcers from condom application	Pelvis -40% Perineal area - 22% Leg or trochanter - 16%.
Salzberg (1996) Veterans Medical Center n = 219	NPUAP		89.1% - complete injury 74% - incomplete injury	Not reported	Not reported
Raney (1989) ALS n = 28 MS n= 33		ALS - 17.9% MS - 30.5%		ALS- 5 patients had 12 ulcers Stage 1 = 66.6% Stage 2 = 33.3% MS -10 patients developed 44 ulcers	Not reported

* percentage calculated on the number of ulcers and not the cases of ulcers

admitted to one ward in a spinal treatment center who were referred from the community. Patients admitted to the center for other spinal problems were not included in the prevalence rate, thus under-reporting of pressure ulcers may have occurred. The low rate found was attributed to the concerns regarding assessment techniques, knowledge of the nurses in grading the pressure ulcers and the chart audit process (Guttenwicht, 1995).

Fuhrer and colleagues (1993) studied the prevalence rate of pressure ulcers in individuals with at least a nine month history of spinal cord injury who had completed rehabilitation and were living in a community setting. Using a community - based sampling frame with over - representation of females to ensure appropriate statistical analyses, a prevalence rate of 33% was found. Patients with ulcers exhibited significantly less motor control, however there were no differences found in the ulcer group with respect to the level of the lesion, and whether the spinal injury was classified as complete or incomplete.

The incidence rate of pressure ulcers in the spinal injured group was studied more frequently in an attempt to determine the clinical risk factors associated with pressure ulcer development as well as the rate, severity and body site affected. The incidence ranged from 0% (Hunter et al., 1992) to 89% (Salzberg et al., 1996). Hunter et al. (1992) studied prevalence and incidence rates of spinal cord injured patients prior to the implementation of a skin prevention program in a rehabilitation setting. An incidence rate of zero percent was found over a four month time frame and was attributed by the author to the following reasons: medical diagnosis (majority of patients with stroke and prosthetic replacements); short length of stay for patients with prosthetic replacements; and excellent skin care practices carried out by the nursing staff. Follow-up studies post

implementation of formal prevention programs have not been reported. Hammond et al. (1994) also found a low incidence rate of 7.4% in an acute and long-term spinal unit. Ten patients accounted for 47 of the ulcers while 83% of the patients had 1-2 ulcers. Penile ulcers from condom catheters were included while Stage I ulcers were excluded from the analysis.

Retrospective studies were also conducted in an attempt to quantify specific conditions, risk factors or traits. Salzberg et al. (1996) found an incidence rate of 89% in spinal injured patients with a complete injury versus 74% in patients with an incomplete injury while conducting a six year retrospective study on 219 patients admitted to a spinal cord injury unit. Observations from annual examinations including chart reviews, patient interviews and usually, but not always, direct observation determined that the median number of ulcers was three.

Vidal and Sarrias (1991) conducted a retrospective study of patients admitted to a spinal cord injury center over a 5 year period to study both the personality and physical conditions of admitted or re-admitted spinal injured patients. Thirty percent of the 884 patients had one or more pressure ulcers on admission with an average of 1.5 pressure ulcers per patient. The ischial region, followed by the sacral area and trochanter were the most common sites for pressure ulcer development. Patients with less spasticity had more severe ulcers.

Ulcer severity in the spinal injured population studied was varied and was attributed to the design of the study and assessment criteria. Pressure ulcers in this client group tended to be deeper and more serious ulcers, with stages 3 and 4 seen more consistently than those in the non-spinal injured group. Body site area most affected by pressure ulcers

remained similar to the non-spinal injured population with a predominance of ulcers located in the sacral, coccyx and trochanter areas.

Few studies describing other subgroups in the neuroscience population were found. Raney (1989) conducted a retrospective chart audit over a five year period to determine if there was a difference in prevalence rates between patients with ALS and patients with MS. A prevalence rate of 17.9% was found in the ALS group compared to 30.3% of MS patients on admission day. Ulcers found were in stages 1 to 3 with the sacrum and hips being the most common body site. The design of the study, the uncertainty that stage 1 ulcers were documented, and the possible inclusion of re-admitted patients counted twice in the overall calculation of prevalence rate were limitations of the study.

Stotts (1988) studied elective neurosurgical and cardiac surgery patients for three weeks following either surgical procedures or diagnostic testing. The overall incidence rate in the combined group was 17% with the individual group rate not reported. Comparisons between the two surgical groups demonstrated that patients undergoing cardiac surgery developed significantly more pressure ulcers on day 16 and day 19 compared to patients undergoing neurosurgical procedures.

Summary Of Prevalence, Incidence And Severity In The Neuroscience Population

In summary, there were no prevalence or incidence studies found that described the problem in the neuroscience population in a tertiary care setting. The prevalence rate ranged from 21% to 33% when studied in spinal cord injury centers and community settings, while incidence rates ranged from 0% to 89% in rehabilitation and spinal unit settings. The variable rates found in the neuroscience population reflected similar issues found in the non-neuroscience population with respect to diverse study designs, methods

and data collection techniques conducted in a variety of health care settings. Ulcer severity tended to be limited to Stage 1 and 2 ulcers, although the spinal injured group had more serious ulcers. The most common site for ulcers was at the coccyx, sacral and ischial areas.

Information on pressure ulcers in the neuroscience population in tertiary settings was not reported in the literature. Therefore a study utilizing data from a tertiary setting focusing on the neuroscience population was warranted. A secondary analysis was used due to the availability of an extensive data set from such a setting.

CHAPTER THREE

Methods

In this chapter the design, setting, sampling procedures, instruments, ethical considerations and data collection methods of both the current study and the original pressure ulcer prevalence studies are presented. The determination of risk and the methods of analysis are described.

Design

A secondary analysis of cross-sectional data obtained from four annual prevalence studies (1993-1996) was undertaken (Ottawa Civic Hospital Clinical Epidemiology Unit, 1993, 1994, 1995, 1996). The neuroscience population from a large in-patient tertiary care setting was described and compared to the non-neuroscience population. For the purpose of this study, the neuroscience population included those patients admitted to both the neurology and neurosurgery services on one unit within the tertiary setting collectively known as the neuroscience unit. In these large scale original Pressure Ulcer Prevalence studies (PUP) the prevalence and severity of pressure ulcers were assessed in the total hospital population, including demographic and risk profiles (Harrison et al., 1996; Fisher et al., 1996). Information was analyzed across the years using cohort comparison methods. The data set from the PUP studies conducted from 1993 to 1996 provided a rich source of information about the problem of pressure ulcers in a hospital setting. Analysis of clinical subgroups, like the neuroscience population had not been conducted and the data set from the original PUP studies was reconstructed to address the objectives in this study.

Secondary Analysis Methods

A secondary analysis approach was used in this study to complete the research objectives about the prevalence, severity, and clinical risk factors of pressure ulcers in the neuroscience population. Secondary analysis involves the use of raw data gathered in a previous study or studies to test new hypotheses or explore new relationships (Glass, 1976; Herron, 1989; Jacobson, Hamilton, & Galloway, 1993; Polit & Hungler, 1999). Specific variables that have not been previously analysed in the initial investigation, relationships not explored, or a change in the unit of analysis are all considered reasons and approaches in conducting a secondary analysis (Polit & Hungler, 1999).

Secondary analysis has many advantages and is considered to be underutilized in the nursing field (Brown & Semradek, 1992; Herron, 1989; Jacobson et al., 1993). Advantages include the facilitation of research through the avoidance of time-consuming and costly steps undertaken in obtaining a sample, designing an instrument and gathering the data (Polit & Hungler, 1999). Secondary analysis also enables beginning researchers to utilize the data collecting skill of more experienced and sophisticated researchers, giving the beginning researcher access to much larger amounts of data than they could easily or economically acquire on their own (Burstein, 1978; Herron, 1989). Furthermore, a closer examination of subgroups can be undertaken, given the size of the original data set (Herron, 1989; Jacobson et al., 1993). The secondary study may also enhance the original study's contribution to scientific knowledge through the reanalysis of data with a fresh perspective (Herron, 1989; Jacobson et al., 1993).

The researcher using secondary analysis must be aware of the limitations of this method. Disadvantages include the researcher not playing a role in the original study, nor

the data collected able to support specific research questions in subsequent secondary studies (Herron, 1989; Jacobson, 1993; Polit & Hungler, 1999). The researcher of the current study was a member of the original PUP team and contributed to data collection and implementation of the studies as a team leader on each of the four years. The researcher was also involved in the educational preparation of the survey team and assisted in ulcer staging validation with the Enterostomal Therapist, thereby ensuring a measure of confidence in data integrity. The population characteristics, sampling methods and instruments used in the primary PUP studies were examined in order to determine the relevancy to the research objectives in this study. In discussion with the Principal Investigator from the PUP studies (M.B.Harrison) it was deemed that the data set obtained during the original studies were suitable for analysis for a subpopulation. The technical storage of data and the ability to access and construct new data subsets were discussed and found to be feasible. The original variables were evaluated and it was determined that the original coding method, supported the research objectives in this study.

Prior to using a secondary analysis method on a specific data set, the researcher must evaluate the methodology employed when collecting the original data. Information about the size and nature of the samples, the response rates, validation efforts, protocols and analytic methods should be available in sufficient detail to allow a knowledgeable critique of the data collection procedures (Stewart & Kamins, 1993). While the validity and reliability of the instruments should be examined, researchers must also decide whether the existing category definitions and measures are appropriate for the study purpose by checking the match between the original conceptualizations and their own,

and the fit between the conceptual definitions of variables and their measurement in the original study (Brown & Semradek, 1992). The qualifications and training of research team members collecting the data must also be examined to ensure confidence in the integrity of the data and collecting procedures. Procedures used for handling missing data must also be reviewed (Jacobson, 1993). Given the advantages of secondary analysis and the attention to its limitations, this method remains an important approach in examining the characteristics of a particular subpopulation.

Study Variables

The variables for this study were the following: the prevalence of pressure ulcers (with/without the inclusion of stage 1 ulcers); the severity of ulcers (stages of ulcers and multiple ulcers); demographic variables (age, gender, time in hospital); and the clinical risk factors of sensory perception, activity, mobility, moisture, nutrition and friction/shear (conceptual framework by Braden and Bergstrom, 1987).

Setting and Sample

The setting for the prevalence studies was a university teaching hospital in Eastern Ontario with of 500 to 700 beds between 1993 –1996. The institution provided a range of services to a metropolitan area as well as a large outlying catchment area totaling 1,00,000 people. Table 6 outlines the protocol used in the Pressure Ulcer Prevalence studies from 1993 -1996.

The sample of patients for the current research study included the neuroscience and non-neuroscience populations taken from the PUP studies from the years 1993 to 1996. Data for the neuroscience population was obtained from a 40 bed neuroscience unit comprised of patients admitted to the medical service of neurology or neurosurgery,

collectively called neuroscience. This population consisted of all patients who were in-patients on the neuroscience unit on each of the yearly study days. This group reflected adults who sought diagnostic, medical and surgical treatment for neurological illness and

Table 6. Pressure Ulcer Prevalence Study Methods 1993-1996.

Study Outline	Description
Study Design:	Cross-sectional; point prevalence
Study Population:	Adult inpatient population during one 12 hour time period (0600-1800), including new admissions. Excluded from the study: obstetrical and nursery in-patients as well as patients admitted for day surgery.
Timing:	Mid-week to reflect new admissions, pre & post operative cases Mid September to avoid summer and winter seasonal variations
Data Collection Instruments:	Demographic and Clinical Profile Form Prevalence Grid The Braden Scale for Predicting Pressure Score Risk
Study Team:	Principal Investigator (Nurse Specialist in Research and Evaluation) Nurse Specialist from Quality Improvement Enterostomal Therapist; team leaders; survey nurses
Procedures:	<p><i>Pre-Study</i></p> <p>Training Workshops for Registered Nurse surveyors Inter-rater reliability assessment - conducted in 1993, Inform patients of study via letter on meal tray and discussion Liason with all nursing units</p> <p><i>Study</i></p> <p>Deploy 4 survey teams across hospital campus Track admissions every two hours Document all non-inclusions and reasons Risk assessment on all patients using the <i>Braden Tool</i> Comprehensive head-to -toe skin assessment Outcome assessment by stages if ulcers present</p>
Data Management:	All study patients verified with hospital census All missing cases accounted for Patients with both risk assessment and skin assessment included in study Data entered on SPSS-PC by experienced data analyst

acute trauma. The patients exhibited the clinical factors of decreased levels of consciousness, altered cognitive and perceptual functioning, decreased mobility, altered

activity levels, change in sensory perception, alterations in nutrition, elimination changes and friction and shear factors irrespective of medical diagnosis. Medical diagnoses common to this unit included stroke, head injury, primary and secondary brain tumors, spinal surgery, spinal cord injury and multiple sclerosis.

The non-neuroscience population were all other patients not on the neuroscience unit on the study days. This group consisted of an adult population who were admitted to the following units: medical, surgical, psychiatry, intensive care, cardiology and cardiac surgery.

Instruments

Data for the current research were obtained from the following instruments used in the original prevalence studies: the *Demographic and Clinical Profile Form*, the *Braden Scale for Predicting Pressure Sore Risk* and the *Ottawa Civic Hospital (OCH) Prevalence Grid* (Appendix B). The *Demographic and Clinical Profile Form* captured information on age, sex, time in hospital, type of pressure relief device used, and the type of nursing unit.

The Braden Scale for Predicting Pressure Sore Risk.

Data on the clinical risk factors for the current study were obtained from the *Braden Scale for Predicting Pressure Sore Risk* (Bergstrom, Braden, Laguzza, & Holman, 1987; Braden, Demuth, & Bergstrom, 1987) used in the original study (Appendix B). The *Braden Scale* was one of two tools recommended in the AHCPR Clinical Practice Guidelines for assessing risk for pressure ulcer development in a standardized manner. The decision to use the scale was based on previous application in a variety of health care settings and the reported sensitivity (83% - 100%) and specificity (64% - 90%).

The *Braden Scale for Predicting Pressure Sore Risk* (Bergstrom, Braden, Laguzza, & Holman, 1987; Bergstrom, Demuth, & Braden, 1987) was developed to "foster early identification of patients at risk for pressure sores." (p. 205). It consists of six mutually exclusive subscales that reflect the critical determinants of pressure (sensory perception, activity, and mobility), and factors influencing the tolerance of the skin and supporting structures for pressure (moisture, nutrition, and friction and shear). Each of the subscales has a title, a descriptor, and a phrase describing the qualifying attribute of that level. Sensory perception, activity, moisture, nutrition, and mobility contain four levels, while the combined friction/shear subscale has three levels. Each subscale and level are mutually exclusive with only one appropriate choice for a given case (Bergstrom, Braden, Laguzza, & Holman, 1987). Each level within each subscale is ranked from 1 to 3 or 4. The ranking of "one" represents the highest risk for pressure ulcer development, while "four" ("three" in the friction/shear subscale) represents no risk. The total risk score could potentially range from 6 to 23.

The intent of the *Braden Scale* was to predict pressure ulcer risk based on the cut-off score, thus assisting in costing decisions between preventing versus treating pressure ulcers. Original validation studies (Bergstrom, Braden, Laguzza, & Holman, 1987) conducted in two medical-surgical units yielded a cut-off score of 16 (sensitivity of 100% and specificity of 90% and 64% respectively), with recommendations that each health care setting conduct studies to determine sensitivity and specificity of the *Braden Scale* to establish appropriate cut-off scores. In the 1993 PUP study, a random sample of non-ulcer patients (n=300), selected from the prevalence study, were assessed Monday, Wednesday and Friday for a two week period using the *Braden Scale*. A specificity of

87% and a sensitivity of 38% were found at the identified risk cut-off score of 16 (Harrison et al., 1996). In this 1993 PUP study, the total Braden score that appeared to have the best balance of sensitivity (67%) and specificity (64%) was 19 (Harrison et al., 1996). Scores on the individual risk subscales were found to be more useful in interpreting both prevention and treatment needs and triggering nursing interventions (Harrison et al., 1996; Salvadalena et al., 1992).

As one objective of this study was to compare clinical risk in the neuroscience population to the non-neuroscience population, the proportion of patients with the presence of one clinical risk factor in the overall *Braden Scale* and the presence of one clinical risk factor in each of the subscales would provide descriptive and objective information with respect to profiling the neuroscience population. The total *Braden Scale* score was not used and reliance was placed on identifying the proportion of patients having any risk as captured in the *Braden* subscales as well as describing the type of risk.

Ottawa Civic Hospital Prevalence Grid

Data on the presence or absence of ulcers, the ulcer stage, ulcer sites and the numbers of ulcers were obtained from the original PUP data collected from *The Ottawa Civic Hospital (OCH) Prevalence Grid*. This form identified 28 specific body sites to assess regarding the maintenance of skin integrity, as well as an additional "other" site if needed. Study nurses used an accompanying diagram of a human body, containing a specific number marked over the 28 bony sites that were presented in anterior and posterior views, to assess skin integrity. The presence or absence of a pressure ulcer, including stage, was documented. Pressure ulcers were staged from 1 to 4 following the NPUAP (1989) classification system (Appendix A). A Stage 1A (non-blanchable

erythema) was also assessed in order to capture initial changes in capillary blood flow related to pressure. A stage X category was also used to assess the presence of black necrotic eschar tissue covering the ulcer, thus preventing accurate staging (Appendix C). Stage X was used in this and another Canadian study (Foster et al, 1992) to improve reliability of the reporting of prevalence rates.

Data Analysis

Data from the original PUP studies were coded yearly into a data set, by an experienced data programmer under guidance of the principal investigator. For the secondary analysis, two data subsets were constructed from the original PUP data set, one representing the neuroscience population and the other representing the non-neuroscience population. The total population was 2,598 cases with a neuroscience population of 166 cases across the four years. As the study variables for this research were included in the original data set, access to the original data collection forms was not required, thereby protecting patient confidentiality.

Data for the current study were analyzed using SPSS/PC+ version 6.1. The first analysis involved the use of parametric statistics to conduct a four year trend analysis of both the neuroscience and non-neuroscience population to determine any statistical or clinically important trends. The second analysis, using non-parametric statistics was used to compare the two populations to determine differences. Statistical significance was established with proportional differences at $p = 0.05$ two-tailed, while clinically important differences were established at a 10% change.

Demographics.

The demographics of the two populations were described using measures of central tendency. Continuous variables such as age and time in hospital were analysed and then converted to categorical variables for analysis and comparison. Chi - square tests (χ^2) of goodness of fit were used to test the differences in proportions of demographic data across the four years in each population. Chi - square tests (χ^2) of independence were used to test differences in proportions of categorical variables between the two populations.

Prevalence.

The prevalence of pressure ulcers was examined comparing the proportion of patients with no ulcers to the proportion of patients with all stages of ulcers (Stages 1 to 4 and Stage X) and stage 2 and higher (Stage 2 to 4 and stage X). Data from the neuroscience and non-neuroscience populations were analyzed separately across the four years, using the chi -square tests to determine statistically significant changes within each population. The proportion of patients with and without ulcers in the all stage category and stage 2 and higher category were compared yearly between the neuroscience and the non-neuroscience populations and analyzed using chi - square tests. In cases where the findings were so small ($n < 20$ or the expected cell value is < 5), Fisher's exact test was utilized (Pett, 1997).

Severity of Pressure Ulcers.

Severity of ulcers was obtained by examining the frequency and proportion of patients by stage of ulcer. It must be noted that a patient with a ulcer is only counted once and the

most severe stage recorded. For example, a patient who had a stage 2 ulcer and a stage 4 ulcer would be counted as one case with a stage 4 ulcer. This information portrays the seriousness of pressure ulcers by reporting the highest ulcer stage found. Chi -Square tests were used to determine differences across the four years in each population separately as well as comparing differences in the proportion of patients between the neuroscience and non-neuroscience population.

