Final Progress Report

Relationship Between Time on a Backboard and Pressure Ulcer Development in Persons with Traumatic Spinal Cord Injuries

Introduction

The purpose of this study is to assess the relationship between time spent immobilized on a spine backboard and the formation of pressure ulcers (PU) in persons with acute spinal cord injury (SCI). According to the Joint Commission, more than 2.5 million patients in acute care facilities in the US suffer from pressure ulcers. The incidence of pressure ulcers in acute SCI has been reported to be as high as 59%. The incidence of pressure ulcers in veterans with chronic SCI in the community has been shown to be 30-40%. At MetroHealth, we have estimated the incidence of PUs in newly injured persons with traumatic SCI to be 34% between 2005 and 2009. In the Ohio Trauma Registry, 41 persons with acute spinal cord injury came into MetroHealth's Emergency Department (ED) with skin breakdown between 2005 and 2009. It is costly to heal pressure ulcers, with annual costs estimated at 5 to 8.5 billion dollars, leading to changes in the Center for Medicare and Medicaid Services' regulations on reimbursements for PUs acquired during hospitalizations last 2008.

This study directly addressed the Ohio EMS grant program Priority 4 by researching the causes, nature, and effects of pressure ulcer formation in individuals with traumatic SCI. The outcomes from this study will provide new knowledge that will directly educate the public, EMS workers and clinicians about PU prevention. In addition, this project will be the catalyst for our continued development of a pressure relieving backboard that would be cost effective and clinically beneficial to patients.

Table of Contents

Executive Summary

Significance: From a historical perspective, pressures of 60 mmHg for one hour on the skin surface of dogs can lead to the development of a Pressure Ulcer (PU). Our own research with able bodied individuals strapped to a backboard (BB) revealed pressures in excess of 260 mmHg. Studies have looked at time in the Emergency Department (ED) on a backboard plus time in surgery as a time variable and its relationship to PU formation, but time in transport, including time from scene to ED, and time at another hospital on a backboard are not included. So, it has not been possible to delineate total time on a backboard and its association with PU development. This project will use Ohio Emergency Medical Services Incident Reporting System (EMSIRS) data, which allows full documentation of total scene and enroute time on a backboard and then MetroHealth's (MH) documentation of time taken off BB recorded on the ED nursing flow sheet. It is in the best interest of the comprehensive health care systems to determine as early in a hospital stay as possible if a patient is at risk for PU development so that early interventions can take place.

Approach: Superficial skin damage assessed through direct observation and palpation on admission to the ED, at admission to Intensive Care Unit (ICU), Days 2 and 3 in the ICU and then every week for up to 4 weeks or until discharge from MHMC. Changes in the skin and the presence of a pressure ulcer were abstracted from nursing notes and the Wound Care Clinical Nurse Specialist notes and then documented on study data logs. Pressure ulcers were graded according to the 2007 conclusions of the National Pressure Advisory Panel. Each pressure ulcer was graded and designated as Stage I, Stage II, Stage III, Stage IV, deep tissue injury, and unstageable.

Innovation: The literature is full of information regarding the incidence, risk factors, treatment options and treatment costs of PUs in patients after acute Spinal Cord Injury (SCI). However, the literature continues to report that 30-50% of persons with SCI develop pressure ulcers and most within the first month post injury. Therefore, one must look at other factors that may increase the risk of PU formation that have not been looked at or changed. One of these risk factors that have not been modified in the recent literature is the time spent on the backboard. The patient with acute SCI is immobilized and transported on a spine backboard for hours before assessment and management in the ED allows the patient to be moved to a standard hospital bed. However, there is no information in the literature that directly demonstrates the risk of PU formation as immobilization time on the backboard increases. A reason for this lack of investigation maybe due to the difficulty determining time on a backboard from scene to time off backboard in the ED. This project utilized Ohio EMSIRS data collected that has patient identifiers through the Northern Ohio Trauma System (NOTS), which documents time on the backboard while in route to the ED and the time taken off the backboard in the ED from the MH ED nursing flow sheet so that a better measure of total time on a backboard can be determined. We will be able to track patients throughout their injury experience from scene through rehabilitation because of this ability to utilize the EMSIRS data.

