A RETROSPECTIVE STUDY TO DESCRIBE THE USE OF THE RICHMOND AGITATION SEDATION SCALE (RASS) FOR ASSESSING SEDATION IN THE TRAUMATIC BRAIN INJURED PATIENT

by

Andrea Jullette-Fantigrassi

A PRACTICE INQUIRY Submitted to the Faculty of the

COLLEGE OF NURSING

In Partial Fulfillment of the Requirements
For the Degree of

DOCTOR OF NURSING PRACTICE

In the Graduate College

THE UNIVERSITY OF ARIZONA

2 0 1 3

THE UNIVERSITY OF ARIZONA
GRADUATE COLLEGE

As members of the Scholarly Project Committee, we certify that we have read the Practice Inquiry prepared by Andrea R. Jullette entitled A Retrospective Study to Describe the use of the Richmond Agitation Sedation Scale (RASS) for Assessing Sedation in the Traumatic Brain Injured Patient and recommend that it be accepted as fulfilling the Practice Inquiry requirement for the Degree of Doctor of Nursing Practice

_____Date:
Leslie Ritter, PhD, RN Professor

_____Date:
Matthew J. Gallek, PhD, RN,CNRN, Assistant Professor

_____Date:
Ted S. Rigney, PhD, ACNP-BC, FAANP, Clinical Associate Professor

Final approval and acceptance of this practice inquiry is contingent upon the candidate's submission of the final copies of the practice inquiry to the Graduate College.

I hereby certify that I have read this practice inquiry prepared under my direction and recommend that it be accepted as fulfilling the practice inquiry requirement.

_____Date:
Practice Inquiry Director: Leslie Ritter, PhD, RN Professor

\

STATEMENT BY AUTHOR

This practice inquiry has been submitted in partial fulfillment of requirements for an advanced degree at The University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

SIGNED: Andrea R Jullette-Fantigrassi

ACKNOWLEDGEMENTS

This has been a long and arduous journey, one I could not have completed without the love, support and encouragement of family and friends. I would like to sincerely thank my husband, Michael, for talking me down off the ledge on numerous occasions and providing me with the strength I needed when I could not find my own. My mother, JoAnn, for her insight, wisdom, love and support. My father, Dale, though you aren't here to celebrate this great accomplishment with me today it was your life lessons and instilled fortitude that made this possible. And finally I would like to thank my closest and dearest friends for all of their support and most importantly the laughs that kept me sane.

I would like to extend my gratitude to my committee for all of the hard work and time they invested in my education over the years, specifically Leslie Ritter, Ted Rigney and Matthew Gallek. Your guidance and experience were essential to obtaining my doctoral degree. A special thanks to Curtis Bey for assisting with the statistical portion of my project inquiry, you are a life saver. I would also like to thank Karla Baning, a wonderful friend and colleague whose support and knowledge were vital in reaching my educational goals.

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Background: Traumatic brain injury (TBI) patients are often sedated, yet sedation assessment scales have not been thoroughly studied in this population. This project inquiry describes the use of the Richmond Agitation Sedation Scale (RASS) in assessing sedation in TBI patients.

Methods: A retrospective, descriptive analysis of 38 ventilated, sedated TBI patients was performed to describe 1) the characteristics of the study TBI population, 2) the use of the RASS to guide titration of sedation medication, and 3) the nursing perspective of a sedation titration protocol that includes the use of the RASS.

Results: Prescribed RASS score for the study population was -2; the actual RASS score was -2.04 +/-1.05. The days spent on mechanical ventilation were 3.46 +/- 1.95. The Injury Severity Score (ISS) correlated with sedation titration ($r = -0.373$; $p<.05$). The ICD-9 code also correlated with the RASS ($r = -0.400$; $p <0.05$). There was no correlation between RASS and sedation titration ($r = -0.061$; $p = 0.717$). The majority of nurses perceived that when using the RASS, sedation level did not affect their feeling of accuracy of neurological assessment (56%), and the patient's agitation level did not affect their feeling of accurate neurological assessment (58%).