Severity was also examined in two ways: 1) the cases with various stages of ulcers, and 2) the cases with ulcers on different body areas. Specific sites of occurrences were organized to formulate six clinically meaningful groupings (coccyx, sacral and ischial tuberosity [CSI], trochanter, ankles, heels, elbows and head/ears). The proportion of patients with all stage ulcers and stage 2 and higher ulcers by site were analysed across the years in each population and reported in terms of frequencies and percentages.

Clinical Risk Factors

The concept of clinical risk, identified by the conceptual framework and measured by the *Braden Scale for Predicting Pressure Sore Risk* was analysed in two ways. First the presence or absence of any clinical risk was identified. Any patient who had one deficit present in any of the subscales was considered to have a clinical risk factor present and therefore to be *at risk* for pressure ulcer development. Secondly, each of the individual risk categories were examined and analysed to ascertain the type of a limitation or deficit. *No risk* was identified in each of the subscales if the patient was assessed as having no limitation using the nomenclature used by Braden et al. (Bergstrom, Braden, Laguzza, & Holman, 1987). If the patient was found to have a limitation in any of the three remaining

attributes in each of the subscales, then the patient was classified as being *at risk*. This dichotomy is presented in Table 7.

The data obtained on the categories of risk versus no risk, were obtained in the neuroscience and non-neuroscience populations. Using descriptive statistics of percentages and frequencies, each population was separately examined yearly with chi - square tests conducted to test the differences in proportions of risk across the four years. The differences in proportions of patients at risk between the neuroscience and non-

Table 7

Clinical Risk Factors for Pressure Ulcer Development Descriptors from the *Braden Scale*. Using the Concept of Risk Versus No Risk.

Clinical Risk Factors	Risk categories			No Risk
Sensory Perception	Completely Limited	Very Limited	Slightly Limited	No impairment
Moisture	Constantly Moist	Moist	Occasionally Moist	Rarely Moist
Activity Mobility	Bedfast Completely Immobile	Chairfast Very Limited	Walks Occasionally Slightly Limited	Walks Frequently No Limitations
Nutrition	Very Poor	Probably Inadequate	Adequate	Excellent
Friction/Shear	Problem	Potential Problem		No Apparent problem

neuroscience populations yearly were then conducted using chi -square tests. Similarly, the frequency of risk and no risk in each of the six subscales was analyzed using the same statistical approach.

Ethical Considerations

Permission was obtained from the Principal Investigator to use the data (Appendix D). Once obtained, ethical approval was sought and received from the Ottawa Civic Hospital Nursing Research Committee and the Ottawa Civic Hospital Ethics Committee for the neuroscience population study (Protocol # 1997272-01H). The original PUP study was approved by the Ottawa Civic Hospital Ethics Committee in 1993 (Protocol Number 1994155-01 H) with yearly review and approval for subsequent years. Prior to and during data collection, voluntary patient participation was sought by both the study nurses and the clinical nurse on the unit. Patients who could not respond because of mental status or cognitive impairment, were included in the study as both risk assessment and skin assessment were conducted as an important part of basic nursing care. Patients with completed risk and skin assessments were entered into the study, while patients who refused or were missing either a skin or risk assessment, were excluded.

Summary

In summary, the purpose of this study was to describe the neuroscience population and to determine if differences existed between the remainder of the in-patient population. A secondary analyses of cross-sectional data obtained from four annual prevalence studies was used to compare and describe both populations. Trend analysis and comparative analyses, using descriptive, parametric and non-parametric statistical tests, were used to determine both clinically and statistically important differences from the neuroscience and non-neuroscience populations. This next chapter will present the study findings on the neuroscience and non-neuroscience populations with respect to prevalence, severity and the clinical risk factors.

CHAPTER FOUR

Results

This chapter presents the results found when the neuroscience and non-neuroscience populations were examined separately over the four years and then compared yearly with respect to the prevalence of pressure ulcers and their associated clinical risk factors.

The purpose of the study was to describe the problem of pressure ulcers in the neuroscience in-patient population from a tertiary care setting and to determine if differences existed in comparison to the non-neuroscience population. The setting and the characteristics of the populations will be described as well as the prevalence rate, the severity of pressure ulcers and their associated clinical risk factors. The four year trend analysis on the neuroscience population will be presented first, then compared to the non-neuroscience population. Detailed information on the statistical findings of the study are located in technical tables 1 to 15 located in Appendix F.

Setting and Population

From the yearly point prevalence studies (1993 to 1996) conducted in an adult tertiary care setting, two populations were extracted for the purposes of this study. Over this time period, the neuroscience population was cared for on one unit in which patients were admitted for investigation and surgical and medical treatment for neurological conditions. On this nursing unit, there were no changes in medical services or bed capacity across the four years. The data set from the neuroscience population consisted of a total of 166 cases from the prevalence studies conducted in 1993 to 1996.

The non-neuroscience population data set represented patients who made up the remainder of the hospital, excluding the obstetrical and newborn population. The clinical services represented in this group remained consistent across the four years and included

general medicine, general surgery and intensive care. Although there was organizational downsizing experienced in 1996 which led to a reduction of approximately 100 beds, the non-neuroscience population had no loss of specific clinical services or major program changes. The number of patients in the data set obtained yearly ranged from 531 to 638 cases with the total data set consisting of 2,432 in-patients (Table 8).

Table 8 The Neuroscience and Non-neuroscience Population from 1993-1996.

		Neuroscience		Non-Neuroscience		Total
		n	(%)	n	(%)	N
1993		41	(6.0%)	638	(94.0%)	679
1994		42	(6.4%)	615	(93.6%)	657
1995		43	(6.3%)	638	(93.7%)	681
1996		40	(7.0%)	541	(93.0%)	581
Total	N (%)	166	(6.4%)	2,432	(93.6%)	2,598

The time in hospital (TIH) conducted on the prevalence studies, represents the length of time from admission day to prevalence day and not the total length of the hospital stay. Length of stay (LOS) information was obtained from the hospital database (Canadian Institute of Health Information) on the total in-patient hospital LOS and the neuroscience unit LOS. Both yearly and September LOS statistics were analyzed (Appendix F, Technical Table 1). It should be noted that the total in-patient hospital statistics represent the total hospital census including the neuroscience unit. The neuroscience unit had higher LOS in the monthly and yearly rates for 1993, 1994 and 1995.

In the prevalence studies, the total in-patient population was defined as patients on the 0600 hour census plus all newly admitted patients until 1800 hours. The proportion of patients assessed during the yearly prevalence surveys was 90% or greater (90% in 1993; 94% in 1994; 98% in 1995 & 1996). Reasons for all patients not included were documented. Patients who were not assessed were categorized into two groups: those who were not available for assessment because of discharge, leave of absence, and

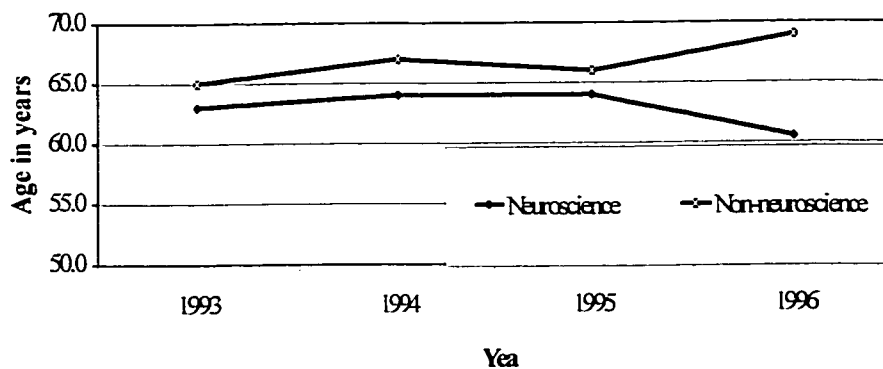
patients where assessments could not be completed for clinical reasons, ie. patients who refused, were critically ill, were in the operating room or died on the day of the study (Appendix E).

Characteristics of the Neuroscience and Non-neuroscience populations

The characteristics of the neuroscience and non-neuroscience populations were examined and compared in the areas of gender, age and time in hospital. Gender in both the neuroscience and non-neuroscience population was similar with males and females being evenly divided in each of the four years with one exception. In 1993, there were 60% males and 40 % females in the neuroscience population (Appendix F, Technical Table 2).

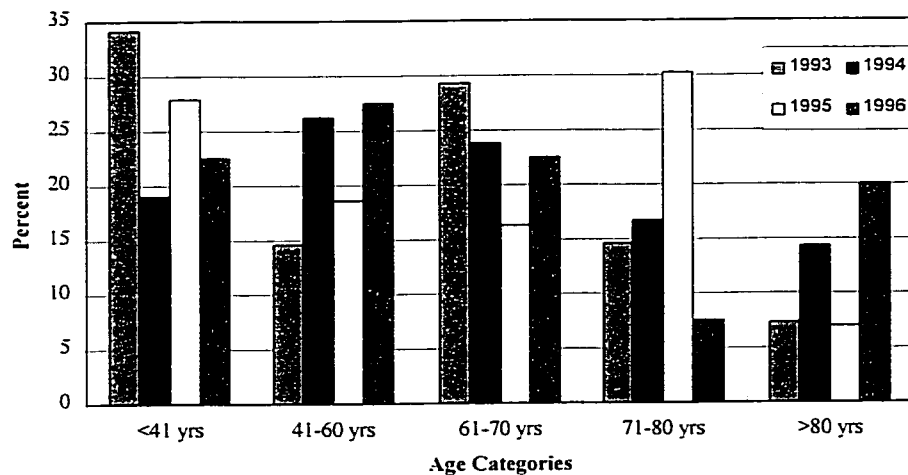
In the neuroscience population the mean age (54.5 to 59.5 years) and median age (60.5 to 64 years) demonstrated a slight upward trend from 1993 to 1995 with a decrease in 1996 (Appendix F, Technical Table 3). In comparison, the mean age (61 to 66.3 years) and the median age (65 to 69 years) in the non-neuroscience population increased over the four years except in 1994. The neuroscience population was younger in comparison to the non-neuroscience population across the four years of the study (Figure 3).

Figure 3 Median Ages of the Neuroscience and Non-neuroscience Populations: 1993-1996.



Age was further examined in the following categories: less than 41 years, ten year increments thereafter, and in the 81 years and over age group (Appendix F, Technical Table 4). In the neuroscience population, a clinically important trend was noted with the proportion of younger patients (< 41 years) diminishing over the four years and an increasing

Figure 4 Age Categories in the Neuroscience Population from 1993 - 1996.



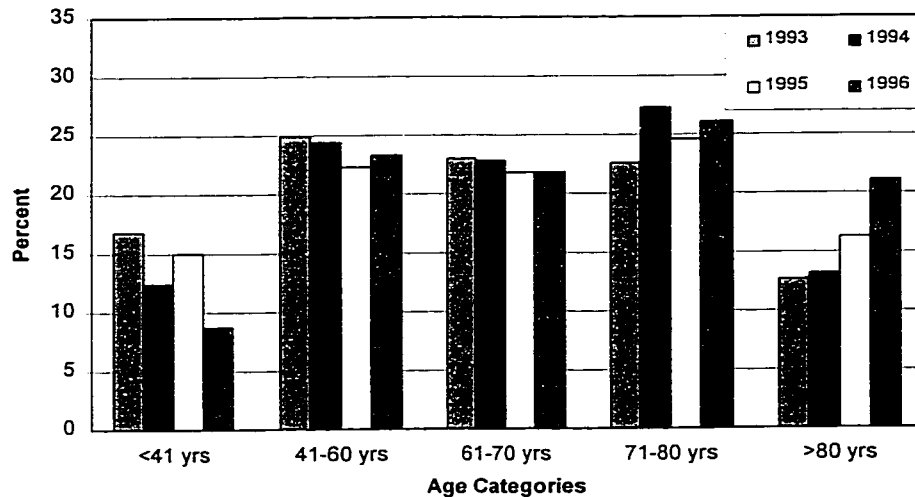
proportion of older patients in the 81 years and over category (Figure 4). This was not statistically significant.

In the non-neuroscience population, there was an equitable proportion of patients in three of the five age categories over the four years. Clinically important trends were noted however in the younger population (< 41 years) and in the older population (> than 80 years). Trend analysis over the four years, demonstrated statistically significant ($\chi^2(12, N = 2,432) = 33.97, p= 0.00$) differences in the age categories of the non-neuroscience population with the 81 years and over, being the fastest growing age cohort (Figure 5).

When comparing the neuroscience and non-neuroscience populations yearly, there was a higher proportion of younger patients (< 41 years) in the neuroscience population in

each of the four years. The neuroscience population also demonstrated the largest variation in the over 81 years category compared to the non-neuroscience population with an increase from 7% to 20%. By 1996, both populations had 20% of the proportion of patients in the age of 81 year category.

Figure 5 Age Categories in the Non-neuroscience Populations: 1993-1996.

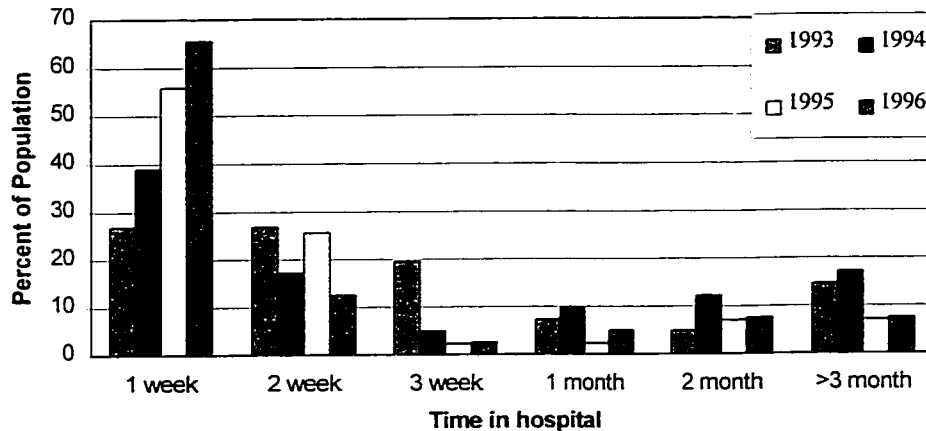


The prevalence study represents a cross-section of in - patients, who at the time of the study would have had varying lengths of hospital stay. The time in hospital (TIH) variable is calculated from the date of admission to the prevalence day. The TIH was examined in categories of one, two and three weeks, and one, two, and three months and longer categories (Appendix F, Technical Table 5). This represents the time in hospital up to and including the study day and not the total hospital admission LOS.

Across the four years, the neuroscience population demonstrated a clinically important trend of shorter hospital stays (Figure 6). The most significant increase was in the proportion of patients who had been in hospital one week or less (26% in 1993 to 66% in 1996). When the TIH categories of week 1 and week 2 were combined, 50% to 75% of the patients were admitted within this time frame. The remaining TIH categories

demonstrated a decline in the proportion of patients admitted within the specific category. The TIH category of 3 weeks and 3 months demonstrated a decline from 1993 to 1994.

Figure 6 Neuroscience Population Time in Hospital: 1993 -1996.



In the non-neuroscience population, the majority of patients were admitted in the week one TIH category (Figure 7). When the TIH categories of week 1 and week 2 were combined 65% to 70% of the patients were admitted within this time frame. Yearly comparisons between the populations, demonstrated that in 1993, the non-neuroscience population had a significantly greater proportion of patients admitted within week 1 whereas the neuroscience population had a significantly higher proportion in the week 3 category [$\chi^2(15, N = 2,597) = 15.71, p = .007$].

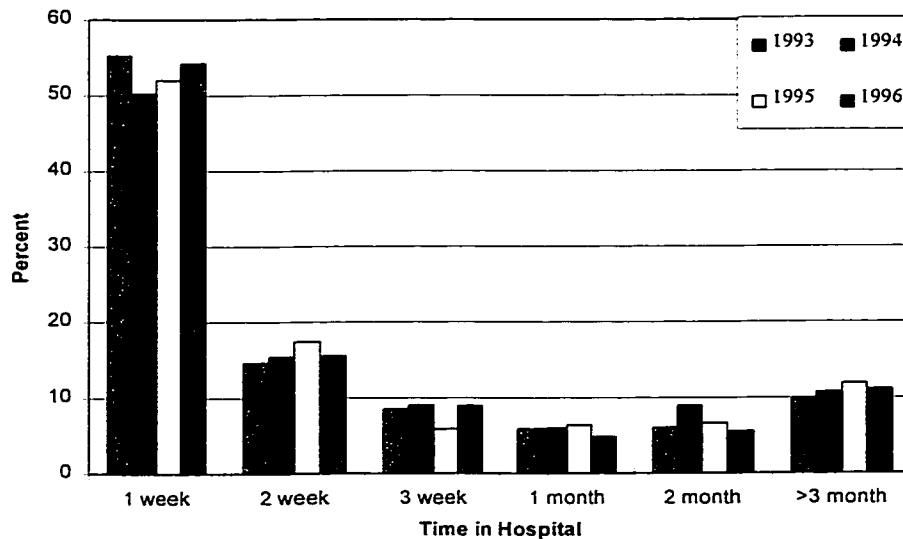
Pressure Ulcers: Prevalence

Research Objective: Determine the prevalence rate of pressure ulcers in an in-patient tertiary care neuroscience population in 1) all stages of ulcers and 2) stage 2 and higher stages

The prevalence of pressure ulcers is typically reported in two ways: (i) all stage ulcers which includes persistent redness, and (ii) more serious ulcers of stage 2 and higher ulcer

stages. This study reports prevalence in both ways for use and comparison with other reported studies.

Figure 7 Non-neuroscience Population Time in Hospital: 1993 - 1996.



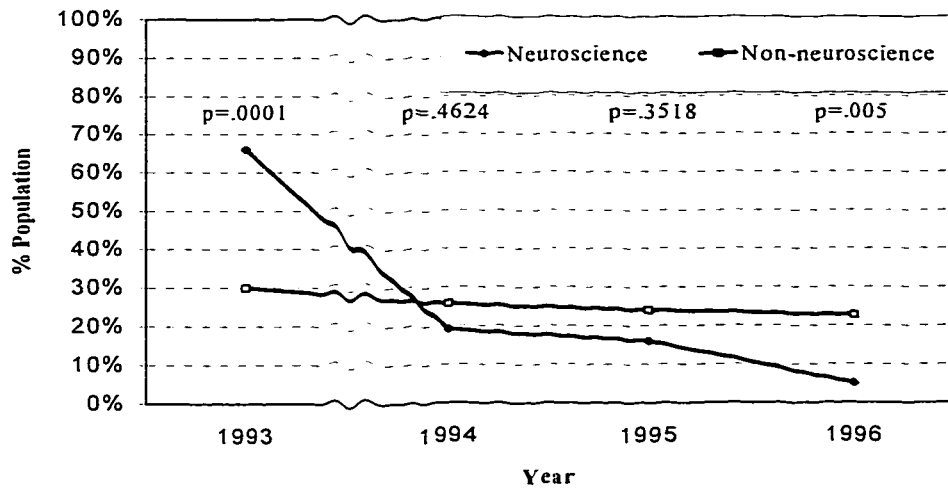
All stage ulcers

The prevalence of "all stage" pressure ulcers was examined in the neuroscience and non-neuroscience populations from 1993-1996 (Appendix F, Technical Table 6). In 1993, the neuroscience population had the highest prevalence rate of any of the four years at 65.9%. The prevalence rate in this population had a significant decline over the next three years to 5% by 1996 [$\chi^2(3, N = 166) = 45.59, p = .0000$]. In comparison, 30% of the non-neuroscience population had an ulcer in 1993 and the prevalence rate decreased incrementally to 22% by 1996.