Results: Forty-nine patients met the inclusion criteria for the study. Eighty-two percent of the sample was male, 59 percent were White and the median age was 46.7 years old. Sixteen percent of patients had a diagnosis of Type II Diabetes and 30.6% of the sample smoked. The mean Body Mass Index (BMI) score was 27.1, which is defined as overweight. Seventy-five percent of patients were Incomplete injuries; as defined by the American Spinal Injury Score (B, C, & D).

18.4% percent of patients developed a pressure ulcer (PU) during their hospitalization. One PU was noted in the Emergency Department, five new PUs developed during the ICU stay and seven new PUs were documented during acute rehabilitation.

The total mean time patients spent on a backboard (BB) was 43.1 minutes.

We were unable to determine any statistically significant differences in mean time on a backboard between those who developed a PU and those who did not. Nor were any statistically significant differences found for sex, race, ASIA scale, smoking status, Type II Diabetes, age or BMI and pressure ulcer development during ICU stay or rehabilitation stay.

Conclusion: We did not find any relationship between pressure ulcer development and time on a backboard with this patient sample. One reason why our study findings do not support laboratory studies of backboard pressure and PU development maybe due to the development of the Northeast Ohio Trauma System, which has protocols for triaging patients to appropriate EDs for care. This has significantly reduced transport time to Trauma Centers. A second reason is that the MetroHealth Trauma Department recently put a spine protocol in place that requires patients brought into the ED to be removed from the backboard as soon as possible. Time Off the backboard is recorded on the Trauma Flow sheet as a way of reminding the team to adhere to the protocol. As a result, the average time spent on the backboard in the ED is 8.7 minutes. A recent study by Cooney and colleagues documenting time of patients coming into the ED of a level 1 trauma center found that the average time on the BB in the ED was 33 minutes and Total Time on the Backboard was 54 minutes.[25] We are far below this study's averages for time on a backboard.

Recommendation: Our recommendation for the State is to investigate if Trauma Centers across the state of Ohio have a Spine protocol for when to expeditiously take a patient off the backboard in the ED. If Spine protocols are not in place then we need to determine why this is the case and encourage all Trauma Centers to initiate such protocols. To continue quality improvement of care to prevent pressure ulcers, standardized documentation forms and language describing skin integrity need to be developed. The expansion of electronic medical records across institutions should also pave the way for earlier identification of high risk patients, allowing the provider to monitor the patients' progress over time, and thereby improving the overall delivery of care.

Information/Qualifications

Melvin Meja, MD: Principal Investigator. Dr. Mejia completed Residency training in Physical Medicine and Rehabilitation (PM&R) at MetroHealth Medical Center / Case Western Reserve University in 2003. He underwent Subspecialty training and certification in Spinal Cord Injury Medicine at the University of Texas Southwestern Medical Center at Dallas, Texas in 2004, where he was later appointed as Assistant Professor, while holding tenure at the Dallas Veterans Affairs North Texas Health System. He rejoined the PM&R Department at MetroHealth in 2006 and currently holds faculty appointment as an Assistant Professor at Case Western Reserve University. He has received the Teaching Awards from the Chair and from the Residents in 2007 and 2008 respectively, and is also a recipient of the Chair Awards for Clinical Care for 2008 and 2010. He is recently named into the Best Doctors in Cleveland since 2009, and also garnered a "Hero Award" by the American National Red Cross in 2010. He has been a member of numerous PM&R and SCI organizations since residency. He has a broad interests and clinical expertise in SCI Medicine and management of the polytrauma patients. Dr. Mejia has initiated several non-funded research projects at MetroHealth dealing with neurogenic bladders and pressure ulcer issues.

Gregory Nemunaitis, MD: Investigator. Dr. Nemunaitis is a Professor of PM&R at Case Western Reserve University and MetroHealth Medical Center. He obtained American Board of Physical Medicine and Rehabilitation (ABPM&R) Board Certification in 1990, and subspecialty certification in Spinal Cord Injury Medicine in 1999. Dr. Nemunaitis serves on the Trauma Committee of the EMS Board as the PM&R Representative to assist in the development of the management of trauma victims in the State of Ohio. His years of teaching service were recognized by the Department of PM&R at MCO with the Nemunaitis Annual Teaching Award in 2002 to be given to deserving residents in PM&R. Dr. Nemunaitis was awarded the Bridge Award in 2001 and 2002 for Health Care Providers in Northeast Ohio for his "outstanding commitment to individuals with a disability in his community," and also received the PM&R Faculty Teaching Award at the MHMC in 2003 and 2005. And the Chair award for Clinical Care in 2004. Having served on the Ohio Polio Network as a Board Member for 14 years, he received the "People First Disability Second" Award in 1995. Dr. Nemunaitis has been a member of ASIA for 15 years, and has given well over 100 local, regional, and national lectures on various aspects of SCI. Dr. Nemunaitis' research interests focus on SCI health and wellness, assistive technology and FES, and he has authored or co-authored 25 papers and abstracts.