Conclusion: While the degree of injury was associated with the ability of the TBI patient to maintain the prescribed RASS level, there was no association between the RASS score and sedation titration, indicating that in this small study, the RASS did not guide sedation titration in the TBI population. However, the time spent at the prescribed RASS level and days of mechanical ventilation, which was similar to reported norms, suggest that the RASS is an adequate tool for assessing sedation in the TBI population. From the nursing perspective, the use of the RASS was not a barrier in assessing sedation titration. To our knowledge, this is the first study to describe the use of RASS for assessment of sedation in TBI patients. Additional prospective studies are necessary to fully understand the ability of the RASS to guide sedation titration.

CHAPTER ONE: INTRODUCTION

Background and Significance

Traumatic brain injuries (TBI) have a significant impact on the health of United States population and our healthcare resources. Annually 1.7 million people suffer a TBI in the United States. Of these, 275,000 are hospitalized, 1.36 million are treated and released and 52,000 will be fatal (Faul, Xu, Waid, & Coronado, 2010). TBI is associated with one-third of injury related deaths in the United States. 100,000 TBI patients will have long term deficits with 2%, or 5 million, of the U.S population requiring permanent assistance to perform activities of daily living (International Brain Injury Association, 2011).

Fiscal Impact

The research produced by Faul et al. (2010) estimates that the United States spends 60 billion dollars annually, 31.7 billion in hospitalization costs and another 16.6 billion in costs associated with fatalities of TBI patients. The total cost associated with acute care and rehabilitation of TBI patients, without consideration for indirect cost to families, is approximately 9 to 10 billion annually. A person suffering a TBI can incur over 4 million dollars in medical costs over their lifetime. Because TBI does not often result in spontaneous death the cost of dying from a TBI can be exorbitant, reaching 454,000 dollars in medical bills for the surviving family members to endure (Faul et al., 2010; International Brain Injury Association, 2011; Roozenbeek, Mass, & Menon, 2013).

Age

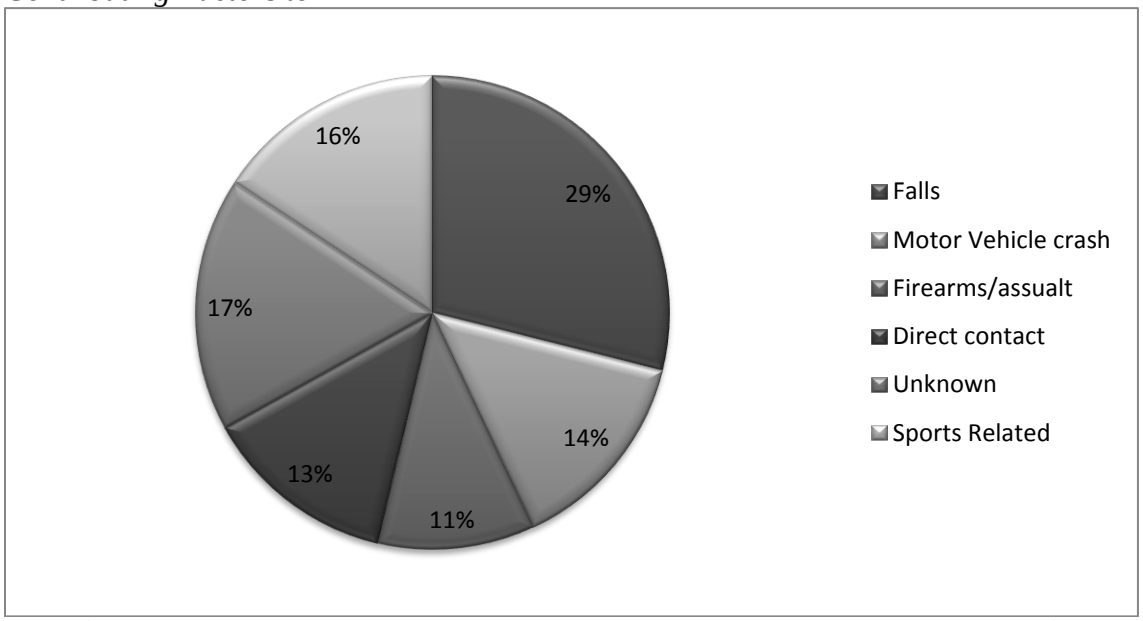
Adults 75 years old or greater and male children age 0-4 account for the majority of hospitalizations and deaths as a result of TBI (Faul et al., 2010; Roozenbeek et al., 2013). TBI

has the highest occurrence among the very young, adolescent, and the old with the majority of injuries occurring at ages 0-4, 15-24, and 60 or greater (Langlois, Rutland-Brown, Marlena, & Rosenthal, 2006) .