Yearly comparisons of the neuroscience and non-neuroscience populations revealed significant differences in two of the four years (Figure 8). The result of Fisher's exact test indicate that in 1993, the neuroscience population had a higher proportion of patients

with ulcers ($p = .000$) and in 1996 the non-neuroscience population had a significantly higher prevalence rate ($p = .005$). These findings demonstrate there were overall differences between the two populations.

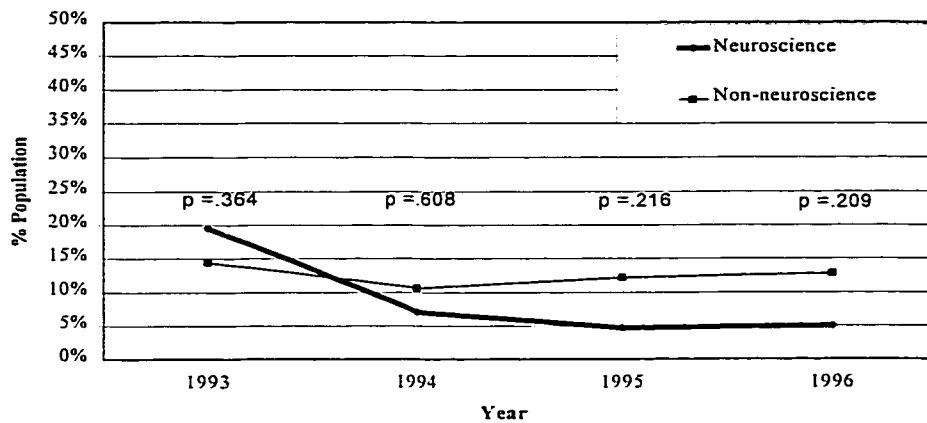
Figure 8 Prevalence of All Stage Pressure Ulcers in the Neuroscience and Non-neuroscience Population: 1993-1996.



Stage 2 and higher ulcer stages

In 1993, the prevalence rate with stage 2 and higher ulcers, in the neuroscience population was 19.5% (Appendix F, Technical Table 7) and, over the four years, (Figure 9) significantly decreased to 5% by 1996 [$\chi^2(3, N = 166) = 7.45509, p = .058$]. By comparison, the proportion of non-neuroscience patients with stage 2 and higher ulcer stages had less variation with a clinically important trend of rates decreasing slightly from 14.4% to 12.8% across the four years. Yearly comparisons between the two populations were not significant.

Figure 9 Prevalence of Stage 2 and Higher Pressure Ulcers in the Neuroscience and Non-neuroscience Populations: 1993 - 1996.

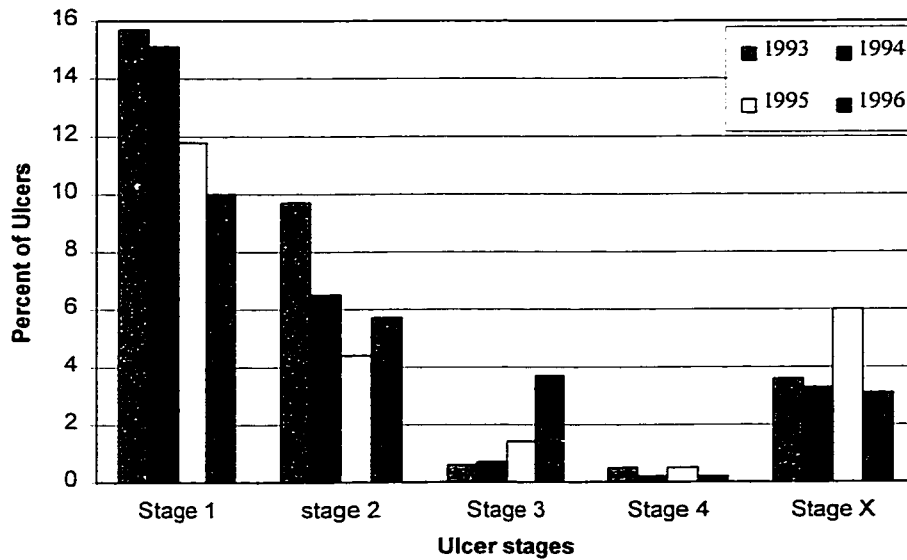


Pressure Ulcers: Severity

Research Objective: Determine the severity of pressure ulcers in an in-patient tertiary care neuroscience population by determining the proportion of ulcers by stage.

Ulcer severity can be determined by analyzing the proportion of patients within each ulcer stage. This represents cases with the highest staged ulcer. In the neuroscience population across the four years, all of the ulcers found were in stage 1 or stage 2 with no ulcers found in stage 3, 4, or Stage X (Appendix F, Technical Table 8). In comparison, the non-neuroscience population had a decreasing trend of stage 2 ulcers (9.7% to 4.4%) and a clinically important increasing trend of Stage 3 ulcers, representing a deeper and more serious ulcer (Figure 10). Over the four years three to six percent of the non-neuroscience population had Stage X ulcers.

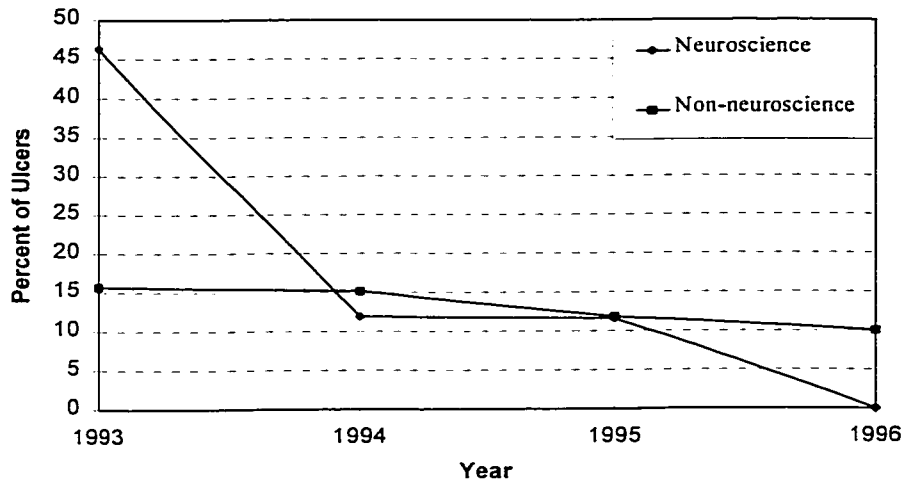
Figure 10 Severity of Pressure Ulcers in the Non-neuroscience Population: 1993 - 1996.



Because the neuroscience population demonstrated a trend towards the development of stage 1 ulcers compared to more serious ulcers, further analysis was conducted on the proportion of patients with stage 1 ulcers (Appendix F, Technical Table 9). This observation is clinically important because Stage 1 ulcers are amenable to pressure prevention techniques to prevent their likely progression to stage 2 and greater.

The neuroscience population demonstrated a sharp decline in the presence of stage 1 ulcers (Figure 11). In 1993, 46.3% of the neuroscience patients were identified as having a stage 1 ulcer. In 1994 and 1995, the proportion of patients in this category dropped to 11% and by 1996, declined to 0%. In the non-neuroscience population the proportion of patients with stage 1 ulcers decreased slightly across the four years from 15.7% in 1993 to 10% in 1996.

Figure 11 Comparison of Stage 1 Pressure Ulcers in the Neuroscience and Non-neuroscience Populations: 1993 - 1996.



Ulcer severity was also examined in the total numbers of ulcers found collectively in each year and not the cases with ulcers (prevalence). The total numbers of ulcers gives some indication of the severity in terms of the numbers of ulcers that need resources allocated to ensure healing. Ulcer severity was also examined in terms of the numbers of ulcers per case, thus representing the maximum number of ulcers per individual or case.

The neuroscience and non-neuroscience populations over the four years exhibited a decreasing number of ulcers (Table 9). This represents that there was an overall improvement in severity as less ulcers developed. As well, the number of ulcers per case decreased in both populations with a slight increase in 1996 in the non-neuroscience population.

Table 9 Numbers of Pressure Ulcers Found in the Neuroscience and Non- neuroscience Population.

	Neuroscience		Non-Neuroscience	
	# of ulcers	Highest ulcer # per case	# of ulcers	Highest ulcer # per case
1993	71	7	415	13
1994	13	4	330	9
1995	15	4	277	7
1996	2	1	230	8

Ulcer Site Occurrence

Research Objective: Compare the ulcer site occurrence in the neuroscience population to the non-neuroscience population.

On prevalence day, 28 body sites were assessed for the presence or absence of pressure ulcers as well as the ulcer stage. Examination ascertained that ulcer frequency was predominant to particular areas on the body in both the neuroscience and non-neuroscience population. The site categories represent important clinical groupings of potential areas of pressure ulcer development. From the 28 sites, the highest six areas of frequency were: 1) the coccyx, sacrum and ischial tuberosities; 2) heels; 3) the posterior aspect of the head and pinna of the ears; 4) ankles; 5) elbows; 6) trochanter and iliac crest. The frequency and percentage of ulcers on the six sites were examined across the four years in the neuroscience and non-neuroscience populations (Appendix F, Technical Tables 10 to 13). These tables outline the total number of ulcers found in the all stage category and stage two and higher category at the six body areas. The total number of ulcers found collectively at the six areas and how they are distributed are presented in the

technical tables.

The six ulcer sites in the neuroscience population that demonstrated the highest proportion of ulcers, including Stage 1 were the following: 1) coccyx, sacral and ischial tuberosity (CSI); 2) elbows; 3) ankles; 4) heels; 5) trochanter and 6) head/ears. In 1993, 79 ulcers from all stages, in the neuroscience population were collectively found at these six sites, with the CSI site having the highest proportion of ulcers (Technical Table 10). Over the next three years ulcer occurrence decreased to 1 ulcer by 1996 with the CSI site remaining clinically prominent (Figure 12).

In the non-neuroscience population the most common sites were the CSI; trochanter; ankle; elbow, head/ear and heel (Technical Table 11). The frequency of all stage ulcers decreased at these sites across the years collectively from 408 ulcers to 212 ulcers with the CSI and trochanter sites being clinically important (Figure 13).

Body site location for more serious ulcers of stage 2 and higher was also examined (Technical Tables 12 & 13). In the neuroscience population, the coccyx/sacral/ishal tuberoisity remained the most common site for ulcers (Technical Table 12) . In 1996, the 2 ulcers found were at the CSI site. In the non-neuroscience population (Technical Table 13) the CSI body site continued to have the most serious stage 2 and higher ulcers, while the ankle and trochanter sites demonstrated clinically important trends (Figure 14).

Figure 12 Body Site Location of All Stage Ulcers in the Neuroscience Population.

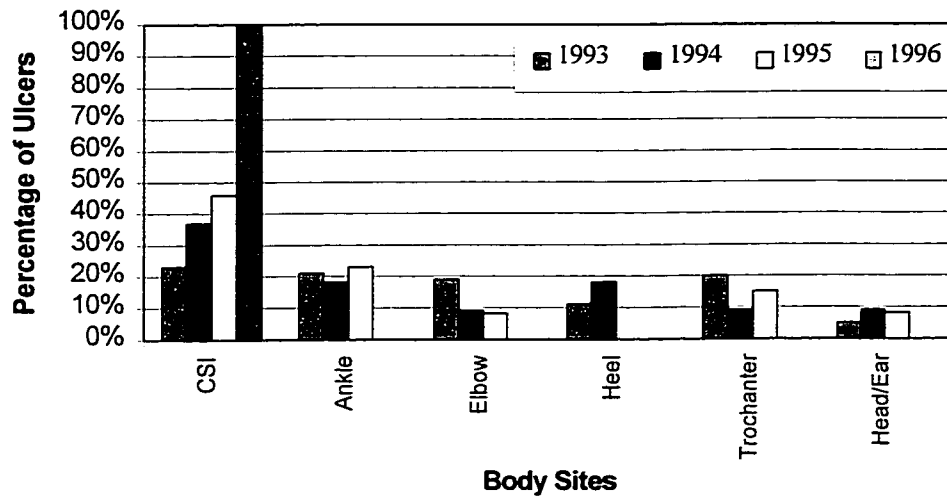


Figure 13 Body Site Location for All Stage Ulcers in the Non-neuroscience Population.

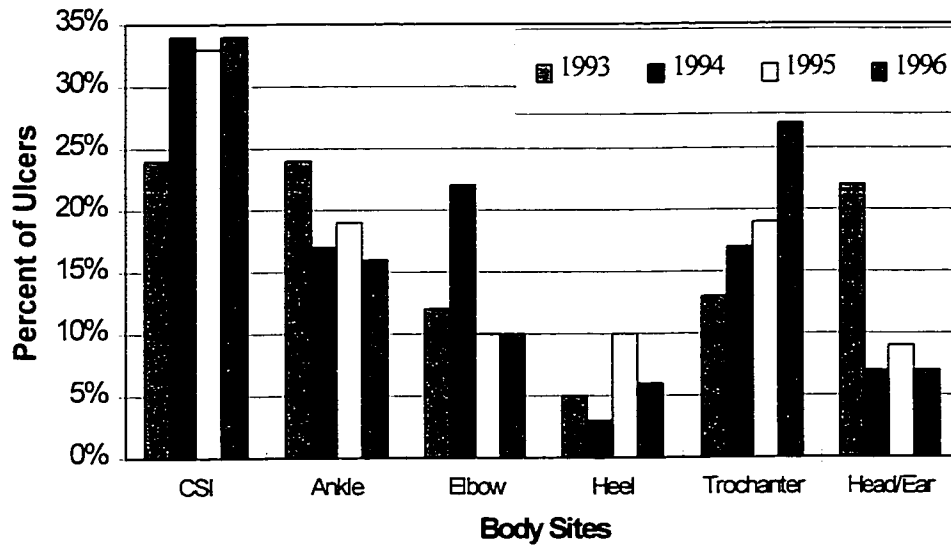
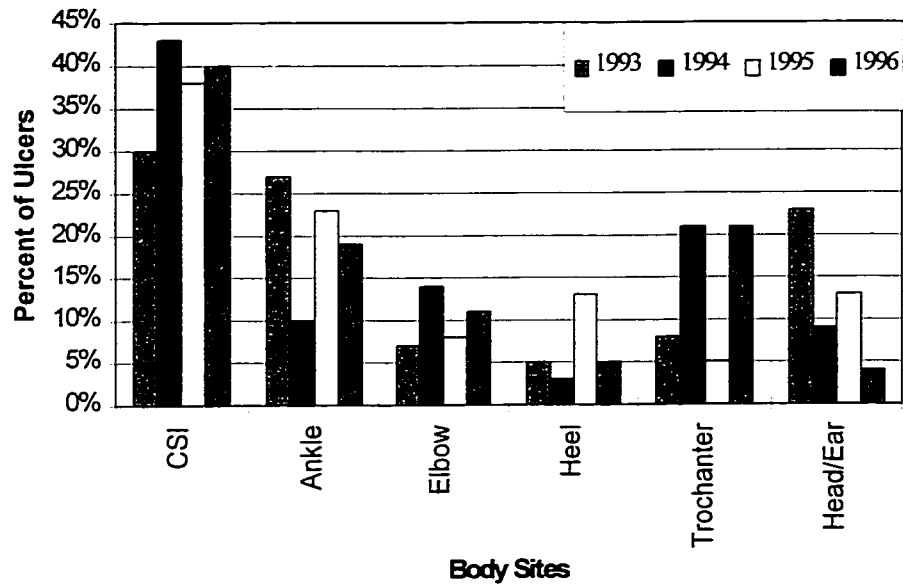


Figure 14 Body Site Location of Stage 2 and Higher Ulcers in the Non-neuroscience Population.



Clinical Risk Factors

Research Objective: Compare the presence or absence of clinical risk factors, as outlined in the Braden Scale, in an in-patient tertiary care neuroscience population to the non-neuroscience in-patient population.

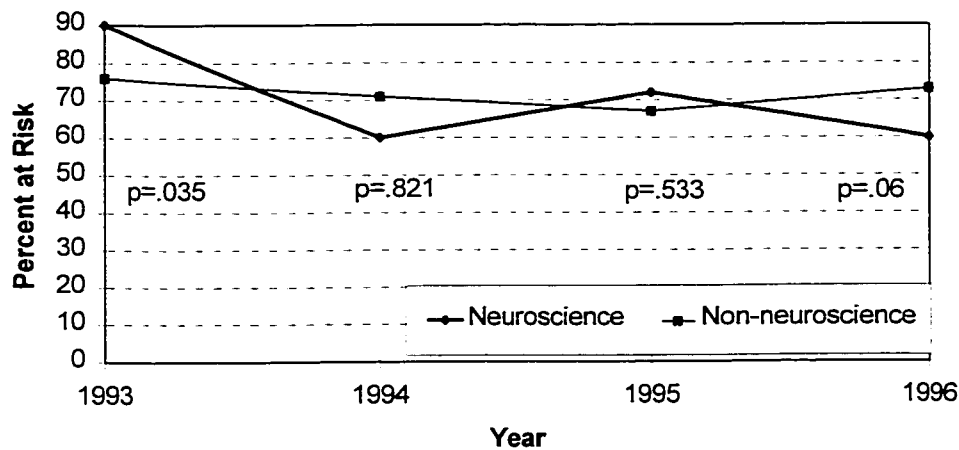
The *Braden Risk Assessment Scale* represents six specific clinical risk factors that are amenable to action in order to prevent skin ulceration. This study has purposely focused on the presence or absence of clinical risk factor(s) in the overall *Scale*. The presence of one or more clinical risk factors identified should trigger clinical concern and appropriate action. Therefore the proportion of patients identified with no risk on the *Braden Scale* were compared to the proportion of patients identified with risk (Appendix F, Technical Table 14).

The presence of clinical risk factors was evident in the neuroscience population. In

1993, 90% of the patients were identified as having at least one clinical risk factor present, which decreased to 69%, 72% and 60% by 1996. In the non-neuroscience population, the proportion of patients at risk in 1993 was 76% and remained relatively stable (67% - 73%) across the next three years (Figure 15).

In 1993, the difference between the neuroscience population and the non-neuroscience population was statistically significant ($\chi^2=4.399, p = .035$). The proportion of neuroscience patients at *no risk* was 10% compared to the 24% in the non-neuroscience patients. There were no statistically significant differences found between the two populations from 1994-1996 in which 60% to 73% of both populations remained at clinical risk for pressure ulcer development.

Figure 15 Proportion of Neuroscience and Non-neuroscience Population at Risk for Pressure Ulcers Based Upon the Braden Scale.



Types of Clinical Risk Factors

Research Objective: Compare the types of clinical factors that contribute to the risk of pressure ulcer development in the neuroscience population to the non-neuroscience in-patient population.

The clinical risk factors of sensory perception, moisture, activity, mobility, nutrition and friction/shear, as assessed by the *Braden Scale*, were examined individually in the neuroscience and non neuroscience populations to determine the precise nature of clinical risk. Technical Table 15 (Appendix F) presents the comparisons between the two populations with the proportion of patients found with the specific type of risk factor.

Sensory Perception

In 1993, 46.3% of the neuroscience population was identified with the clinical risk factor of sensory perception. Trend analysis over the four years demonstrated significant decrease to 7.5% by 1996 [$\chi^2 (1, N = 166) = 18.7709, p = .0003$]. In the non-neuroscience population, the proportion of patients at risk fluctuated from 21% to 15% to 18%. Yearly comparisons between the two populations demonstrated significant differences in 1993 and 1995 with the neuroscience population double the proportion of patients at risk compared to the non-neuroscience population ($p = .00015$; $p = .0009$) with a clinically important difference in 1996 (Figure 16).