Mary Joan Roach, Ph.D. Investigator/Project Manager. Dr. Roach has a faculty appointment in the Dept. of PM&R at Case Western Reserve University (CWRU), School of Medicine and Senior Researcher in the Center for Health Research and Policy at CWRU/MetroHealth. Currently, Dr. Roach is the Program Manager for an Ohio EMS Trauma Grant, which Dr. Mejia is Principal Investigator. As an Urban Sociologist, her research and teaching expertise lies in the area of race and ethnic relations, community structure and quality of life, access issues related to health care and sociological research methodologies. Since 1981 she has focused on developing scientific means through which social issues can be studied and quantified in the service setting through questionnaires, focus groups and in-depth interviews. She is an author on 20 published papers on this topic and has been a significant participant in 12 major funded research projects in the fields of medicine and sociology. Recently, she had been the Research Director for the SCI Model System grant and was involved with the Health Services' Special Interest Group of the SCI Model Systems and chaired the group responsible for informing Project Directors on demographic and health services data points in the National SCI Database.

Michael Nowak, Ph.D. Investigator/Data Manager. Dr. Nowak is the Regional Data Manager and Regional Trauma Registrar for the Northern Ohio Trauma System. His primary appointment is in the Department of Surgery, Division of Trauma. He is responsible for data collection, analysis and dissemination of all trauma data from Northern Ohio Trauma System Hospitals, which includes MetroHealth Medical Center. Prior to coming to MetroHealth, Dr. Nowak was a healthcare consultant who provided expertise in data analysis and statistical sampling to hospitals and insurance companies.

Background

Significance

The purpose of this study is to assess the relationship between time spent immobilized on a spine backboard and the formation of pressure ulcers (PU) in persons with acute spinal cord injury (SCI). The recommendations of the American College of Surgeons for early management of the trauma victim with a potential SCI consist of immobilization with a hard backboard, a rigid cervical collar, lateral support devices, and tape or straps to secure the patient.[1,2] The most important concern during the initial management of patients with potential SCI is that neurologic function may be impaired due to movement of the unstable or injured vertebrae. It is estimated that 3% to 25% of pressure ulcers in patients with traumatic SCI occur after the initial traumatic insult, either during transit or early in the course of management.[3,4] While immobilization on a hard backboard is effective in limiting motion, it has been associated with skin breakdown.[5-9] The incidence of PUs in newly admitted patients with SCI has been reported to be as high a 59%.[6] The incidence of PUs in veterans with chronic SCI in the community has been shown to be 30-40%.[10-12]

It has been found that PU formation varies directly with length of time immobilized and amount of pressure generated.[5,6,13,14] Experimental studies indicate that a constant pressure of 60mmHg for one hour is sufficient to cause irreversible tissue damage in dogs, that time factor is more important than pressure intensity,[13] and that threshold pressure level for damage seems to be reduced after an SCI.[6] It has been reported that patients brought to the ED on a backboard were immobilized for an average of 165 minutes if radiographic studies were required.[14]

The MetroHealth Rehabilitation Institute of Ohio has completed an assessment of pressures on a spine backboard using a sample of able bodied persons in a laboratory setting. In an abstract published in 2008, we determined the average sacral interface pressures on 40 healthy volunteers was 262mmHg, 4 times higher than recommeded.[15-16] Reports indicate the average cost to heal one complex full thickness pressure ulcer is estimated to be $70,000.00.[17] Less serious pressure ulcers cost $20,000 to $30,000 to heal.[18,19] Fogerty and colleagues recently estimated the annual cost of treating medical PUs to be between 5 billion and 8.5 billion dollars.[20] The cost of hospital-acquired PUs has been estimated to be between 2.2 and 3.6 billion dollars.[21] These costs were the impetus for the Center for Medicare and Medicaid Services (CMS) to change their regulations on reimbursement for pressure ulcers that are formed during hospitalizations. In 2008, CMS classified PUs as preventable hospital acquired conditions, and therefore, are no longer eligible for added insurance reimbursement that had been available in the past. It is in the best interest of the health care system, which includes trauma systems, to determine as early in a hospital stay as possible if a patient is at risk for PU development so that early intervention can take place. Not only are PUs important for patient safety, health and quality of life, but are cost burdens on the health care system. For example, a person with SCI who develops a sacral PU prior to admission to acute rehabilitation may have to postpone rehabilitation due to the necessity to avoid any further damage by pressure to the sacral region.