Contributing Source of Injury

Falls are the leading cause of TBI accounting for 35% of hospitalizations and motor vehicle crashes are the leading cause of death from TBI accounting for 17% of hospitalizations (Figure 1). Firearms and assault attribute to 13% of all TBI. Direct contact to the face or skull account for 16% of TBI related injuries. Unknown etiology of the TBI patients accounts for 21% of the TBI population (Faul et al., 2010). Approximately 18-19.2% of TBI are sports related, with winter sports such as skiing or ice skating, accounting for the greatest number of TBI (Langlois et al., 2006; International Brain Injury Association, 2011).

Figure 1
Contributing Factors to TBI



Adapted from Langlois, J. A., Rutland-Brown, W., Marlena, M., & Rosenthal, M. (2006). The epidemiology and impact of traumatic brain injury: A brief overview. *Journal of Head Trauma and Rehabilitation*, *21*(5), 375-378.

Clinical Problem

Sedatives and analgesics are utilized routinely among critical care patients in an effort to minimize the physiological stress response, provide anxiolysis, facilitate ventilation, and expedite care. Patients that suffer a TBI represent a subset of critical care patients that may require sedation. Many patients with TBI require sedation to provide nursing care, perform invasive medical procedures, optimize mechanical ventilation, and facilitate cerebral perfusion. The improper use of sedatives in this population can have adverse effects and worsen the neurological injury (Diawai, Thoyre, & Auyong, 2007).

The Society of Critical Care Medicine established clinical practice guidelines for the use of sedatives and analgesics based on the premise of optimal sedation with minimal consequence. It is their recommendation that all critically ill patients be assessed regularly for pain and sedation and that all medications be titrated to a pre-approved sedation level to maintain light levels of sedation, unless clinically contraindicated (Barr et al., 2013; Jacobi et al., 2002). Sedation scales were developed to provide such a guide for sedation titration.

The use of sedation scales has not been adequately evaluated among the TBI populations. In fact TBI patients have been specifically stated as exclusionary criterion in previous research seeking to quantify the effectiveness of sedation scales. The TBI population is a subset of critical care patients that presents with unique challenges for sedation and agitation assessment. To assume that data collected regarding the effectiveness of sedation scales can be transferred to this population is a dangerous approach given the propensity to increase morbidity and mortality through improper sedation administration among this population. Demonstrating that a sedation scale is usable in this population would be useful in guiding sedation and decreasing injury.

The pathophysiology of TBI can be greatly influenced by sedation titration, leading to increased morbidity and mortality. Patients with TBI represent a subset of critical care patients at increased risk for sedation-related complications. Patients suffering TBI present with neurotransmitter dysfunction which may result in cognitive, sensory, or motor function impairment. The physiological effects of neurotransmitter dysfunction often makes the use of sedative agents necessary as well as complicates the ability to assess sedation and agitation. The goal of sedation in the TBI patient is to prevent secondary neuronal injury related to increased intracranial pressure (ICP) or insufficient cerebral perfusion pressure (CPP) and provide comfort while preserving an intact neurological assessment which remains the gold standard for assessing neurological decline (Rhoney & Parker, 2001).

The use of sedative agents in this population facilitates mechanical ventilation and decreases ICP. However, over-sedation causes systemic vasodilation and decreased cerebral blood flow. This in turn increases tissue infarction and neurological damage which results in expansion of the secondary injury (Rhoney & Parker, 2001). Under-sedation results in increased cerebral blood flow (CBF) and cerebral metabolic oxygen consumption (CMRO2) causing increased ICP, CPP, and tissue infarction (Rhoney & Parker). Medication titration must be done cautiously and with the idea of a predetermined sedation level of a sedation assessment scale (Rhoney & Parker).

Improper sedation administration effects cerebral metabolism and intracranial elasticity by changing cerebral vasculature and blood flow which results in decreased CPP, increased ICP, and neuronal death. Understanding the elaborate interactions of sedatives on cerebral physiology is imperative in guiding the use of these medications in this vulnerable population.