Moisture

In the neuroscience population there was a significant downward trend in the proportion of patients with the presence of moisture. In 1993 56% of the neuroscience population were identified at risk with the clinical factor of moisture. The presence of this risk factor significantly decreased over the next three years to 10% [$\chi^2 (3, N = 166) = 20.060; p = .0001$]. In comparison, 27% of the non-neuroscience population were identified at risk in 1993. Although this proportion decreased slightly in 1994, the proportion of patients at risk returned to 28% risk by 1996. Yearly comparisons identified the neuroscience population with double the proportion of patients at risk than the non-

neuroscience population (Figure 17). This was significant in 1993, 1994, and 1995 ($p = .00009$; $p = .00001$; and $p = .00225$).

Figure 16 Proportion of Neuroscience and Non-neuroscience Populations with the Clinical Risk Factor of Sensory Perception.

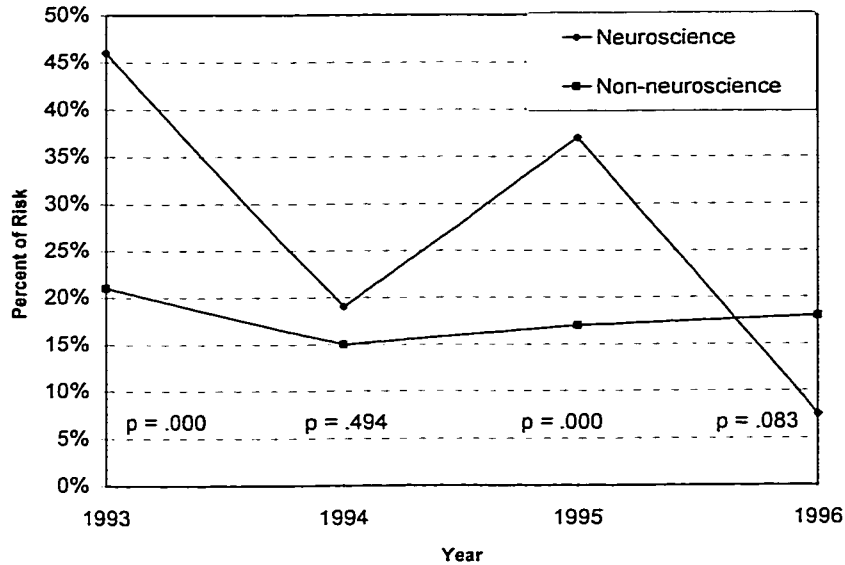
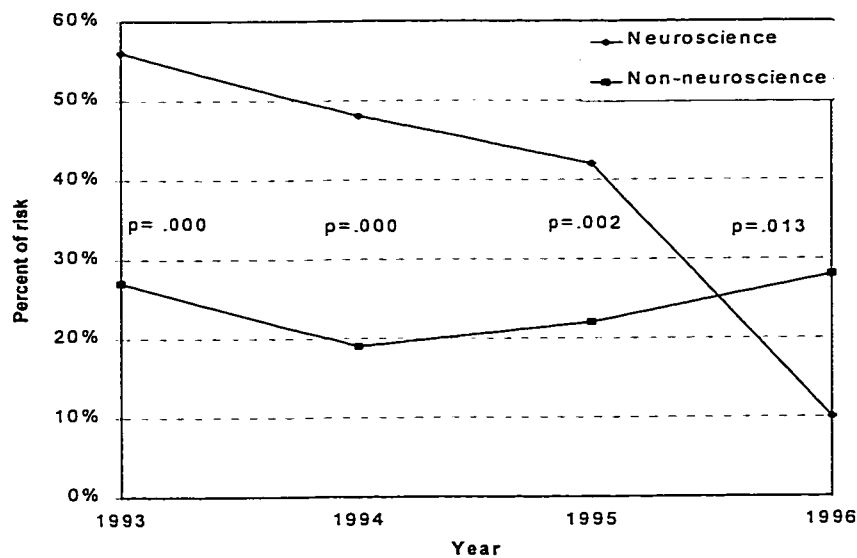


Figure 17 Proportion of Neuroscience and Non-neuroscience Populations with the Clinical Risk of Moisture.



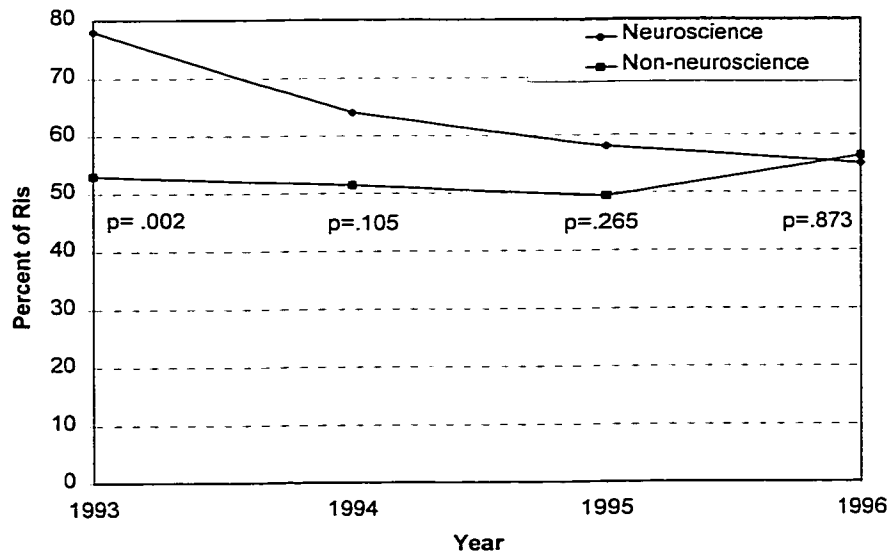
Activity

Over the four years the proportion of neuroscience patients with the clinical risk of activity decreased from 78% to 55%. The non-neuroscience population ranged from 49% to 56% and slightly surpassed the neuroscience population in 1996. The neuroscience population was significantly higher in 1993 in yearly comparisons ($p = .0026$) (Figure 18).

Mobility

In 1993, 58% of the neuroscience patients were identified at risk in the mobility subscale. Over the next three years there was a significant decrease to 22.5% [$\chi^2(3, N = 166) = 11.45, p = .009$]. The non-neuroscience population remained stable across the four years with 31% to 36.6% of the population identified with the clinical risk factor of

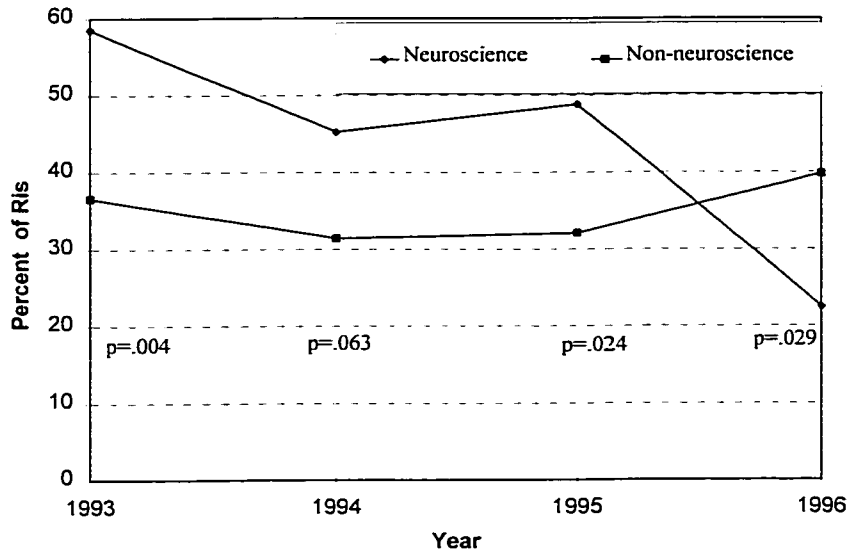
Figure 18 Proportion of Neuroscience and Non-neuroscience Populations With the Clinical Risk Factor of Activity.



immobility. Comparisons between the two populations revealed significant differences in 1993 between the neuroscience population and the non-neuroscience population ($p =$

.0049) (Figure 19).

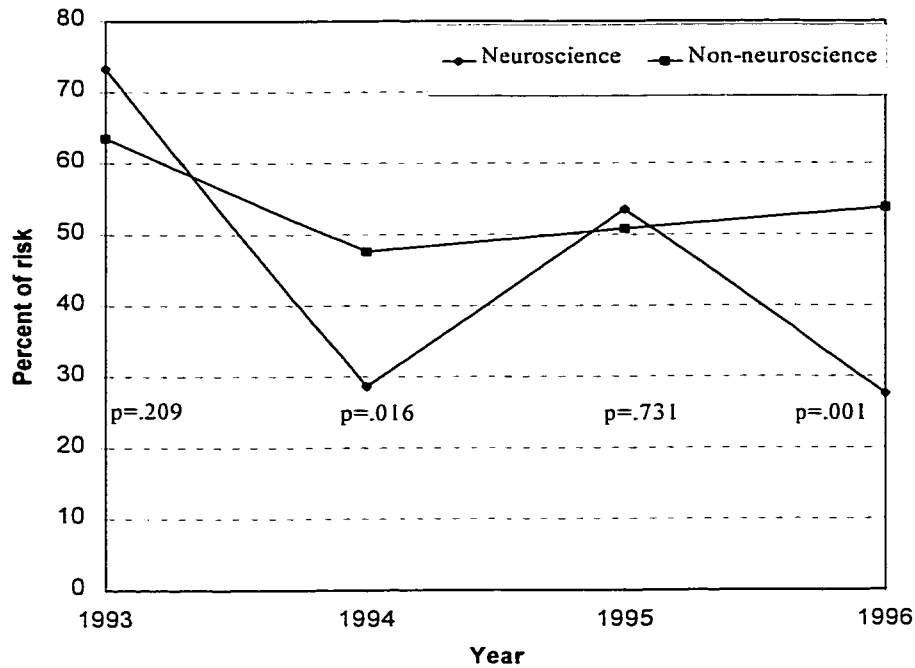
Figure 19 Proportion of Neuroscience and Non-neuroscience Populations with the Clinical Risk Factor of Mobility.



Nutrition

The neuroscience population had marked fluctuations with significant differences over the four years with respect to nutritional risk. In 1993, 73% of patients were identified at risk which decreased sharply to 28% the following year. In 1995, 53.5% were identified at risk which dropped again to 7% [$\chi^2(3, N = 166) = 23.817; p = .0000$]. In the non-neuroscience population the proportion of patients at risk also decreased significantly over the four years from 63.5% to 50% [$\chi^2(3, N = 2,428) = 35.819; p = .0000$]. In 1994 and 1996 the proportion of non-neuroscience population was significantly higher than the neuroscience population ($p = .01; p = .001$) (Figure 20).

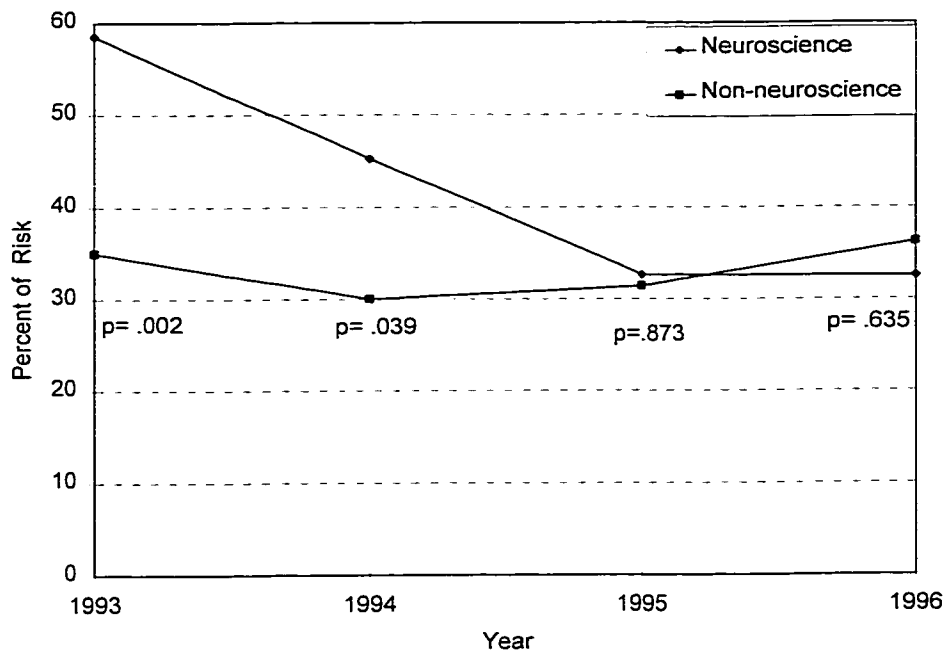
Figure 20 Proportion of Neuroscience and Non-neuroscience Populations with the Clinical Risk Factors of Nutrition.



Friction and Shear

In 1993, over half (58.%) of the neuroscience patients were identified as being at risk for pressure ulcer development related to friction/shear. A clinically important trend was noted over the four years in the decrease to 32% by 1996. The proportion of non-neuroscience patients remained consistent across the years at 30% to 36% rate. Yearly comparisons between the two populations revealed significant differences in 1993 with the proportion of neuroscience population being almost double to that of the non-neuroscience population ($p = .002$) (Figure 21).

Figure 21 Proportion of Neuroscience and Non-neuroscience Populations with the Clinical Risk Factor of Friction and Shear.



Summary

In conclusion, the prevalence of pressure ulcers and the clinical risk factors have been examined in the neuroscience population from an acute tertiary care in-patient setting. Although the neuroscience population over the four years reflected a younger group of patients than the non-neuroscience population, there was an increasing older age group (> 80 years) seen in both populations over the four years. The neuroscience population demonstrated a clinically important trend of time in hospital with the one week doubling over the four years in comparison to the non-neuroscience population. An unusually high prevalence rate of "all stage" ulcers was found in the neuroscience population, which decreased significantly to 5% by 1996. The proportion of patients with the more serious ulcer stages of stage 2 and greater were also higher in the neuroscience population

although it decreased as well over the four years. The proportion of patients with stage 1 ulcer category decreased as well, thus reflecting substantial improvement in pressure ulcer occurrence from 1993 to 1996. Ulcer site occurrence remained the highest at the coccyx, sacral and ischial tuberosity combined site.

Using the *Braden Scale* for examining the concept of risk versus no risk, the neuroscience population demonstrated an increased clinical risk in 1993 and 1995 in comparison to the non-neuroscience population. Comparisons between the two populations in each of the subscales demonstrated that the proportion of neuroscience patients was significantly higher at risk in the following categories: sensory perception (1993 and 1995); moisture (1993, 1994 and 1995); activity (1993); mobility (1993) and friction/shear (1993). In comparison, the non-neuroscience population demonstrated a significantly higher risk in the nutrition subscale in 1994 and 1996.

The final chapter of the thesis will focus on the discussion of the study results. The limitations as well as implications for practice, education and research will be presented.

CHAPTER FIVE

Discussion

This final chapter focuses on the discussion of the study findings and includes study limitations. Implications for practice and future research are presented.

General Summary of Findings

The results of the study demonstrate that in a tertiary setting, similarities and differences exist between the neuroscience and non-neuroscience populations with respect to prevalence, severity and clinical risk factors. Table 10 outlines the major findings of the study.

Table 10 The Major Similarities and Differences found between the Neuroscience and Non-neuroscience Population from 1993-1996.

Similarities	Differences
<ul style="list-style-type: none">• ↑ age seen over the four years• ↓ in severity of ulcers in the highest stage of ulcers & the number of ulcers per patient• Concentration of pressure ulcers at the coccyx, sacrum and ischial tuberosity area	<ul style="list-style-type: none">• Decrease in prevalence of all stage ulcer category & the stage 2 and higher ulcer category in the neuroscience population• Concentration of pressure ulcers at the trochanter and ankles in the non-neuroscience population as the second major site for concern• Neuroscience population had a higher proportion of patients with the clinical risk factors of sensory perception, moisture, activity, mobility, and friction/shear categories in 1993- 1995• Trend towards shorter time in hospital in the neuroscience population

Prevalence

A major difference between the neuroscience and non-neuroscience populations were the prevalence rates found. Results of the study indicated that the prevalence of pressure ulcers in the neuroscience population decreased significantly over the four years in both the all stage ulcer category and stage 2 and higher ulcer category. Reasons for the significant decrease in this setting are unclear however several circumstances may have contributed individually and collectively to this outcome.

The extent of the pressure ulcer problem in the neuroscience setting was unknown prior to the 1993 prevalence study. The initial very high rate (67%) of pressure ulcers in this setting may have led nurses to reflect on their practice. The conduct of yearly prevalence studies may have increased awareness of the problem with subsequent increased surveillance and prevention measures for ulcers.

A direct method of pressure ulcer reduction was the introduction of a Skin Care Program (SCP) in 1995 in selected high risk units (neurosciences, orthopaedics, general surgery, and geriatrics). A comparable decrease in the prevalence rates in the non-neuroscience population were not found and may be reflective of the presence of the other four high - risk units within this population. Because these units were deemed high risk related to their higher prevalence rate, their collective presence in the non-neuroscience population may have contributed to the overall higher prevalence rate. The prevalence rate may have also remained consistently higher due to the lack of the education of the nursing staff in the non high - risk areas.

Pressure ulcer severity decreased in both the neuroscience and non-neuroscience populations over the four years however, less severe ulcers were seen in the neuroscience

population as well as the numbers of ulcers on one person. Reasons for the decrease in severity in the neuroscience population may include the initiation of a SCP in the neuroscience area as well as increased surveillance, the introduction of prevention and treatment strategies, such as the presence of informal turn schedules, and the presence of a multidiscipline team approach with respect to mobility and nutritional issues.

Surveillance and prevention strategies likely impeded stage 1 ulcers from becoming stage 2 ulcers or higher ulcers stages. The decrease in the numbers of ulcers per case, may reflect positive preventative techniques undertaken by nurses as well as decreased risk factors intrinsic to the individual.

The non-neuroscience population also demonstrated a decreasing trend over the four years in both the highest ulcer stage and the numbers of ulcers present. The marginal improvement seen however in the highest number of ulcers per case may reflect a limited implementation of the SCP on the four high risk units and the non-implementation of the SCP on the other units. The non-neuroscience population may have had more underlying medical conditions such as diabetes mellitus, cardiovascular problems and other co-morbid conditions which may have contributed to overall ulcer severity.

Study findings on age suggest the possibility that age contributed to the overall prevalence rates found including severity of ulcers. Although the neuroscience population was younger in comparison to the non-neuroscience population across the four years, an increase in the over 80 age cohort was seen in both populations. In 1996 in both populations, over 20% of patients were in this older age group. The recognition of older individuals hospitalized in tertiary settings is important to note. It is estimated that 14.5% of the Canadian population will be over 65 years by the year 2011 (Canadian Study of

Health and Aging Working Group, 1994), thus the issues with skin maintenance in the elderly is both a concern and challenge. Loss of dermal and subcutaneous tissue, thinning of the epidermal layer, age-related vascular changes and increased fragility of capillary layers pre-dispose the older individual to changes in skin integrity and thus contribute to the increased risk of pressure ulcers and skin tears.

The highest occurrence of pressure ulcers at the coccyx, sacral and ischial tuberosities (CSI) sites was found to be similar in both populations across the four years in both the all stage ulcer category and the stage 2 and higher ulcer category. Ulcers at this site represent patients who have not had pressure relief while in supine lying or sitting positions. This study findings of ulcer site occurrence were similar to the literature. The results from this study may also reflect the trend toward the older cohort group found in this setting. As well it is postulated that patients in hospital reflect a "sicker " population as pre-admission usage and short hospital stays minimize the presence of a well hospital population.