From our research with able bodied individuals strapped to a backboard, we know that the pressure on the sacral region is at a level (>60mmHg) where a person is at risk for pressure development. What we do not know is if our findings translate into the real world with persons who are transported on a backboard from the scene of the accident. It is assumed that a relationship exists between transport on a backboard and pressure ulcer development in persons with traumatic SCI, however, there is no published research assessing this relationship.

One recent study developed a risk profile for hospital-acquired pressure ulcers and found that of 111 patients with PUs, 20.7% had suspected deep tissue injury (SDTI), and 43% of those were transported on a backboard.[19] The researchers also found that the odds of a PU not healing by discharge is increased 15-fold in persons with SCI compared to patients without SCI. This emphasizes the importance of determining if transport on a spine backboard is related to the risk of PU development. If we can determine a relationship between total time spent on a backboard, then preventive measures can be implemented, such as a pressure reducing backboard in all EMS transport vehicles, to eliminate or at least reduce this risk for PU development.

This study will directly address Ohio EMS grant program Priority 4 by researching the causes, nature, and effects of PU formation in individuals with traumatic SCI. The outcomes from this study will provide new knowledge that will directly educate the public, EMS workers and clinicians about injury prevention. In addition, this project will be the catalyst for our continued development of a pressure relieving backboard that would be cost effective and clinically beneficial to patients.

The Study's Objective is: To assess the relationship of time spent on a spine and the development of pressure ulcers in persons with traumatic SCI.
In addition Sex, Race, Smoking Status, Type II Diabetes Status and AIS were also evaluated as independent variables in the generation of PU

Methods
This is an observational study using administrative databases; patient electronic medical records and the Ohio EMSIRS data points collected through the Northern Ohio Trauma System (NOTS). The project followed newly injured patients from EMS deployment through their discharge from MetroHealth Rehabilitation Institute of Ohio.

Sample
During the project year, 263 traumatic SCI cases were screened for study inclusion. Of those, 49 were brought to the ED at MHMC on a standard backboard and subsequently were admitted to the MetroHealth Rehabilitation Institute of Ohio (MRIO). Those who did not meet study inclusion included, not transported on a backboard, not a traumatic spinal cord injury, under the age of 18, or were admitted to MHMC rehabilitation from an outside acute care hospital more than 24 hours post injury.

Measures
To reach the study objective we collected independent measures of patient demographic data, injury clinical data, and amount of time on the backboard. These measures were from patients' electronic medical record (EMR) and the Northern Ohio Trauma System's (NOTS) database (the NOTS database includes the state of Ohio's EMSIRS data from the Cleveland EMS system for patients going to either MetroHealth System or the Cleveland Clinic Foundation System). The main outcome measure for the study is development of a PU and was recorded through abstracted from nursing and wound nursing notes in patients' EMR.

Subject Characteristics: Age, gender, race, weight, height, BMI, and injury etiology were documented. Age was recorded as number of years, sex a binomial measures (0=male; 1=female), race a four category measure (0=Caucasian, 1=African-American, 2=Hispanic, and 3=Other), height in inches and weight in pounds. The subject characteristics were abstracted from subjects' electronic medical record (EMR).

Clinical Measures: Type of ICU bed/mattress; type of bed/mattress on the surgical floor, type of rehabilitation bed/mattress; Level of Injury (Complete Tetraplegia, Incomplete Tetraplegia, Complete Paraplegia, Incomplete Paraplegia), ASIA Impairment Scale (AIS), BMI, smoker, and having type II diabetes. These measures were abstracted from patients' EMR.