Sedation Scales

Evidence based guidelines for the use of sedation among the acutely ill has been published by the American College of Critical Care Medicine and Society of Critical Care Medicine to guide therapies (Barr et al., 2013). Sedation scales are bedside tools used to determine the level of sedation a patient is exhibiting. They allow for medication titration to achieve a preset sedation goal. Sedation scales were formulated to improve sedation related complications. The Society of Critical Care Medicine found that sedation scales allow for improved communication between nurse and physician as well as decreased ventilatory times, tracheostomy necessity, shortened length of stay, and lower hospital costs (Sessler et al., 2002). The clinical practice guidelines published by the Society of Critical Care Medicine have recommended the use of the Richmond Agitation Sedation Scale (RASS) and the Sedation Agitation Scale (SAS) as the most valid and reliable scales for assessing sedation in critically ill patients (Barr et al., 2013). For the purpose of this practice inquiry only the RASS will be discussed.

The RASS is the most tested subjective scale available for assessing sedation among sedated and ventilated patients (Osterman et. al, 2002; Maj et al., 2005; Sessler, Grap, & Ramsay, 2008). The RASS was developed by a multidisciplinary team consisting of critical care physicians, nurses and pharmacists in an effort to create an optimal sedation assessment tool (Sessler et al., 2002). The RASS has established reliability and validity for monitoring sedation among critically ill patients (Sessler et al., 2002). Current research has tested the RASS for inter-rater reliability and validity in many critical care settings (Akgun & Siegal, 2007; Sessler et al. 2008). However, and of great significance to this project, the majority of studies researching

sedation scales specifically list TBI as an exclusionary criterion, reasons for exclusion were not offered (Grap et al., 2003; Robinson et al., 2008; Sessler et al., 2008). A single study performed by Sessler et.al. (2002) utilized neuroscience intensive care (NICU) patients among the populations tested for the RASS inter-rater reliability. However, the effectiveness of the RASS to assess sedation among the NICU populations compared to general medical intensive care patients was not specifically addressed in this study.

A study performed by Joseph Zambramski (2009) known as the Sedation Protocol in Neurologic Injury (SPIN) utilized the RASS tool to assess sedation in the TBI population. The focus of the SPIN study was to evaluate the implementation of a sedation protocol among TBI patients, the RASS was chosen for this study as it was the accepted sedation assessment tool for critically ill patients at the study institution. The SPIN study was the database used for this practice inquiry and will be discussed in further detail in chapter 2.

Knowledge Gap

The use of sedation scales to assess sedation has been tested among general medical surgical populations and some scales have demonstrated good inter-rater reliability and validity, specifically the RASS. However this scale has not been well tested among the TBI population. This practice inquiry seeks to describe the use of the RASS among a TBI population and address the existing gap in knowledge. The need to identify a sedation assessment tool that is effective in this population is necessary to decrease morbidity and mortality among TBI populations. The RASS incorporates levels of sedation and agitation into the assessment and has demonstrated reliability and validity among other critically ill populations, suggesting that this tool would be optimal for assessing the traumatically brain injured patient.

Purpose and Specific Aims

The use of sedation scales has not been well described in the TBI population. The overall purpose of this practice inquiry is to describe the use of the RASS in a TBI population. The data collection source is the previously described SPIN study. A retrospective descriptive study design utilizing secondary analysis of the previously collected data of the SPIN study will be conducted to:

1) Describe the characteristics of the study TBI population, to include ICD-9 code, age, gender, ethnicity, alcohol and drug use, length of intensive care stay, and Injury Severity Score (ISS).

2) Describe the use of the RASS to guide titration of sedation medication in this population as measured by percent of time spent within the prescribed RASS level, sedation titration in accordance with the RASS, and days of mechanical ventilation.

3) Describe the nursing perspective of a sedation titration protocol that includes the use of the RASS, as measured by the perception of accuracy of neurologic assessment of sedation and agitation.

The findings of this study will serve to guide future practice in establishing an optimal sedation assessment scale among TBI patients that will reduce long term complications and the fiscal strain associated with secondary brain injury.