While the combined CSI site was the highest ulcer site in both populations, it became the exclusive site for ulcers by 1996 in the neuroscience population. The reasons are numerous and may reflect the status and relationship of both skin integrity and the underlying muscle innervation. Immobilization in a supine position for long periods of time prior to hospitalization and during initial treatment are often the norm in traumatic cases because of the threat of spinal instability. Continued immobilization in patients with spinal cord injuries who require traction and or surgery heighten the risk for pressure ulcer development. As well, patients with neurological conditions such as stroke, head injury and spinal cord injury with resultant problems of mobility, co-ordination and

balance may succumb to friction injuries during transfer movements to and from operating tables, stretchers and chair surfaces. Shear injuries may also be caused during periods of sitting where seating balance is problematic. Increased moisture at the CSI site, as a result of bladder rehabilitation techniques, may have also contributed collectively to the presence of pressure ulcers at this site.

In comparison, the non-neuroscience population demonstrated an increasing trend of pressure ulcers at the trochanter and ankle sites representing patients in side-lying positions. Inadequate pressure relief over these vulnerable bony areas may account for the findings. The non-neuroscience population was older over the four years which may have contributed to ulcer severity as well as body site location with respect to the ageing process and the decreased cues to respond to pressure changes. The different body areas of pressure ulcers found in the two populations demonstrate that the focus of prevention and pressure relieving techniques may need to be different.

Clinical Risk Factors

Another difference that was found between the two populations was the proportion of neuroscience patients that demonstrated the presence of clinical risk factors. Although in each of the Braden subscales, the proportion of patients with the presence of clinical risk varied over the years, overall the proportion of patients in the neuroscience population experienced more clinical risk factors in areas of mobility, activity, sensory perception, moisture and friction/shear.

The mobility subscale of the *Braden Scale* captures information on the patient's ability to make immediate alterations in response to pressure. In three of the four years, the neuroscience population had statistically significant (1993) and clinically important

differences in mobility with a higher proportion of patients immobile. As well, the neuroscience population continued to demonstrate higher proportions of patients with the clinical risk factor of decreased activity levels in three of the four years with half to three-quarters of the population requiring assistance to make major physical activity changes. The overall decrease to 55% in the neuroscience population in 1996 reflect a higher than usual group of relatively well patients. The study findings support the relationship between the clinical factors seen in patients with neurological illness and the relationship of the clinical risk factors of pressure ulcer development.

A higher proportion of patients with decreased activity levels in the neuroscience population may be due to the inability to weight bear from neurological causes. As well, medically imposed activity limitations related to preoperative and post-operative procedures including lumbar and ventricular drainage, or the use of injury preventing restraints may have contributed to the increased risk found in three of the four years. In both populations, the proportion of patients with the limitation of activity may also reflect the nature of hospitalized patients in acute tertiary settings.

Another difference found between the neuroscience and the non-neuroscience populations were the proportion of patients with sensory perception alterations. The neuroscience population was quite variable in this category with not only a higher proportion of patients found but significant differences found in 1993 and 1995. This variability may reflect the differences in medical conditions on the unit at the time of the study. Given that this subscale measures the lack of mental and/or sensory awareness, the findings support the presence of this clinical risk factor in the patients with neurological illness or disease. Over the four years, less than 50% of the neuroscience patients

demonstrated sensory perception limitations according to the *Braden Scale*. Although this appears low, the scale measures mental awareness and not necessarily cognitive changes which may have been present. The recognition of the extent of the sensory perception limitation in this population is important as the ability to respond to pressure is an key component of pressure ulcer prevention.

Study findings indicated that significant differences were found between the neuroscience and non-neuroscience populations with respect to the clinical risk factor of moisture in 1993-1995. The proportion of patients in the neuroscience population was doubled to that of the non-neuroscience patients. Urinary and fecal incontinence are problematic in this population and may be related to lesions in the frontal lobe, pontine micuration center and spinal cord as well as other pre-existing causes. Further differences were seen between the two populations in the friction/shear subscale as the neuroscience population demonstrated statistically significant differences in 1993 and clinically important differences in 1994. The higher clinical risk seen in the neuroscience population except for 1996, is most likely related to the combined effects of mobility and activity limitations as well as altered mental states of restlessness, commonly seen in this group. Patients with limited activity and limited mobility, dependent on caregivers for both surface transfers and position changes to reduce pressure ulcers, are at risk for friction shear injuries if improper techniques are employed. This relationship is further substantiated when comparing the proportion of patients with the clinical risk factor of activity and friction/shear as well as the clinical risk factor of mobility and friction/shear in each of the populations.

The clinical risk of nutrition, as measured by the *Braden Scale*, takes into account self-reporting or observational accounts of protein intake over the last three to five day period, including the method of intake (oral or nasogastric). Because deficits in nutrition may take longer to appear, the nutritional subscale may not accurately reflect the overall status of nutrition. However, the *Braden Scale* does evaluate the presence of nutritional risk and therefore should be considered as such.

In contrast to the other clinical risk factors, the clinical risk of nutrition was quite variable and found to be significantly lower in the neuroscience population in two of the four years. In the non-neuroscience population, the higher median age compared to the neuroscience population may have influenced the higher degree of clinical risk seen over the four years in this particular subscale. Nutritional status in the elderly, especially in a hospital setting may have contributed to this outcome. The variability seen in the neuroscience population may have been related to the physiological problems of difficulty swallowing, cranial nerve dysfunction and altered level of consciousness. When comparing the clinical risk factor of sensory perception and the clinical risk factor of nutrition in the neuroscience population, the trends over the four years are similar, further supporting the impact that consciousness has on nutrition in this population.

Comparative analysis was also conducted on the neuroscience and non-neuroscience populations from the *Braden Scale* using the concept of risk/no risk rather than a specific category of risk. While both populations demonstrated a high (60% to 90%) presence of at least one risk factor, the neuroscience population demonstrated a higher risk in 1993 and 1995. Although the comparative analysis was not significant, the concept of risk /no

risk was more useful determining the presence of clinical risk compared to the identification of patients at risk using a specific cut- off score.

The low proportion of patients (40%) not at risk in the neuroscience population in 1996 is unique. This represents 16 patients, who on prevalence day, did not have one risk factor present as listed in the *Braden Scale*. This finding suggests a high proportion of patients ready for discharge rather than newly admitted ill patients or a number of patients awaiting elective surgery or both.

While the concept of risk versus no-risk was useful methodologically in this study, the subscale analysis was clinically more useful as it identified the proportion of patients at risk with specific clinical risk factors. Targeting interventions that are appropriate to the specific clinical risk factors have more merit than applying global prevention strategies based on a total score

In summary, the findings from this study confirmed that the neuroscience population demonstrated differences in prevalence, severity and the clinical risk factors that promote pressure ulcer development. This next section outlines a conceptual framework that may be useful in regards to the neuroscience population and pressure ulcer development.

A neuroscience pressure ulcer conceptual framework

The findings from this study suggest the need for a conceptual framework to guide practice and research with the intent to prevent or minimize the severity of pressure ulcers. Because this study demonstrated differences between the neuroscience and the general hospital population, it is clear that a tailored conceptual framework would be useful. The Braden and Bergstrom (1987) conceptual model was useful in the general population for identifying risk factors leading to pressure ulcers. Although Johnson

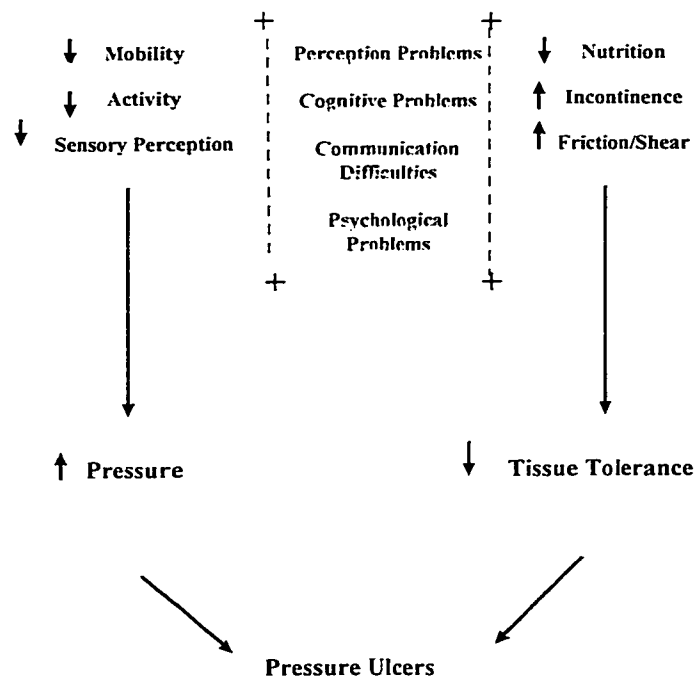
(1994) outlined a framework that was thought to be useful in the neuroscience population, no relationships were posited.

A proposed framework developed by the researcher (LJ) is entitled the *Potential Clinical Risk Factors related to the Development of Pressure Ulcers in the Neuroscience Population* (Figure 22). The intent of this study was not model testing, however findings have clarified thinking about the conceptualization necessary to guide neuroscience practice and research with respect to pressure ulcers. A new framework was developed by integrating the Braden and Bergstrom (1987) conceptual schema and the Johnson (1994) framework. The LJ framework makes explicit the relationship of decreased mobility, activity and impaired sensory perception that are associated with increased pressure, as well as the relationship of impaired nutrition, incontinence and friction and shear problems that contribute to decreased tissue tolerance.

The LJ framework includes the clinical factors of perception problems, cognitive problems, communication difficulties and psychological factors that were identified in the Johnson framework although these factors are now incorporated in a different relationship. These latter clinical factors, commonly seen in the neuroscience population related to the effects of disease and trauma, are represented as clinical factors that interact with the more general six clinical risk factors (mobility, activity etc.). It is proposed that some or all of these clinical neurological factors in the LJ framework may vary from time to time in the individual and are based on the patient's current neurological state. Thus, the presence of these clinical neurological risk factors, may pose an additive effect to the risk of pressure ulcer development.

Figure 22

Potential Clinical Risk Factors related to the Development of Pressure Ulcers in the Neuroscience Population (LJ) Framework.



This next section outlines the implications for practice. This includes the role of the advanced practice nurse.

Implications for Practice

Implications for practice from this study include the development and implementation of a neuroscience skin care program, skin protection, pressure reduction, and improving

tissue tolerance. Recommendations from this study support the implementation of a tailored clinical skin care program for the neuroscience population. The focus of a skin care program would include assessment, and prevention and treatment strategies. The neuroscience skin care program would aim to minimize the problem through the implementation of a research-based risk assessment tool and the introduction of prevention and treatment strategies. The skin care program elements should include: the identification of patients at risk using reliable and valid scales, the identification and staging of ulcers including new pressure ulcer treatments, a user-friendly documentation system, and the use of a standardized care plan of nursing interventions corresponding to the risk categories on the risk assessment scales.

The use of a standard care plan for the maintenance of skin integrity will provide an outline and decision points on how to provide what is now considered to be basic care to patients at risk for skin breakdown (AHCPR, 1992, 1994). Standardized care plans that are used in the elderly population and the neuroscience population need to be customized to ensure the changes of skin and tissue tolerance in light of ageing and loss of muscle innervation seen in neuroscience patients are incorporated. The loss of muscle innervation puts the risk of skin breakdown much higher so patients with paralysis need extra vigilance in risk assessment. Furthermore, nurses working with neuroscience patients may not link the clinical effects of neurological illness and their relationship to the clinical risk factors that contribute to pressure ulcer development (Johnson, 1994).

Findings from this study demonstrate that both the neuroscience and non-neuroscience populations developed ulcers, despite a increasing proportion of patients with shorter time in hospital on the study days over the four years. The first two weeks of

hospitalization is a critical period for pressure ulcer risk assessment. Findings from other studies indicate that despite overall decreased length of stays, patients continue to acquire ulcers following hospital admission. Baldwin (1998) found that the mean time to the development of the first pressure ulcer was nine days in a critical trauma unit, while Goodridge et al. (1998) found 50% of the patients who developed ulcers did so in the first week of hospitalization. Implications for practice include the importance of admission and continued risk assessment in patients admitted to tertiary settings. Although risk assessment is supported on admission, the frequency of risk assessment is varied, depending on the population. Because the neuroscience population is at high risk for pressure ulcers, they and other complex patients in tertiary settings require daily risk assessment until stabilization of the level of clinical risk has occurred. Clinicians working with the patient and family over the first few days require time to assess pre and intra-hospital patient specific factors that contribute to pressure ulcer risk as well as validated findings, thereby increasing the likelihood of ensuring the appropriate interventions are implemented. Once stabilization has occurred, risk assessment every 48 hours may be appropriate to capture changes in patient status that would alter prevention and treatment approaches. At any time when the clinical condition changes, re-evaluation of the frequency of risk assessment should be undertaken. Risk assessment tools are intended to supplement nursing judgement and not to replace it. Nurses working with patients must always incorporate past and current health status as well as current assessment findings when making care decisions.

Implications for practice include the use of the neuroscience risk assessment scale that would capture the elements as outlined in the LJ conceptual framework. The neuroscience

risk assessment scale would include the existing elements in the *Braden* subscales as well as incorporate the additional elements from other neuroscience scales as mentioned. Reliability and validity testing would be required to ensure the neuroscience risk assessment scale appropriately and consistently measures the risk of pressure ulcers. A subscale analysis approach when using the risk assessment scale may be more useful as this study demonstrated the value of subscale information compared to a total score. Therefore it would be appropriate to use a subscale analysis approach when using the neuroscience risk assessment scale.

A second area for implications for practice includes skin protection, especially in the older age group. The use of emollients, and products that lubricate and protect the skin from dryness, and skin tears are important. The use of a skin tear classification system (McGough-Csarny & Kopac, 1998) may also be useful in assessing skin integrity especially in the elderly. The use of protective dressings on vulnerable bony areas are important to maintain skin integrity and minimize both skin tears and the effects of friction. The use of protective dressings on intact vulnerable skin needs to be recognized for its role in preventing pressure ulcers and cost issues of these dressings should be included as part of the skin care program.

Another implication for practice includes pressure relief. This concept is incorporated into the management of tissue loads. The goal of tissue load management is to create an environment that enhances soft tissue viability and promotes healing of the pressure ulcer(s) (AHCPR, 1994). The viability of tissue depends on consistent interventions that relieve pressure while in and out of bed and include other tangible supports such as turning sheets, lifting devices, and pressure reducing mattresses, beds and cushions.

Implications for practice include increased vigilance to skin assessment as patients with the presence of sensory perception will not naturally seek to re-position themselves as they do not perceive pressure. Specific turn schedules that include supine positioning for meals, has been recently published (Braden, 1998). Utilizing all skin surfaces for positioning and avoiding the trochanter and heel areas are important. Frequent small body adjustments are also recommended and should be considered in situations such as spinal instability where more major changes in body positions relies on the presence and skill of many people. Reduction of pressure also incorporates keeping the head of the bed at its lowest elevation if possible to prevent shearing.

Pressure relief is also obtained through the correct selection of a mattress. Many pressure-relieving mattresses are on the market and the selection of which one to use, especially in patients with spinal instability, required careful analysis. Currently the Cochrane Database of Systemic Reviews (Cullum, Deeks, Sheldon, Song, & Fletcher, 1999) have found that the standard hospital mattress, when compared to a variety of other pressure reducing and pressure relieving mattresses was not adequate. The use of a pressure -relief mattress, especially in spinal - injured patients is important. When patients can be mobilized, the prevention of friction injuries in body areas that are already compromised require the consistent use of lifting devices, transfer sheets as well as proper transfer techniques. Consultation with the occupational therapist will provide appropriate strategies for effective seating arrangements.

Another implication for practice includes issues regarding ambulation, medical therapy decisions restricting ambulation and the resource allocation required to prevent pressure ulcers from developing. Ensuring that patients who have activity limitations

receive relief from pressure, implies that frequent mobilization is required on a daily basis. Although frequent ambulation is important, ambulation strategies, especially in most hospital settings, may be centered on therapeutic mobility and not necessarily focused on pressure-relief. Nursing staff and family members who are knowledgeable on the clinical risk factors of pressure ulcer development, may be better positioned to support frequent and maximum ambulation. Although the imposed ambulation restrictions may be non-negotiable for specific and selected conditions and procedures, there may be windows of opportunity that the nurse should explore. This may include such aspects of volume drainage versus pressure drainage of cerebral spinal fluid in selected cases, thus allowing patients to ambulate during non-drainage episodes. This technique has proven to be useful in specific cases as suggested and observed by the researcher. Finally, having the resources allocated to ensure that the patient is ambulated, is essential. Findings from this study will provide tangible information for administrative decisions regarding the risk factors associated with the neuroscience population.

Further implications for practice include maintaining and improving tissue tolerance and includes the management of moisture and nutrition. Patients, unable to acknowledge or feel moisture or report pain following friction/shear injuries, may develop pressure ulcers more easily. As the avoidance of urinary catheters is in keeping with rehabilitation techniques used in this population (Hickey, 1997; Zejdlik, 1992), the findings have important implications for nursing. The management of urinary incontinence as outlined in Clinical Practice Guidelines (AHCPR, Urinary Incontinence, 1992) is useful. Resource allocation with respect to staffing needs for frequent toileting as well as supplies such as skin protectants and absorbent briefs are additional areas for consideration. Patient

education in the management of continuing incontinence need to be explored with patients and their families.

The importance of nutrition cannot be underestimated in both the prevention and healing of pressure ulcers. The study findings indicate that much nutritional support is required in tertiary settings. Malnutrition in elderly patients from tertiary settings, has been reported (Azad, Murphy, Amos, & Toppan, 1999) as well as malnutrition following stroke conditions (Davalos et al., 1996). Clinical studies suggest that patients with pressure ulcers need a caloric intake 1.0 to 1.5 g/kg per day while patients under stress require 30-35 kcal/kg/per day (Thomas, 1997). Sufficient calories, adequate protein and essential vitamins are key nutrients associated with healing of pressure ulcers. In a hospital setting, the correct amount and type of diet is usually prescribed, and easy access to a dietician for evaluation and subsequent follow-up is available. Ensuring the patient eats the meal or is fed the complete meal if needed, maybe the bigger issue. Inadequate staffing levels, insufficient nurse to patient ratios and the lack of recognition that nutrition has on the prevention and healing of pressure ulcers may compromise the patient from receiving full dietary intake over 24 hours. Further issues such as depression, existing dietary habits and choices, cultural and religious beliefs, must be considered when assessing the patient. Certain neuroscience subgroups such as patients with head injuries and to a lesser degree, patients with spinal injuries, are considered stressed and require a higher amount of calories which may be difficult to achieve in light of other physiological sequela.

Implications for practice include the importance of nurses in tertiary settings to become knowledgeable on prevention strategies, staging criteria and subsequent

treatment approaches. Nurses, acting on this knowledge, may prevent some ulcers from occurring and may also prevent existing ulcers from advancing to a more serious stage (Hayes, Robinson Wolf, & McHugh, 1994; Pieper & Mott, 1995; Pieper & Weiland, 1997). The physiology of wounds and the healing process including indicators for changes in treatment decisions are complex. Registered Nurses from the neuroscience area should receive organizational support to attend educational workshops in which the elements skin care program including wound management would be taught.

This next section outlines the implications for advanced practice nurses. There are implications for practice, education, consultation, and research.

Implications for Advanced Practice Nurses

The study findings have implications for advanced practice nurses in neuroscience as well as nurses specialized in skin and wound care. Advance practice nurses working in pre-hospital clinics are in unique position to assess areas of risk and initiate appropriate interventions prior to elective admission. The recognition of sub-optimal nutrition as well as mobility status prior to admission are areas where pre-hospital screening may identify at risk patients. Appropriate intervention, patient education and follow-up may minimize the extent of clinical risk on admission to hospital. Monitoring of on-going risk following hospitalization is also appropriate in the neuroscience population, especially when permanent risk remains related to neurological disease.

Another implication for advanced practice includes the focus of potential subgroups within the neuroscience population such as patients undergoing elective spinal instrumentation surgery for spinal stenosis and other degenerative or traumatic conditions. This surgery may be of particular concern given the length of time of the

operation and the imposed immobility afterwards, including the application of spinal braces.