Time on Backboard: Time on the backboard during transport was recorded from the NOTS database. These included: Amount of time at the scene, Amount of enroute time to MHMC ED; Scene time to arrival at a hospital outside of MH and time from outside hospital to MHMC ED. Time on the backboard in the ED was determined by time of arrival to the MHMC ED and time taken off the backboard, which is recorded on the ED's Nursing Flow Sheet.

Pressure Ulcers: Superficial skin damage was assessed through direct observation and palpation by nurses at admission to the ED, on Day 1 of admission to MHMC, Day 2, Day 3 and then every week for up to 4 weeks or until discharge from MRIO. Changes in the skin and the presence of a PU will be abstracted from nursing notes and the Wound Care Clinical Nurse Specialist notes and then documented on study data logs. Pressure ulcers will be graded according to the 2007 conclusions of the National Pressure Advisory Panel.[23] Each pressure ulcer will be graded and designated as Stage I, Stage II, Stage III, Stage IV, deep tissue injury, and unstageable.

Analysis

Analysis consisted of descriptive statistics, such as frequencies, means, and standard deviations. Chi-square tests for independence were performed to explore the associations among categorical level measures (e.g. sex, race) and pressure ulcer development (yes/no). T-tests were conducted to examine continuous level variables to determine differences between those with and without pressure ulcer development.

For patients missing Scene and Enroute time, the sample mean was used as a replacement.

Results

Table 1 shows the demographic statistics of the study sample. Eight-two percent of the sample was male, 59 percent were White and the median age was 46.7 years old.

Table 1. Sample Demographics (N = 49)

Characteristic	**Percent (n)**	
Sex		
Female	18.4 (9)	
Male	81.6 (40)	
Race		
Black	36.7 (18)	
White	59.2 (29)	
*Missing	4.1 (2)	
	Mean	**SD**
Age	46.7	19.9

*The information was not found documented in patients' EMR.

Table 2 displays the characteristics of the clinical measures used in the study. Sixteen percent of patients had a diagnosis of Type II Diabetes and 30.6% of the sample was a current smoker. The mean Body Mass Index (BMI) score was 27.1, which is defined as overweight. Seventy-five percent of patients were Incomplete injuries; as defined by the American Spinal Injury Score (B, C, & D). Eighteen percent of patients developed a pressure ulcer (PU) during their hospitalizations. One PU was noted in the Emergency Department, five new PUs developed during the ICU stay and seven new PUs were documented during acute rehabilitation.

Table 2. Clinical Measures (N = 49)

Clinical Measures	**Percent n**	
Type II Diabetes		
Yes	16.3 (8)	
Smoker		
Yes	30.6 (5)	
American Spinal Injury Score		
A	24.5 (12)	
B	2.0 (1)	
C	26.5 (13)	
D	46.9 (23)	
Pressure Ulcer (PU) at Admit to Emergency Department	1	
New PU During ICU Stay	5	
New PU During Acute Rehabilitation	7	
Total number of patients who developed a PU at some time from ED through acute rehabilitation	18.4 (9)	
	Mean	**SD**
BMI	27.1 (overweight)	5.0
Scene Time	18.1 min.	10.7
Enroute Time	14.1 min.	8.5
Time on Backboard (BB) in ED	8.7 min.	5.4
Total Time on BB	43.1 min.	23.0

The total mean time patients spent on a backboard (BB) was 43 minutes. The total mean time spent on a BB from admission to the ED and being taken off the BB was 8.7 minutes. Table 3 displays the results determining if there were statistically significant differences in time on a backboard and developing a PU during hospitalization. No significant differences in mean time on a backboard between those who developed a PU and those who did not were found.

Table 3 T-Test for Differences Between Time on the Backboard and Pressure Ulcer Development During Hospitalization (N = 49)

	t	**95% Confidence Intervals**		**Sig**
Time		Lower	Upper	
Scene Time	.240	-8.8	14.6	.621
EnRoute Time	.108	-5.0	6.5	.803
In ED Time	.258	-3.7	3.6	.964
Total Time	.380	-12.6	18.5	.706

Table 4 describes the Chi-Square statistic for categorical variables and pressure ulcer development. No statistically significant differences were found for sex, race, ASIA scale, smoking status or Type II diabetes status and pressure ulcer development during ICU or rehabilitation status.