Significance to Advanced Practice

The Advanced Practice Nurse (APN) is responsible for providing care throughout the continuum for the TBI populations. Despite education and increasing safety awareness the number of patients presenting with TBI increases annually (Faul et.al, 2010). The Acute Care

Nurse Practitioner will be responsible for managing sedation and should be cognizant that their practice can greatly affect the morbidity and mortality of this population. Understanding the complexity of the pathophysiology in relation to sedation medication is essential to preventing sedation related secondary brain injury in TBI patients. Employing a sedation scale to guide titration may be an effective way to reduce sedation related injury in TBI populations. Identifying a sedation scale that has been proven to be reliable and valid among this complex population is imperative to reducing sedation related injury and improving outcomes of our TBI populations.

CHAPTER TWO: LITERATURE REVIEW

Introduction

For decades the desire to alleviate pain has been the driving force of medical advancement. The use of anesthetics and sedatives have been documented throughout history, evidence of the opium poppy seed as medicinal treatment has been found as far back as 4200 B.C. (Dray, 2012). The use of herbs and opium is documented in early European history as a way to alleviate pain and induce stupor. The 19th century introduced the use of nitrous oxide and similar inhalants to induce sedation, until this time persons requiring surgical intervention often chose death over the pain and psychological trauma of surgery (Dray, 2012). The 20th century continued to bring further medical advancement in anesthetic and sedative medication and techniques while the 21st century strives to achieve maximal benefits of sedation while minimizing adverse effects (Dray, 2012).

Pathophysiology

The pathophysiologic cascade of TBI can be greatly influenced by improper sedation titration, causing increased neuronal death which leads to increased morbidity and mortality. Patients suffering TBI present with cognitive, sensory, and motor function impairment that makes the use of sedative agents necessary. The goal of sedation in the TBI patient is to prevent secondary neuronal injury related to increased intracranial pressure (ICP) or insufficient cerebral perfusion pressure (CPP) and provide comfort while preserving an intact neurological assessment which remains the gold standard for assessing neurological decline (Rhoney & Parker, 2001).

The cranium is a non-expandable, hollow, bony structure that encompasses and protects the brain. The cranial vault consists of 10% blood, 10% cerebral spinal fluid (CSF), and 80% brain tissue, each of these components contribute to intracranial pressure (ICP; Porth, 2005; Kumar, Abul, & Fausto, 2005). A normal ICP is 0-15mmHg and continually fluctuates with respiration and activity, this fluctuation is possible because of reciprocal compensation of the cranial components; a minimal increase in one component will result in a decrease in one or both of the other components. Blood and CSF are the primary compensatory mechanisms, brain tissue has little mechanism for change (Porth, 2005). Increase in ICP is buffered by movement of CSF into the spinal subarachnoid space and by increased absorption. The cerebral vasculature constricts in response to rising ICP to move blood out of the venous bed and back into circulation. Variations in any of the three components that exceed the compensatory mechanisms ability to balance pressure will elevate the ICP; once these mechanisms have failed small changes produce extensive alterations in ICP (Porth, 2005; Kumar et al., 2005).

Brain injuries can be separated into 2 categories, primary and secondary injury. Primary injury is the cerebral damage that occurs during the initial impact. The primary injury results in displacement of cerebral structures related to active hemorrhage, this is known as the core ischemic zone (Corte, n.d.). The core ischemic zone has a blood flow below 10-20% of normal, resulting in rapid tissue ischemia and cellular death. Brain tissue in this zone is generally unsalvageable regardless of intervention; once a neuron has died it cannot be regenerated. The area of secondary injury in TBI is known as the penumbra, which lies between well perfused brain tissue and the core ischemic zone. The penumbra is fed by collateral blood vessels and has the potential to maintain viability if adequate perfusion and oxygenation is supplied to the area.

The penumbra is very sensitive to fluctuations in cerebral metabolic oxygen consumption (CMRO2) and cerebral blood flow (CBF). Small variations of these parameters will propagate ischemia-induced biochemical events and result in expansion of the penumbra. Ischemia and death of neuronal tissue effects communication among neurons resulting in neurotransmitter dysfunction and variable physical, cognitive and emotional deficits based on the area of the brain effected. Ischemia that occurs early in the injury phase is associated with poor outcomes and increased mortality (Corte, n.d; Kumar et al. 2005; Porth, 2005).