Advanced practice neuroscience nurses are in a leadership role to provide clinical support to staff nurses. Clinical support includes assisting staff to focus on risk tool selection, wound assessment tool selection, documentation issues and continuity of care processes. The current AHCPR Guidelines (1992, 1994) have recommended the *Braden Scale* as one of two tools that has demonstrated reliability and validity with respect to risk assessment. This study found that the *Braden Scale* demonstrated important differences with respect to subpopulation analysis. Opportunities to review, test, revise and adopt risk assessment tools are within the scope of the advanced practice role.

Clinical support must also assist in the adoption of either a wound assessment tool or ensuring the latest wound characteristics that pertain to pressure ulcers are assessed. Current AHCPR recommendation's (van Rijswijk & Braden, 1999) suggest that in order to plan treatment and evaluate its effects, pressure ulcers must also be assessed in terms of depth, size, sinus tracts, undermining, tunnelling, exudate, necrotic tissue, and the presence of granulation tissue and epithelization. Advanced practice skin specialist nurses or enterostomal therapists with expertise in this area, may also provide support to the clinical staff in making appropriate assessments and subsequent treatment plans.

Clinical assessment and follow-up treatment plans rely on effective and efficient communication. Advanced practice nurses may contribute to the design and implementation of a computerized documentation system including subsequent treatment plans that support evidence - based pressure ulcer care.

Advanced practice nurses can also play a pivotal role in continuous quality initiatives and improvements with skin care practices. Tailored skin care programs need to be developed, and reviewed and revised periodically to ensure any evidence-based findings are implemented at the clinical level. While it is important to focus on the prevention and treatment aspects of pressure ulcers, advanced practice nurses also need to focus on clinical outcome perspectives. Has the implementation of a tailored skin care program decreased prevalence and incidence rates of pressure ulcers? Did the ulcer heal in the suggested time length, given the clinical situation of the patient? Was the patient and family knowledgeable in skin assessment, ulcer management and where to seek health support on discharge? Was prevention or healing of pressure ulcers maintained across the health care continuum for the neurological patient? The shift to an outcome - based practice is an important quality initiative in health care (Bolton, van Rijswijk, & Shaffer, 1997; Hill, 1999).

Advanced practice nurses are positioned to use epidemiology techniques to organize and examine data obtained from prevalence or incidence studies or both. In this study, epidemiological techniques were used to obtain information about a specific population that would lead to clinical decisions. Employing these techniques in future studies should be considered.

Advanced practice nurses have an important role to play in contributing to policy development and revisions. From this study, continued support was found for the use of a risk assessment tool in determining risk for the development of pressure ulcers. Based on the study findings however, the need to revise the policy regarding the frequency of patient assessments within tertiary settings was recommended.

Advanced practice nurses need to provide education to the stake - holders regarding risk assessment and the management of pressure ulcers. Although the AHCPR Guidelines have been published for a number of years, dissemination of the Guideline findings and recommendations are not common knowledge to all practising nurses or other health care workers. The volume of literature on the prevention and treatment of pressure ulcers continue to expand. Studies have indicated that knowledge gaps of pressure ulcer risk and prevention in health care settings exist (Goodridge, Biglow, Ledoyen, & Hordienko, 1997; Hayes, Robinson, & McHugh; 1994; Russell, 1996). Educational initiatives must target the learning needs of staff with on-going diffusion of information, discussion and clinical relevancy, using principles of adult learning (Hayes, et al., 1994; Kresevic & Naylor, 1995).

Education initiatives such as providing information sessions to patients and their potential care-givers is another are important so neuroscience patients who have long trajectories of illnesses, may become knowledgeable and feel supported in this particular aspect of care.

Advance practice nurses work with other health disciplines as they care for neuroscience patients, in both complex settings. Complex neuroscience patients with severe life-threatening injuries and multiple system involvement, are at risk for pressure ulcers (Baldwin, 1998). Data gathering in such situations and determining the treatment goals and interventions require co-ordination and expertise of many disciplines.

Advanced practice nurses are in a unique role to establish and provide linkages with others across the tertiary setting, to ensure treatment goals are facilitated and the prevention of pressure ulcers are optimal. The multidisciplinary nature, commonly seen

in neuroscience units, lends itself to support this clinical and consultative role. As the elder population increases in tertiary care environments, the advance practice nurse needs to consult and collaborate with geriatricians, skin care experts, and other professionals who work with this vulnerable population.

Collaboration with other health disciplines across the continuity of care outside the tertiary setting is essential for the effective healing of pressure ulcers. Patients expect that knowledge and expertise of assessment and treatment regimes are uniform across the health care delivery system. Delayed healing may be an outcome of inadequate knowledge, lack of equipment and resources as well as health care delivery problems. Through education and consultative processes, advanced practice nurses may be able to support patients directly and indirectly by ensuring that all risk situations and treatment regimes are clearly communicated.

Further collaborative efforts to prevent pressure ulcers is seen at an organisational level. Organizational support is required to ensure necessary equipment, supplies, and resources are in place to facilitate practice changes. Many and diverse stakeholders are involved in pressure ulcer management. This includes not only staff who are involved in prescriptive initiatives namely physicians, enterostomal therapists, nurses, physiotherapists, and dieticians, but also material management and purchasing agents with respect to the appropriateness of products including bed surfaces, lifting devices, wound cleansing and dressing products. The role of advanced practice nurses in the facilitation of wound management at a macro level has demonstrated positive outcomes at an organisational level such as a multi-disciplinary approach, philosophy of continuous quality improvement and strategies for further studies (Sideranko & Yeston, 1994).

Advance practice nurses have a role to play in the use and dissemination of research findings with respect to pressure ulcers. Accessibility to evidence -based findings are essential and are slowly becoming the norm rather than the exception. The use of a research transfer model would further assist evidenced -based findings to be adopted (Logan & Graham, 1998).

Advance practice nurses also have a role in the establishment of clinical trials for the evaluation of specific treatments or interventional therapies. Because of the vast and complex nature of the risk of pressure ulcers, their development, and subsequent treatment, advance practice nurses working in a tertiary setting, are best positioned to collaborate with other departments such as Research and Evaluation and Quality Care chairs to work within a research agenda on pressure ulcers. The importance of a systematic research approach that advances knowledge in this clinical area is essential to ensure appropriate management of pressure ulcers.

Implications for Research

This section outlines the implications for research related to the literature and study findings. The first implication for research from this study is related to the testing of a conceptual framework developed specifically for the neuroscience population. The testing of the clinical neurological risk factors and their additive effect is necessary to determine the nature of the relationship to pressure ulcer development. The clinical neurological risk factors presented in the LJ framework would need to be developed into an operational tool for validation and testing. Existing neurological tools that measure aspects of perception and cognition such as the Folstein Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975) or the Neurobehavioural Cognitive Status Scale (Kiernan,

Mueller, Langston, & van Dyke, 1987) may be useful in providing distinct levels of normal and abnormal status. Furthermore, there may be specific neurological tools used in selected groups that might also be appropriate. For example the National Institute of Health Stroke Scale (Brott et al., 1989) measuring specific aspects of cognitive functioning such as neglect, may be useful when measuring pressure ulcer risk in this selected client group.

A second implication for research includes further enquiry using secondary analysis. There are many benefits of using a secondary analysis method to explore and test new hypotheses. From this study, two further secondary analyses could be undertaken. The first is the analysis of descriptive information on the proportion of patients in each of the attributes within each of the *Braden* subscales. Although the concept of risk/no risk in each of the subscale provided important information, the dichotomization of this analysis may cause loss of information about the extent of the level of risk. By studying the proportion of patients in each of the risk categories, information obtained could be used in a number of ways. This information would assist in decision-making regarding resource allocation. For example, hiring decisions with respect to the type and numbers of staff might be based on the percentage of patients requiring mobilization and activity support to prevent or minimize pressure ulcers. In addition, information on the proportion of patients in the risk categories would also provide data for pressure ulcer prediction analysis. Larger populations would be required however to ensure reasonable statistical analysis.

This study demonstrated that subgroup analysis provided important and different information from the total hospital prevalence studies conducted in the original PUP

research. Implications for tertiary settings include the need to focus on subgroup analysis that will further develop the knowledge base. A review of hospital databases that demonstrated high volume and high risk subgroups would assist in determining which other subgroup may benefit from the analysis.

Study Limitations

The limitations of this study are related to research design, and the size and nature of the populations studied. The cross-sectional design of prevalence studies does not allow determination of causal relationships between the presence of clinical risk factors and the development of pressure ulcers. Although incidence studies conducted in the neuroscience population would add further information on the relationship of risk and the concomitant development of pressure ulcers, the study design supports an important first step in preliminary information on the extent of the problem in the neuroscience population.

Secondary analysis of previously collected data limits other information that might be relevant to the profile of the neuroscience population. Information on perception, cognition and communication abilities, would have provided further insight as to the support needed to maintain mobility and activity performances as well as concerns regarding incontinence.

The generalizability of the study may be limited to the neuroscience population in this setting. The neuroscience population was heterogenous with respect to the combined neurology and neurosurgery focus. Given the study analyzed point prevalence information over four years from a large tertiary setting, confidence in the findings is increased.

Conclusion

In conclusion, this study has been an important first step in demonstrating the usefulness of a secondary analysis of a data set that captured information on prevalence, severity and clinical risk factors of pressure ulcers to compare specific populations. The study indicated that differences and similarities comparing the neuroscience and non-neuroscience population were found in cohort comparisons over the four years. Trend analysis further contributed in clarifying the neuroscience population characteristics. Continued emphasis on specific population analysis is critical in tertiary settings.

A framework for the potential clinical risk factors for pressure ulcer development in the neuroscience population was developed in recognition of the similarities between pressure ulcer development and the characteristics of neurological illness and their contributory effect. The integration of specific neuroscience assessment and the *Braden Scale* is an important contribution to comprehensiveness and efficiency in nursing assessment. It is recommended that further work continue in this area so validation of the risk tool can be accomplished. The unique characteristics of the neuroscience population continue to require defining in order to prevent and minimize the damaging effects of pressure ulcers.

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Appendix A

Comparisons of Classifications Used in Pressure Ulcer Staging

Appendix A
Pressure Ulcer Staging: A Literature Review

Author	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7
Allcock		Blanchable hyperthermia.. Skin is intact	Non-blanching hyperthermia. Blister may be present	Superficial ulceration involving any break in the skin surface, e.g. de-roofed blisters	Ulceration into the dermis & subcutaneous tissues. Includes sores covered with eschar, with/without necrotic tissue.	Ulceration extends into the subcutaneous fat, underlying muscle may appear swollen and inflamed.	Infective necrosis extending deep into fascia. Muscle tissue destruction & possible bone involvement.	Unknown
NPUAP; AHCPR		Non-blanchable erythema of intact skin	Partial thickness skin loss involving epidermis and/or dermis. Superficial ulcer presenting clinically as an abrasion, blister, or shallow crater	Full thickness skin loss involving damage or necrosis of subcutaneous tissue that may extend down to underlying fascia. Clinically, deep crater with or without undermining of tissue	Full thickness skin loss with extensive destruction, tissue necrosis or damage to muscle, bone, or supporting structures. Undermining and sinus tracts may also be associated with this stage of pressure ulcer.			

Appendix A

Author	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7
Dealy		Redness which does not fade and blanches under light pressure	Redness which does not blanch, blistering or superficial break in the skin	Break in the skin through to the dermis	Sore down to the subcuticular layer	Sore extends to other tissue eg. Muscle tendon or bone		
Enis and Sarmiento pressure sores classification system (Vial)	Limited to the epidermis	Involving the epidermal and dermal layers	Extending through dermal layers and involving subcutaneous adipose tissue and muscle.	Sore extending into muscle and joints	Destruction of all soft tissue structures to underlying bones or joints.			
Gunnewicht	Fixed red mark which does not blanch on pressing	Broken skin limited to superficial epidermal and dermal layers	Full - thickness sore extending into subcutaneous tissue	Sore extending into muscle	Sore extending into bones and joints			
Yarony-Kirk	IA : Red area, present longer than 30 min., but less than 24 hours Stage 1B: Red area longer than 24 hours	Epidermis and /or dermis ulcerated with no subcutaneous tissue	Subcutaneous fat observed, no muscle observed	Muscle/fascia observed, but no bone observed	Bone observed, but no involvement of joint space	Involvement of joint space		

Appendix A

Author	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7
Torrence		Reactive hyperaemia with blanching when light finger pressure applied indicating that the micro-circulation is intact.	Erythema remains when light pressure is applied, indicating a degree of micro-circulation disruption and inflammation.	Ulcer edges distinct but with erythema and unduration present	Ulcer extends into subcutaneous fat; may be undermining. Ulcer had distinct margin but inflammation, fibrosis and retraction distorts deeper area of sore	Destruction of muscle, with involvement of joints and body cavities		
Shea	Redness of skin with or without vesicle formation	Excoriation, vesiculation, or skin break. Includes fat as well as epidermal and dermal layers	Tissue destruction extending into muscle. May include necrosis, infection, or both	Ulcer is through skin, fat, and muscle and extends to bone. Often necrosis, infection, or both are present.				

Appendix A
Classification References

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Appendix B

Research Instruments:

Demographic and Clinical Profile Form

The Braden Scale for Predicting Pressure Sore Risk

The Ottawa Civic Hospital (OCH) Prevalence Grid

Instructions:

1. Circle or place an X on the appropriate # for each risk category.
2. Mark score in column on right side of page for each risk category.
3. Add scores from each risk category and mark total in space provided.

Addressograph

BRADEN SCALE

<p>SENSORY PERCEPTION ability to respond meaningfully to pressure-related discomfort.</p>	<p>1. COMPLETELY LIMITED: Unresponsive (does not moan, flinch or grasp) to painful stimuli, due to diminished level of consciousness or sedation. OR Limited ability to feel pain over most of body surface.</p>	<p>2. VERY LIMITED: Responds only to painful stimuli. Cannot communicate discomfort except by moaning or restlessness. OR Has a sensory impairment which limits the ability to feel pain or discomfort over 1/2 of body.</p>	<p>3. SLIGHTLY LIMITED: Responds to verbal commands, but cannot always communicate discomfort or need to be turned. OR Has some sensory impairment which limits ability to feel pain or discomfort in 1 or 2 extremities.</p>	<p>4. NO IMPAIRMENT: Responds to verbal commands. Has no sensory deficit which would limit ability to feel or voice pain or discomfort.</p>	<p>Score: ____</p>
<p>MOISTURE degree to which skin is exposed to moisture</p>	<p>1. CONSTANTLY MOIST: Skin is kept moist almost constantly by perspiration, urine, etc. Dampness is detected every time patient is moved or turned.</p>	<p>2. MOIST: Skin is often, but not always moist. Linen must be changed at least once a shift.</p>	<p>3. OCCASIONALLY MOIST: Skin is occasionally moist, requiring an extra linen change approximately once a day.</p>	<p>4. RARELY MOIST: Skin is usually dry, linen only requires changing at routine intervals.</p>	<p>Score: ____</p>
<p>ACTIVITY degree of physical activity</p>	<p>1. BEDFAST: Confined to bed.</p>	<p>2. CHAIRFAST: Ability to walk severely limited or non-existent. Cannot bear own weight and/or must be assisted into chair or wheelchair.</p>	<p>3. WALKS OCCASIONALLY: Walks occasionally during day, but for very short distances, with or without assistance. Spends majority of each shift in bed or chair.</p>	<p>4. WALKS FREQUENTLY: Walks outside the room at least twice a day and inside room at least once every 2 hours during waking hours.</p>	<p>Score: ____</p>
<p>MOBILITY ability to change and control body position</p>	<p>1. COMPLETELY IMMOBILE Does not make even slight changes in body or extremity position without assistance.</p>	<p>2. VERY LIMITED: Makes occasional slight changes in body or extremity position but unable to make frequent or significant changes independently.</p>	<p>3. SLIGHTLY LIMITED: Makes frequent though slight changes in body or extremity position independently.</p>	<p>4. NO LIMITATIONS: Makes major and frequent changes in position without assistance.</p>	<p>Score: ____</p>
<p>NUTRITION usual food intake pattern</p>	<p>1. VERY POOR: Never eats a complete meal. Rarely eats more than 1/3 of any food offered. Eats 2 servings or less of protein (meat or dairy products) per day. Takes fluids poorly. Does not take a liquid dietary supplement. OR is NPO and/or maintained on clear fluids or IV's for more than 5 days.</p>	<p>2. PROBABLY INADEQUATE: Rarely eats a complete meal and generally eats only about 1/2 of any food offered. Protein intake includes only 3 servings of meat or dairy products per day. Occasionally will take a dietary supplement. OR receives less than optimum amount of liquid or tube feeding.</p>	<p>3. ADEQUATE: Eats over half of most meals. Eats a total of four servings of protein (meat, dairy products) each day. Occasionally will refuse a meal, but will usually take a supplement if offered. OR is on tube feeding or TPN regimen which probably meets most of nutritional needs.</p>	<p>4. EXCELLENT: Eats most of every meal. Never refuses a meal. Usually eats a total of 4 or more servings of meat and dairy products. Occasionally eats between meals. Does not refuse supplementation.</p>	<p>Score: ____</p>
<p>FRICION/SHEAR</p>	<p>1. PROBLEM: Requires moderate to maximum assistance in moving. Complete lifting without sliding against sheet is impossible. Frequently slides down in bed or chair, requiring frequent repositioning with maximum assistance. Spasticity contractures or agitation leads to almost constant friction.</p>	<p>2. POTENTIAL PROBLEM: Moves feebly or requires minimum assistance. During a move skin probably slides to some extent against sheets, chair, restraints, or other devices. Maintains relatively good position in chair or bed most of the time but occasionally slides down.</p>	<p>3. NO APPARENT PROBLEM: Moves in bed and in chair independently and has sufficient muscle strength to lift up completely during move. Maintains good position in bed or chair at all times.</p>		<p>Score: ____</p>

TOTAL SCORE: _____

INSTRUCTIONS:

Mark appropriate box(es).

1. Type of Pressure Reducing Device (PRD) and/or Support Surface:

- hospital mattress only
- hospital mattress with PRD/overlay
- special support surface/mattress replacement
- special beds/bed replacement
- anatomical padding
- chair PRD

If Braden Score is 16 or less, complete number 2 and 3.

2. Nursing Care Plan or Standard Care Plan related to skin care is initiated.
Review documentation in the Nursing Care Plan and Kardex.

- YES NO

3. Interventions to reduce the risk of skin breakdown are noted in the Plan of Care.
Review documentation in the Nursing Care Plan, Kardex, flowsheet and notes (previous 24 hours).

- YES NO

If patient has pressure ulcer, complete 4 and 5

4. Was the pressure ulcer identified upon admission to the hospital?
Review documentation in the Nursing History and Admission Notes.

- YES NO Not able to determine

5. Dressing protocol is noted in the Plan of Care.
Review Documentation in the Nursing Care Plan and Kardex.

- YES NO

Instructions:

1. Indicate the number of ulcer(s) at each site in the appropriate stage box(es)
2. Note type of dressing used according to dressing key.
3. Mark a box for every assessment site.