Table 4 Chi-Square Test for PU development by Sex, Race, Smoking Status, Type II Diabetes Status and ASIA (N = 49)

	Chi-Square	**Sig**
Characteristic		
Sex	.466	.497
Race	.311	.577
ASIA	6.2	.103
Smoking Status	.280	.597
Type II Diabetes Status	3.4	.070

Table 5 displays the T-Test results for continuous patient characteristics and pressure ulcer development. No statistically significant results were found between age and BMI and pressure ulcer development during ICU stay or rehabilitation stay.

Table 5 T-test for Differences in Age and BMI Between Patients With a Pressure Ulcer and Patients Without a Pressure Ulcer (N = 49)

	t	**95% Confidence Intervals**		**Sig**
PU During ICU Stay		Lower	Upper	
Age	-.501	-16.7	10.1	.619
BMI	-.743	-2.1	4.6	.461

Limitations of the Study

No available data on time spent on the Operating Room table, which may or may not have special support surfaces (gel mat, foam). Data may be available, but the Anesthesia records are not integrated / do not interface currently with the main MH EMR system. There are plans this year, however, of integrating Anesthesia records to the main EMR, which will further improve patient management. This will reveal missing data pertaining to time spent supine on the OR table, which may also contribute to the development of PU.

Documentation of PUs in the patient's EMR was inconsistent and at times missing pertinent information about skin integrity, such as, blanching status and stage of PU. As a result, we may have missed PUs that existed or the timing of the PU may have been mislabeled. For example, the PU may have begun in the ICU, but was first documented in Rehabilitation.

Conclusion

We did not find any relationship between pressure ulcer development and time on a backboard with this patient population. One reason why our studies findings do not support laboratory studies of backboard pressure and PU development maybe due to the development of the Northeast Ohio Trauma System, which has protocols for triaging patients to appropriate EDs for care. This has reduced transport time to Trauma Centers. Also most of these patients came

from an urban setting with short transport times. A second reason is that the MetroHealth Trauma Department recently developed a Spine clearance protocol; the patients do not need to be on the board while they undergo multiple imaging studies for their spine evaluations. Therefore, patients brought into the ED are to be removed from the backboard as soon as possible. As a result, the average time spent on the backboard in the ED is only 8.7 minutes. A recent study by Cooney and colleagues documenting time of patients coming into the ED of a level 1 trauma center found that the average time on the BB in the ED was 33 minutes and Total Time on the Backboard was 54 minutes.[25] We are far below this study's averages for time on a backboard.

Recommendations

Our recommendation for the State is to investigate if Trauma Centers across the state of Ohio have a Spine protocol for when to expeditiously take a patient off the backboard in the ED. If Spine protocols are not in place then we need to determine why this is the case and encourage all Trauma Centers to initiate such protocols.

To continue quality improvement of care to prevent pressure ulcers, standardized documentation forms and language describing skin integrity need to be developed. The expansion of electronic medical records across institutions should also pave the way for earlier identification of high risk patients, allowing the provider to monitor the patients' progress over time, and thereby improving the overall delivery of care.

References

1) McGuire RA Jr. Protection of the unstable spine during transport and early hospitalization. Journal of Mississippi State Medical Association 1991;32:305-308.

2) Trauma CO. Spine and Spinal Cord Trauma. Advanced trauma Life Support for Doctors. Student Course Manual. 6th ed. Chicago, IL, ACS: 215-242, 1997.

3) Brunette D, Rockswold G. neurologic recovery following rapid spinal realignment for complete cervical spinal cord injury. J Trauma 1987;27:445-447, 1987.

4) Burney RE, Waggoner R, et al. Stabilization of spinal injury for early transfer. J Trauma-Injury Infection & Critical care 1989;29:1497-1499.

5) Linares HA, Mawson AR, et al. Association between pressure sores and immobilization in the immediate post-injury period. Orthopedics 1987;10: 571-573.

6) Mawson AR, Biumdo JJ Jr., et al. Risk factors for early occurring pressure ulcers following spinal cord injury. Am J Phys Med & Rehabil 1988;67:123-127.

7) Chan D, Goldberg R, et al. The effect of spinal immobilization on healthy volunteers. Ann Emerg Med 1994;23:48-51.

8) Wilczweski, P; Grimm, D; Gianakis, A; Gill, B; Sarver, W; McNett, M. Risk Factors Associated with Pressure Ulcer Development in Critically Ill Traumatic Spinal Cord Injury Patients. Journal of Trauma Nursing. 19(1):5-10, January/March 2012.