1. No dressing	7. MVPF (film)
2. Dry gauze	8. Hydrocolloid
3. Hypertonic – NaCl gauze	9. Foam
4. Wet gauze – NaCl	10. Hydrogel
5. Wet gauze – Antiseptic	11. Other
6. Topical Antibiotic	

Assessment Site	No Symptom	Stage Ia	Stage Ib	Stage II	Stage III	Stage IV	Stage X	Dressing
1. Back of head								
2. Right ear								
3. Right scapula								
4. Right elbow								
5. Vertebrae (upper-mid)								
6. Coccyx/Sacrum								
7. Right iliac crest								
8. Right trochanter (hip)								
9. Right ischial tuberosity								
10. Left knee (inner)								
11. Right knee (outer)								
12. Right lower leg								
13. Left ankle (inner)								
14. Right ankle (outer)								
15. Right heel								
16. Right toe(s)								
17. Left ear								
18. Left scapula								
19. Left elbow								
20. Left iliac crest								
21. Left trochanter (hip)								
22. Left ischial tuberosity								
23. Right knee (inner)								
24. Left knee (outer)								
25. Left lower leg								
26. Right ankle (inner)								
27. Left ankle (outer)								
28. Left heel								
29. Left toe(s)								
30. Other (specify)								

Comments:

Appendix C

Ottawa Civic Hospital - Skin Care Study

Pressure Ulcer Staging Criteria: 1993-1996

OTTAWA CIVIC HSOPITAL – SKIN CARE STUDY
Pressure Ulcer staging Criteria: 1993-1996

Stage 1 A –Blanchable Erythema

A reddened area of unbroken skin over a bony prominence, which does not fade within 30 minutes of pressure relief. May be edematous, warm and painful. Blanching indicates that the interruption of capillary blood flow has not yet resulted in cell death.

Stage 1 B – Non blanchable

A red discoloration of unbroken skin over a bony prominence, which does not fade within 30 minutes of pressure relief. May be edematous, warm and painful. Non blanching indicates that the interruption in capillary blood flow has already resulted in cell death.

Stage 1I

Irregular partial thickness loss of skin over a bony prominence, involving the epidermis and dermis. The area may be cracked, blistered or broken. The surrounding skin may be red, edematous, warm and painful. Blanching occurs only on outer edges of the wound.

Stage 1II

Shallow, full thickness skin breakdown over a bony prominence, involving complete loss of epidermis and dermis extending into the subcutaneous tissue,. Distinct wound margins visible. Necrotic tissue and/or exudate may be present at the base of the wound. The sound base is not usually painful.

Stage 1V

Deep, full thickness skin breakdown involving complete loss of the epidermis, dermis, and subcutaneous tissue and possibly extending into muscle, bone, and joint. Necrotic tissue and/or exudate may be present. The wound base may extend beyond the superficial wound surface (sinus undercuts/undermining). Edge may appear to roll over into wound and base is not usually painful.

Stage X

A pressure sore that cannot be accurately staged due to the presence of necrotic tissue covering the wound base.

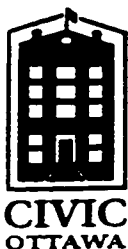
Appendix D

Ethics Approval:

Pressure Ulcer Prevalence Study Principle Investigator

Ottawa Civic Hospital Nursing Research Committee

Ottawa Civic Hospital Ethics Committee



September 4, 1997

Ottawa Civic Hospital
Loeb Research Institute
Institut de recherche Loeb de
l'Hôpital Civic d'Ottawa

1053 Carling Avenue
Ottawa, Ontario
CANADA K1Y 4E9

Tel: 613-761-5165
Fax: 613-761-5351
www.civich.ottawa.on.ca

Clinical Epidemiology Unit



Margaret B. Harrison, RN, PhD (Cand.)
Principal Investigator, CEU, C4
Nurse Specialist, Research & Evaluation
Patient Services Division
Clinical Associate, University of Ottawa
Telephone: (613) 798-5555 ext. 3028
Fax: (613) 761-5394
e-mail: mharrison@civich.ottawa.on.ca

Lynn Joseph, RN, MScN (Candidate)
Clinical Nurse Educator
Medical Portfolio, Neurosciences
Ottawa Civic Hospital
1053 Carling Avenue
Ottawa, Ontario K1Y 4E9

Dear Lynn,

Re: Pressure ulcers in a neuroscience population: A secondary analysis of prevalence, risk and clinical factors. L. Joseph, RN, MscN (candidate)

This letter is to confirm our discussions regarding your request for access, through the Clinical Epidemiology Unit, to the four year data set on ulcer risk and prevalence of OCH inpatients. Your proposal is very timely, with the neuroscience group undoubtedly being a population of interest with regard to this problem.

As requested, I would be pleased to construct a subset of neuroscience inpatients and one of the rest of the hospital inpatients over the four years of prevalence studies. Aside from the obvious academic motivation, the comparative analysis will certainly be helpful to the hospital in planning the implementation of the skin care program in this area.

I look forward to working with you on your research. Please accept my best wishes for a successful project!

Margaret B. Harrison, RN, PhD (Candidate)
Principal Investigator, Clinical Epidemiology Unit, Loeb Research Institute
Nurse Specialist Research & Evaluation, Patient Services Division
Clinical Associate, University of Ottawa School of Nursing

Un institut de recherche approuvé
par Revenu Canada / A Revenu Canada
proved research institute



affilié à l'Université d'Ottawa/
affiliated with the University of Ottawa

June 10, 1997

Lynn Joseph
Nurse Educator
Ottawa Civic Hospital
1053 Carling Avenue
Ottawa, Ontario
K1Y 4E9

Dear Lynn

Re: Pressure ulcers in a neuroscience population: A secondary analysis of prevalence, severity, risk and clinical factors

I am pleased to inform you that your research proposal has been granted final approval by the Nursing Research Committee. The understanding is that you will make the changes discussed today and incorporate the recommendations of Dr. Jo Logan and Margaret Harrison. This is a very exciting proposal and should improve our knowledge of patient care.

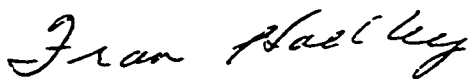
Divisional nursing policy requires investigators to complete appropriate research progress reports and submit a report of findings upon completion of the project to the Department of Interdisciplinary Research and Professional Development. If requested, you are expected to provide further feedback to nursing staff who have participated in the research.

Please send your proposal and appropriate application forms to the hospital Research Ethics Committee for review. For information about applying to this committee, call 761-4395. Please do not begin your study until you have received final approval from the Research Ethics Committee.

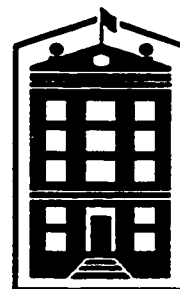
For your information, the deadline for application to the Ottawa Civic Hospital Nursing Research Fund is October 15, 1997. Other research funding information is available in the Department of Interdisciplinary Research and Professional Development.

Best wishes for successful completion of the study. If you have any further questions or require any other assistance, do not hesitate to call.

Sincerely



Fran Hadley
Nurse Specialist - Research & Evaluation
Professional Practice



**CIVIC
OTTAWA**

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Civique d'Ottawa

1053 Carling
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K1Y 4E9

(613) 761-4000

**Loeb Research Institute
Ottawa Civic Hospital
1053 Carling Avenue
Ottawa, Ontario
K1Y 4E9**

September 15, 1997

Ms. Lynn Joseph
Norman Patterson Building
First Floor
Nursing Education
Ottawa Civic Hospital

Dear Ms. Joseph:

Re: Protocol # 1997202-01H Pressure Ulcers in a Neuroscience Population
Protocol approval valid until - September 15, 1998

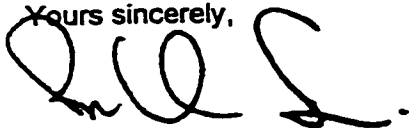
Thank you for your letter of September 4, 1997. Your proposed study involves secondary use of the Pressure Ulcer Prevalence study, which is a quality assurance-based project, using linkable data. Chart review is done of patients with ulcers.

Your study (listed above) has been given expedited review by the Research Ethics Committee and is approved. No changes, amendments or addenda may be made in the protocol or the consent form without the Research Ethics Committee review and approval.

The validation date should be indicated on the bottom of all consent forms and information sheets. Approximately one month prior to the expiration date listed above, a single renewal form should be sent to the Research Services Office.

Guidelines of the Medical Research Council require a greater involvement of the Research Ethics Committee in studies over the course of their execution. You must maintain as part of your records copies of the signed consent form. As well, you must inform the Committee of adverse events encountered during the study, here or elsewhere, or of significant new information which becomes available after the Committee review, either of which may impinge on the ethics of continuing the study. The REC will review the new information to determine if the protocol should be modified, discontinued, or should continue as originally approved.

Yours sincerely,



**Raphael Saginur, M.D.
Chairman
Research Ethics Committee**

**Loeb Research Institute
Ottawa Civic Hospital
1053 Carling Avenue
Ottawa, Ontario
K1Y 4E9**

11 September, 1998

Ms. Lynn Joseph
Norman Patterson Building
First Floor, Nursing Education
Ottawa Civic Hospital

Dear Ms. Joseph:

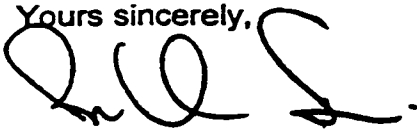
Re: Protocol #1997202-01H Pressure Ulcers in a Neuroscience Population
Renewal Expiry Date – 15/9/1999

I am pleased to inform you that your Annual Renewal Request (listed above) was reviewed by the Research Ethics Committee and approved. No changes, amendments or addenda may be made in the protocol or the consent form without the Research Ethics Committee review and approval.

Renewal is valid for a period of one year. The validation date should be indicated on the bottom of all consent forms and information sheets/letter (see copy attached). Approximately one month prior to that time, a single renewal form should be sent to the Research Administration office.

Medical Research Council guidelines require a greater involvement of the Research Ethics Committee in studies over the course of their execution. You must maintain, as part of your records, copies of the signed consent form. As well, you must inform the Committee of adverse events encountered during the study, here or elsewhere, or of significant new information which becomes available after the Committee review, either of which may impinge on the ethics of continuing the study. The REC will review the new information to determine if the protocol would be modified, discontinued, or should continue as originally approved.

Yours sincerely,



Raphael Saginur, M.D.
Chairman
Research Ethics Committee



The Ottawa
Hospital

L'Hôpital
d'Ottawa

Research Ethics Board
Conseil d'éthique en recherches
761-4146 ~ 761-4902 ~ 761-5072
Fax No. ~ 761-4920

Friday, September 17, 1999

Ms. Lynn Joseph
Norman Patterson Building
First Floor
Nursing Education
Ottawa Hospital - Civic Campus

Dear Ms. Joseph:

RE: Protocol# - 1997202-01H Pressure Ulcers in a Neuroscience Population
Renewal Expiry Date - Saturday, September 16, 2000

I am pleased to inform you that your Annual Renewal Request (listed above) was reviewed by the Research Ethics Board (REB) and approved. No changes, amendments or addenda may be made in the protocol or the consent form without the REB's review and approval.

Renewal is valid for a period of one year. Approximately one month prior to that time, a single renewal form should be sent to the Research Services office.

Medical Research Council guidelines require a greater involvement of the REB in studies over the course of their execution. You must maintain, as part of your records, copies of the signed consent form. As well, you must inform the Board of adverse events encountered during the study, here or elsewhere, or of significant new information which becomes available after the Board review, either of which may impinge on the ethics of continuing the study. The REB will review the new information to determine if the protocol would be modified, discontinued, or should continue as originally approved.

Yours sincerely,

Raphael Saginur, M.D.
Chairman
Ottawa Hospital Research Ethics Board

Appendix E

Pressure Ulcer Prevalence (PUP) Population Flow Charts:

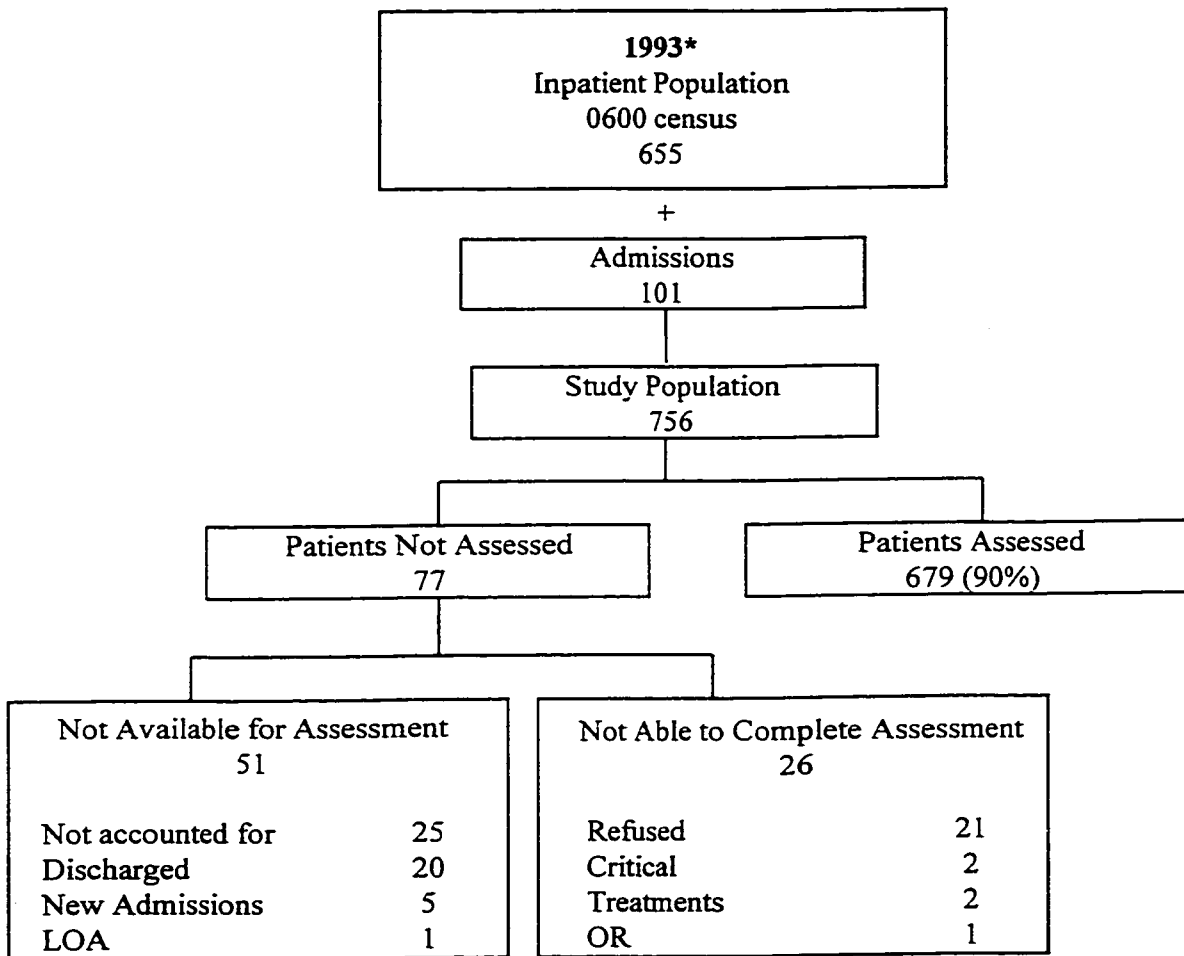
1993

1994

1995

1996

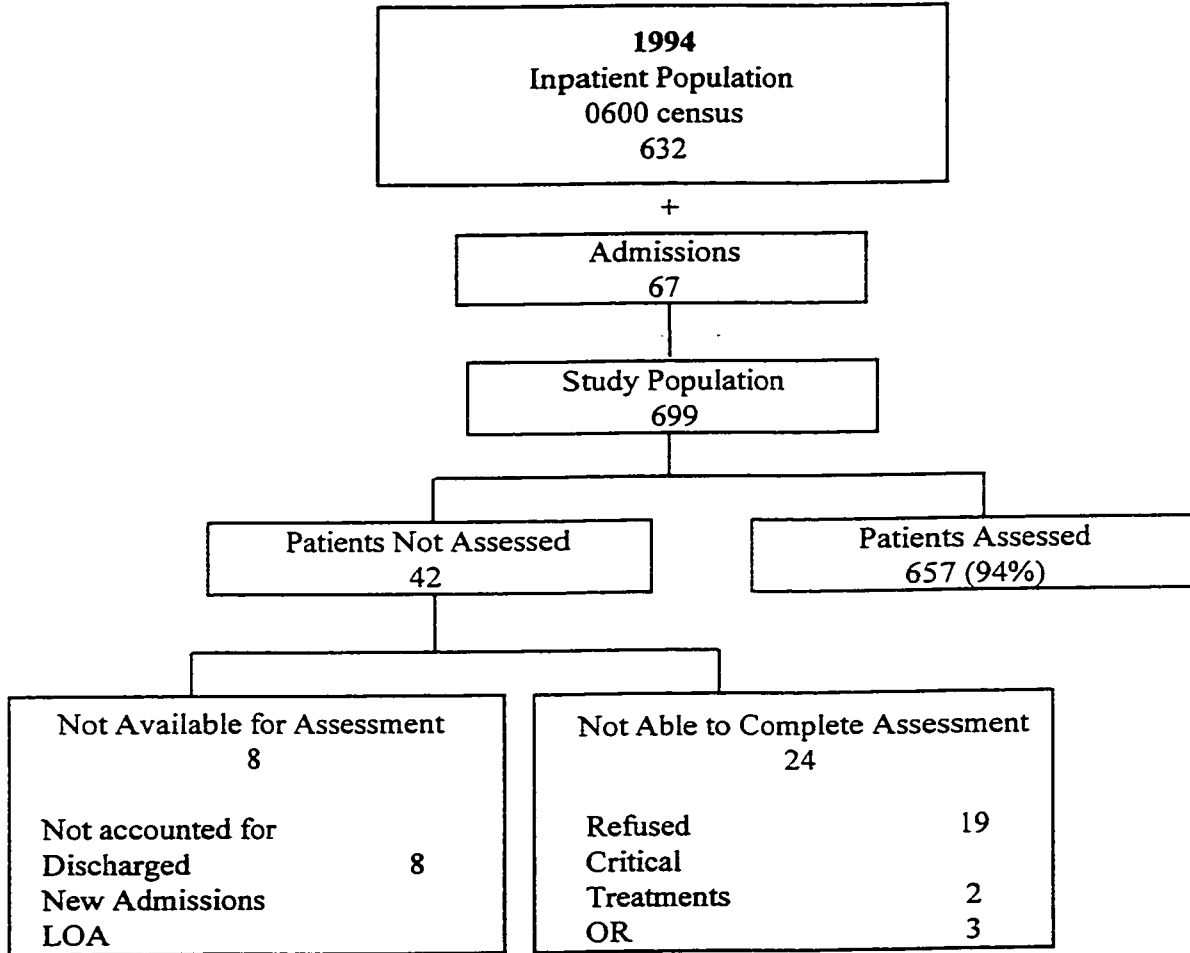
Appendix E
 Pressure Ulcer Prevalence (PUP) Population Flow Chart:
 1993



* The study population for 1993 is different than the numbers described by Harrison et al. (1996) because the obstetric patients are not included in the 4 year trend analysis.

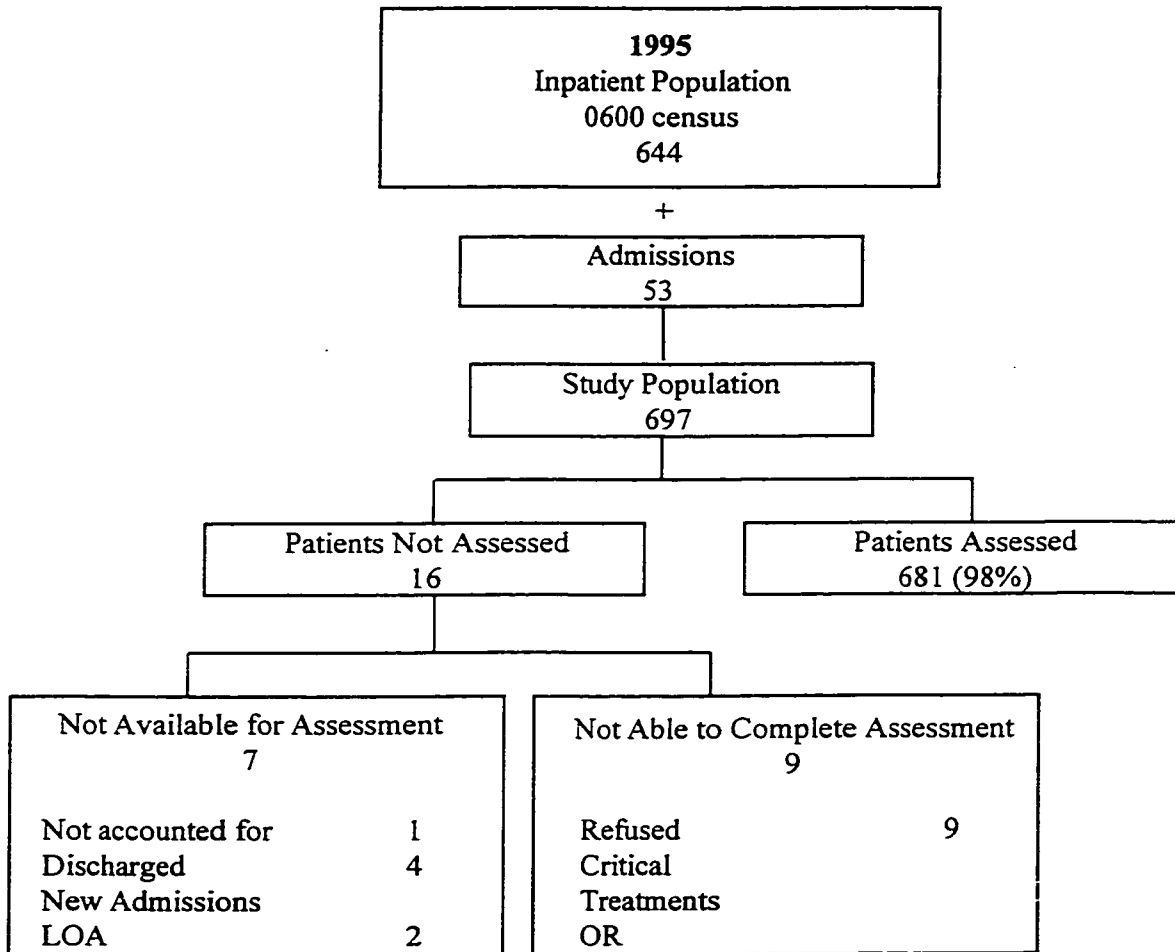
Appendix E

Pressure Ulcer Prevalence (PUP) Population
Flow Chart: 1994



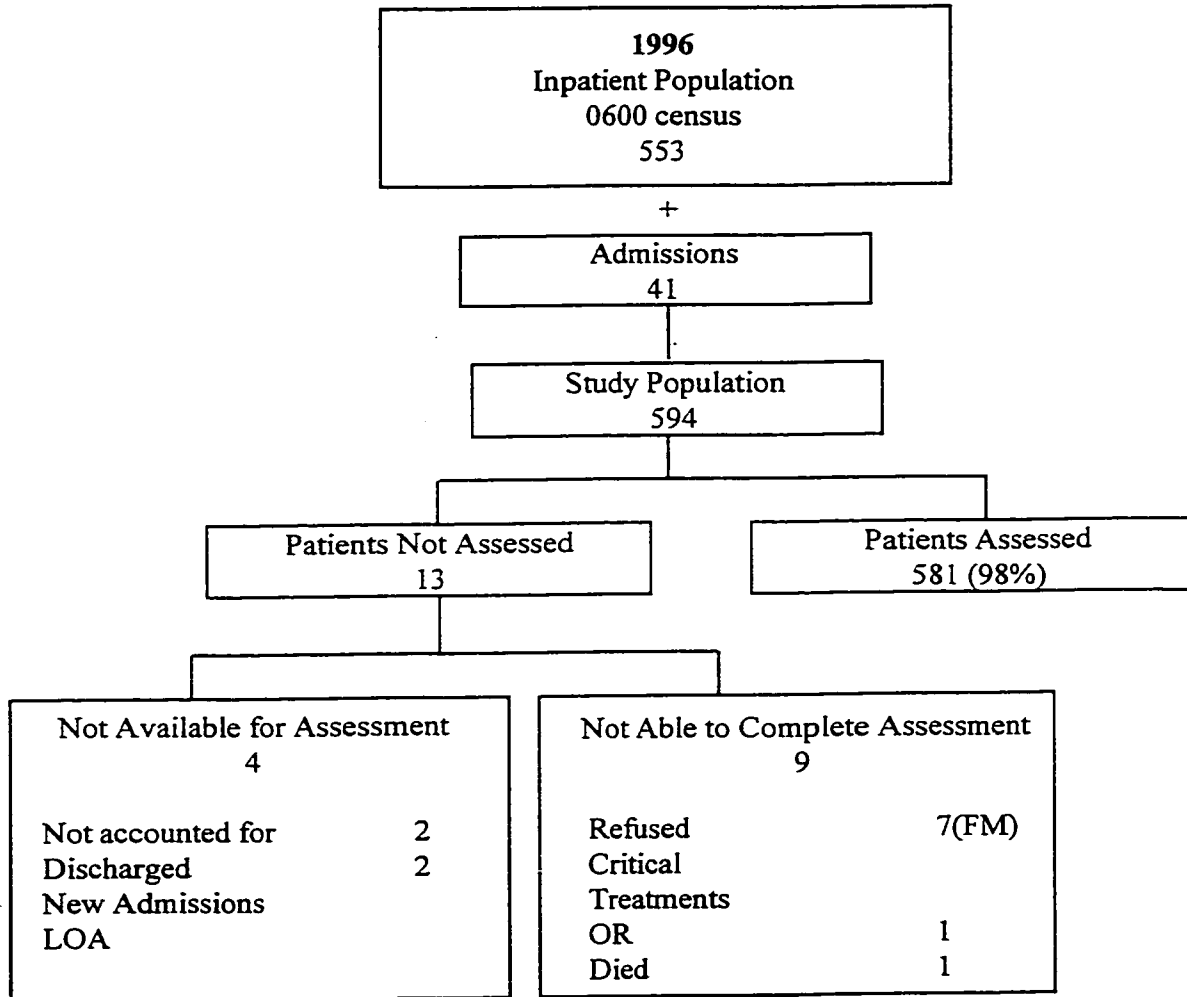
Ottawa Civic Hospital Clinical Epidemiology Unit, Loeb Research Institute (1997).
Pressure ulcers: A four year trend analysis. Ottawa Civic Hospital.

Appendix E
 Pressure Ulcer Prevalence (PUP) Population
 Flow Chart: 1995



Ottawa Civic Hospital Clinical Epidemiology Unit, Loeb Research Institute (1997).
 Pressure ulcers: A four year trend analysis. Ottawa Civic Hospital.

Appendix E
 Pressure Ulcer Prevalence (PUP) Population
 Flow Chart: 1996



Ottawa Civic Hospital Clinical Epidemiology Unit, Loeb Research Institute (1997).
 Presssure ulcers: A four year trend analysis. Ottawa Civic Hospital.

Appendix F
Technical Tables

Technical Table 1

Length of Stay Data on the Total Hospital Population and the Neuroscience Unit from 1993 to 1996

	Total Hospital Days	Neuroscience Unit Days
1993 - September	9.6	10.11
Fiscal Year -93/94	10.15	14.18
1994 September	8.85	9.93
Fiscal Year -94/95	9.4	12.52
1995 September	8.69	9.92
Fiscal Year -95/96	9.14	10.73
1996 September	8.49	7.81
Fiscal Year -96/97	8.69	11.3

Technical Table 2

Comparison of Gender Characteristics of the Neuroscience and Non-neuroscience Populations in 1993-1996.

	Neuroscience		Non-Neuroscience		χ^2	<i>p</i>
	%	(n)	%	(n)		
1993 females	39	(16)	49	(313)	1.55	.213
males	61	(25)	51	(325)		
1994 females	50	(21)	52	(317)	.037	.846
males	50	(21)	48	(298)		
1995 females	51	(22)	50	(317)	.035	.851
males	49	(21)	50	(321)		
1996 females	52	(21)	51	(274)	.051	.821
males	48	(19)	49	(267)		

Technical Table 3

Mean and Median Ages of the Neuroscience and Non-neuroscience Populations from 1993 to 1996

	Neuroscience			Non-neuroscience		
	Mean	(SD)	Median	Mean	(SD)	Median
1993	54.6	20.1	63	61	18.1	65
1994	59.5	18.4	64	63.1	16.6	67
1995	59.3	18.4	64	62.7	18.2	66
1996	58.8	19.3	60.5	66.4	16.2	69

Technical Table 4

Comparison of Age Characteristics of the Neuroscience and Non-neuroscience Populations in 1993-1996.

	Year Categories	Neuroscience		Non-Neuroscience		χ^2	<i>p</i>
		%	(n)	%	(n)		
1993	<41	34.1	(14)	16.8	(107)	10.8	.028
	41-60	14.6	(6)	24.9	(159)		
	61-70	29.3	(12)	23.0	(147)		
	71-80	14.6	(6)	22.6	(144)		
	> 81	7.3	(3)	12.7	(81)		
1994	<41	19.0	(8)	12.4	(76)	3.16	.531
	41-60	26.2	(11)	24.4	(150)		
	61-70	23.8	(10)	22.8	(140)		
	71-80	16.7	(7)	27.3	(168)		
	> 81	14.3	(6)	13.2	(81)		
1995	<41	27.9	(12)	15.0	(96)	7.75	.101
	41-60	18.6	(8)	22.3	(142)		
	61-70	16.3	(7)	21.8	(139)		
	71-80	30.2	(13)	24.6	(157)		
	> 81	7.0	(3)	16.3	(104)		
1996	<41	22.5	(9)	8.7	(47)	12.83	0.12
	41-60	27.5	(1)	23.3	(126)		
	61-70	22.5	(9)	21.8	(118)		
	71-80	7.5	(3)	26.1	(141)		
	> 81	20.0	(8)	21.1	(109)		

Technical Table 5

Comparison of Length of Stay Characteristics of the Neuroscience and Non-neuroscience Populations in 1993-1996.

		Neuroscience		Non-Neuroscience		χ^2	<i>p</i>
		%	(n)	%	(n)		
1993	1 week	26.8	(11)	55.2	(351)	15.71	.007
	2 week	26.8	(11)	14.6	(93)		
	3 week	19.5	(8)	8.5	(54)		
	1 month	7.3	(3)	5.8	(37)		
	2 month	4.9	(2)	6.0	(38)		
	3 month & >	14.6	(6)	9.9	(63)		
1994	1 week	39.0	(16)	50.2	(306)	4.61	.464
	2 week	17.1	(7)	15.4	(94)		
	3 week	4.9	(2)	9.0	(55)		
	1 month	9.8	(4)	5.9	(36)		
	2 month	12.2	(5)	8.9	(54)		
	3 month & >	17.1	(7)	10.7	(65)		
1995	1 week	55.8	(24)	52.0	(331)	4.386	.495
	2 week	25.6	(11)	17.4	(111)		
	3 week	2.3	(1)	5.8	(37)		
	1 month	2.3	(1)	6.3	(40)		
	2 month	7.0	(3)	6.6	(42)		
	3 month & >	7.0	(3)	11.9	(76)		
1996	1 week	65.5	(26)	54.2	(293)	3.51	.621
	2 week	12.5	(5)	15.5	(84)		
	3 week	2.5	(1)	8.9	(48)		
	1 month	5.0	(2)	4.8	(26)		
	2 month	7.5	(3)	5.5	(30)		
	3 month & >	7.5	(3)	11.1	(60)		

Technical Table 6

Prevalence of Pressure Ulcers in the Neuroscience and Non-neuroscience Populations from 1993 -1996.

	Neuroscience			Non-Neuroscience			<i>p</i>
	PU (+)		(n)	PU (+)		(n)	
	%	CI.		%	CI.		
1993	65.9	53, 80	(27/41)	30.1	26, 34	(192/638)	.00001
1994	19.9	10, 36	(8/42)	25.7	23, 29	(158/615)	.46248
1995	16.3	5, 27	(7/43)	24.0	21, 27	(153/638)	.35181
1996	5.0	0, 12	(2/40)	22.7	19, 27	(123/541)	.00504

CI. stands for confidence intervals at 95%.

The *p* value is for a two-tailed Fisher's exact test.

Technical Table 7

Prevalence of Stage 2 and Higher Ulcers in the Neuroscience and Non-neuroscience Population from 1993-1996.

	Neuroscience			Non-neuroscience			<i>p</i>
	%	CI	(n)	%	CI	(n)	
1993	19.5	7, 14	(8/41)	14.4	11, 17	(92/638)	.36445
1994	7.1	1, 15	(3/42)	10.6	9, 13	(65/615)	.60839
1995	4.7	1, 11	(2/43)	12.2	9, 15	(78/638)	.21623
1996	5.0	1.5, 10.5	(2/40)	12.8	10,16	(69/541)	.20962

CI. Stands for confidence interval at 95%. The *p* value is for a two-tailed Fisher's exact test.

Technical Table 8

Comparison of Ulcer Stages in the Neuroscience and Non-neuroscience Populations in 1993-1996.

	Neuroscience		Non-Neuroscience		χ^2	<i>p</i>
	%	(n)	%	(n)		
1993						
no ulcers	34.1	(14)	69.9	(446)	33.457	.0000
stage 1A	46.3	(19)	15.7	(100)		
stage 2	19.5	(8)	9.7	(62)		
stage 3	0	(0)	.6	(4)		
stage 4	0	(0)	.5	(3)		
stage X	0	(0)	3.6	(23)		
1994						
no ulcers	81.0	(34)	74.3	(457)	2.814	.8317
stage 1A	4.8	(2)	8.9	(55)		
stage 1B	7.1	(3)	6.2	(38)		
stage 2	7.1	(3)	6.5	(40)		
stage 3	0	(0)	0.7	(4)		
stage 4	0	(0)	0.2	(1)		
stage X	0	(0)	3.3	(20)		
1995						
no ulcers	83.7	(36)	76.0	(485)	4.809	.5684
stage 1A	11.6	(5)	9.6	(61)		
stage 1B	0.0	(0)	2.2	(14)		
stage 2	4.7	(2)	4.4	(28)		
stage 3	0.0	(0)	1.4	(9)		
stage 4	0.0	(0)	0.5	(3)		
stage X	0.0	(0)	6.0	(38)		
1996						
no ulcers	95.0	(38)	77.3	(418)	8.329	.2149
stage 1A	0.0	(0)	8.3	(45)		
stage 1B	0.0	(0)	1.7	(9)		
stage 2	5.0	(2)	5.7	(31)		
stage 3	0.0	(0)	3.7	(20)		
stage 4	0.0	(0)	0.2	(1)		
stage X	0.0	(0)	3.1	(17)		

The χ^2 result is not statistically significant as 50% of the cells have an expected frequency of less than 5.

Technical Table 9

Prevalence of Stage 1 Ulcers in the Neuroscience and Non-neuroscience Populations from 1993-1996.

	Neuroscience			Non-neuroscience		
	%	CI.	(n)	%	CI.	(n)
1993	46.3	31, 61	(19/41)	15.7	15.8 16.2	(100/638)
1994	11.9	2, 22	(5/42)	15.1	12, 18	(93/615)
1995	11.6	2, 20	(5/43)	11.8	9, 15	(75/638)
1996	0.0	0, 0	(0/40)	10.0	7, 13	(54/541)

CI. stands for confidence intervals at 95%.

Technical Table 10

Percentage of All Stage Ulcers at Specific Body Areas in the Neuroscience Population from 1993 -1996

	1993	1994	1995	1996
Total # of Ulcers at 6 body areas	79	11	13	1
Coccyx, sacrum, ischial tuberosities	23%	37%	46%	100%
Ankle	21%	18%	23%	0
Elbow	19%	9%	8%	0
Heel	11%	18%	0%	0
Trochanter	20%	9%	15%	0
Head/ears	5%	9%	8%	0
Total	100%	100%	100%	100%

Technical Table 11

Percentage of Stage 2 and Higher Ulcers at Specific Body Sites in the Neuroscience Population from 1993 -1996

	1993	1994	1995	1996
N= Total # of Ulcers	12	5	3	1
Coccyx, sacrum, ischial tuberosities	17%	40%	67%	100%
Ankle	25%	40%	0%	0%
Elbow	50%	0%	0%	0%
Heel	0%	20%	0%	0%
Trochanter	0%	0%	0%	0%
Head/ears	8%	0%	33%	0%
Total	100%	100%	100%	100%

Technical Table 12
Percentage of All Stage Ulcers at Specific Body Sites in the Non-neuroscience Population from 1993 -1996

	1993	1994	1995	1996
N= Total # of Ulcers	408	240	256	212
Coccyx, sacrum, ischial tuberosities	24%	34%	33%	34%
Ankle	24%	17%	19%	16%
Elbow	12%	22%	10%	10%
Heel	5%	3%	10%	6%
Trochanter	13%	17%	19%	27%
Head/ears	22%	7%	9%	7%
Total	100%	100%	100%	100%

Technical Table 13
Percentage of Stage 2 and Higher Ulcers at Specific Body Sites in the Non-neuroscience Population from 1993 -1996

	1993	1994	1995	1996
N= Total # of Ulcers	166	77	109	91
Coccyx, sacrum, ischial tuberosities	30%	43%	38%	40%
Ankle	27%	10%	23%	19%
Elbow	7%	14%	8%	11%
Heel	5%	3%	13%	5%
Trochanter	8%	21%	5%	21%
Head/ears	23%	9%	13%	4%
Total	100%	100%	100%	100%

Technical Table 14
Comparison of Risk in the Neuroscience and Non-neuroscience Populations from 1993 -1996.

	Neuroscience		Non-Neuroscience		χ^2	p
	%	(n)	%	(n)		
1993	90	(37)	76	(481)	4.40	.035
1994	69	(29)	71	(434)	0.05	.821
1995	72	(31)	67	(430)	0.398	.533
1996	60	(24)	73	(396)	3.39	.065

Technical Table 15

Comparison of the Different Clinical Risk Factors in the Neuroscience and Non-neuroscience Populations from 1993 -1996.

	Neuroscience		Non-Neuroscience		χ^2	<i>p</i>
	%	(n)	%	(n)		
Sensory Perception Risk						
1993	46	(19)	21	(133)	14.35	.000
1994	19	(8)	15	(93)	0.46	.494
1995	37	(16)	17	(109)	10.89	.000
1996	7.5	(3)	18	(99)	3.00	.083
Moisture Risk						
1993	56	(23)	27.4	(174)	15.41	.000
1994	48	(20)	19.3	(119)	18.83	.000
1995	42	(18)	21.6	(138)	9.33	.002
1996	10	(4)	28	(151)	6.11	.013
Activity Risk						
1993	78	(32)	53	(343)	9.06	.002
1994	64	(27)	51.4	(316)	2.62	.105
1995	58	(25)	49.4	(315)	1.24	.265
1996	55	(22)	56.3	(304)	0.02	.873
Mobility Risk						
1993	58.5	(24)	36.6	(233)	7.89	.005
1994	45.2	(19)	31.4	(193)	3.45	.063
1995	48.8	(21)	32.1	(205)	5.07	.024
1996	22.5	(9)	39.8	(215)	4.71	.029
Nutrition Risk						
1993	73.2	(30)	63.5	(403)	1.57	.209
1994	28.6	(12)	47.6	(292)	5.70	.016
1995	53.5	(23)	50.8	(324)	0.12	.731
1996	27.5	(11)	53.8	(291)	10.31	.001
Friction/Shear Risk						
1993	58.5	(24)	35	(222)	9.297	.002
1994	45.2	(19)	30	(185)	4.218	.039
1995	32.6	(14)	31.4	(200)	.0251	.873
1996	32.5	(13)	36.2	(196)	.2248	.635