9) Garber SL, Rintala DH. Pressure ulcers in veterans with spinal cord injury: a retrospective study. J Rehabil Res Dev 2003;40(5):433-41.

10) Factors predicting pressure ulcers in veterans with spinal cord injuries. Smith BM, Guihan M, LaVela SL, Garber SL. Am J Phys Med Rehabil 2008;87(9):750-7.

11) Husain T. An experimental study of some pressure effects on tissues, with reference to the bed-sore problem. J Pathol Bacteriol 1953;66(2):347-58.

12) Kosiak M. Etiology of decubitus ulcers. Arch Phys Med Rehabil 1961;39:19-28.

13) Lerner EB, Moscati R. Duration of patient immobilization in the ED. Am J Emerg Med 2000;18:28-30.

14) Cordell WH, Hollingsworth JC, Olinger ML, Stroman SJ, Nelson DR.Pain and tissue-interface pressures during spine-board immobilization. Ann Emerg Med 1995;26(1):31-6.

15) Boulet M, Nemunaitis G, Kaufman B, Clark G, Bogie K. Effect of a liner on the Dispersion of Backboard Interface Sacral Skin Pressures. J Spinal Cord Med. 2007;30(2):195.

16) Boulet M, Nemunaitis G, Kaufman B. Nagy J, Clark G, Buzanowska K. The effect of a liner on the dispersion of backboard interface sacral skin pressures. J Spinal Cord Med 2008;31(2):224.

17) National Pressure Ulcer Advisory Panel. Pressure ulcers prevalence, cost, and risk assessment: Consensus development conference statement. Decubitus 2 (1989): 24-8.

18) U.S. Department of Health and Human Services, Public Health Service. Proceedings of the first colloquium on preventing secondary disabilities among people with spinal cord injuries, edited by P.L. Graitcer and F.M. Maynard. Alanta:Centers for Disease Control, 1990.

19) Alderden J, Whitney JD, Taylor SM, Zaratkiewicz. Risk Profile Characteristics Associated With Outcomes of Hospital-Acquired Pressure Ulcers: A Retrospective Review. Crit Care Nurse 2011;31:430-443.

20) Fogerty MD, Aburad NN, Nanney L, Arbogast PG, Poulose B, Barbul A. Risk factors for pressure ulcers in acute care hospitals. Wound Repair Regen. Jan-Feb 2008:16(1):11-8.

21) Whittington KT, Briones R. National Prevalence and Incidence Study: 6-year sequential acute care data. Adv Skin Wound Care. Nov=Dec 2004:17(9):490-4.

22) Ohio Trauma Registry, Division of Emergency Medical Services, Ohio Department of Public Safety, 2005. Queried in March 2012.

23) National Pressure Ulcer Advisory Panel. Pressure Ulcer Stages Revised by NPUAP, 2007. Reviewed at http://www.npuap.org/pr2.htm on March 2, 2012.

24) Consortium for Spinal Cord Medicine, Clinical Practice Guidelines May 2008. Early Acute Management in Adults with Spinal Cord Injury: a Clinical Practice Guideline for Health Care Professionals. Paralyzed Veterans of America.

25) Cooney DR, Wallus H, Asaly M, Wojcik S. Backboard time for patients receiving spinal stabilization by emergency medical services. Interntional J Emerg Med 2013, 6(17): 1-3.

Fiscal Report

Based on a report completed by Linda Carnivale, Research Business Analyst in MetroHealth's Research Administration Business Office, all funds were expended as budgeted, as shown below.

Personnel	Role	Effort	Budget (salary only)	Actual (salary only)	Variance
Melvin Mejia, MD	PI	12.75%	22,595	22,425.12	169.88
Gregory Nemunaitis, MD	Co-Inv.	3%	6,229	6,806.88	(577.88)
Mary Joan Roach, PhD	Proj. Mgr.	35%	32,693	32,820.75	(127.75)
Michael Nowak, PhD	Data Mgr.	3%	2,483	2,482.97	0.03
TOTALS:			**$ 64,000**	**$ 64,535.72**	**(535.72)**
Note: deficit will be covered by grantee, in addition to fringe (approx. $16,661) and F&A ($34,880) that was not allowable on grant and was budgeted in-kind.					