The use of sedative agents in this population facilitates mechanical ventilation and decreases ICP. However, over-sedation causes systemic vasodilation and decreased CBF increasing tissue infarction and neurological damage which results in expansion of the secondary injury (Jacobi et al., 2002). Under-sedation results in increased CBF and CMRO2 consumption causing increased ICP, CPP, and tissue infarction (Rhoney & Parker, 2001). The Brain Trauma Foundation & American Association of Neurological Surgeons (2010) published guidelines for the management of severe traumatic brain injury which recognized the beneficial effects of sedatives on TBI as well as the detrimental effects of inappropriate administration. The guidelines support the use of sedatives despite the lack of research demonstrating positive affect on long term outcomes and caution practitioners to utilize these medications with close consideration of the potential for undesirable side effects that contribute to secondary injury. Medication titration must be done cautiously and with the idea of a predetermined sedation level of a sedation assessment scale (Barr et al., 2013).

Medications utilized for sedation effect cerebral metabolism and intracranial elasticity by changing cerebral vasculature and blood flow. Improper titration of these medications results in

decreased CPP, increased ICP, and neuronal death (Rhoney & Parker, 2001). Understanding the elaborate interactions of sedatives on cerebral physiology is imperative in guiding the use of these medications in this vulnerable population.

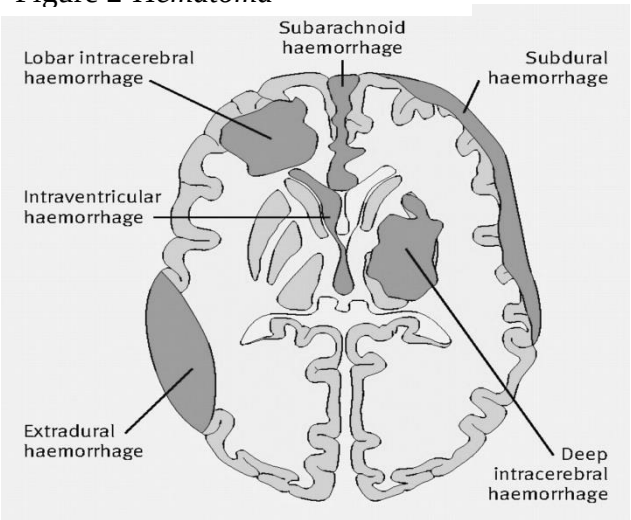
The formidability of assessing sedation in TBI populations stems from the pathophysiologic process. Neurological injury effects a patient's presentation in a multitude of ways depending on the site of injury. The ability to present calmly, maintain eye contact or follow commands may be impaired by neurological dysfunction which could affect the ability of sedation scales to accurately assess sedation in this population.

Types of Traumatic Brain Injury

For the purpose of this project inquiry 3 subtypes of TBI will be discussed; concussion, hematoma, and diffuse axonal injury (DAI). A concussion is defined as a transitory disruption of brain function with or without an associated loss of consciousness (Porth, 2005). Concussive patients generally recover within a 24hr period but may experience ongoing pathologic symptoms of headache, vertigo, and memory impairment for weeks to months (Porth, 2005).

Hematomas include subarachnoid (SAH), subdural (SDH) and epidural hematoma (EDH) (Figure 2). Hematomas are the result of vascular injury and extravasation, the degree and location of the active extravasation are the determining factors of the presenting neurological deficit. The differentiation of SAH, SDH, and EDH is based on the extra-axial or meningeal space in which the

Figure 2-*Hematoma*



Adapted from the web Brain and Spine Institute (2010)http://www.bing.com/images/search?q=extra+axial+hemorrhage&FORM=HDRSC2#view=detail&id=D14A292A81E9B2A9A5390C3142AB5F50297E2BB9

bleeding occurs (Porth, 2005). Traumatic hematomas may present with headache, confusion, somnolence, seizures, and focal neurological deficits and may progress to respiratory depression, coma and death without intervention (Papadakis & McPhee, 2013).

DAI is a global injury that occurs throughout the parenchymal tissue, known as shearing. DAI often presents as a global brain injury encompassing many lobes of the brain, neurons are stretched and severed as a result of accelerating/decelerating forces (Papadakis & McPhee, 2013). Severe DAI is the leading cause of death among TBI related injury (Brain and Spinal Cord Organization, 2012). DAI ranges from mild to severe and often present as a persistent loss of consciousness and coma with the severe DAI patient remaining in a vegetative state or progressing to brain death (Papadakis & McPhee, 2013).

The International Classification of Diseases ninth edition, or ICD-9, was utilized for the purpose of classifying the type of TBI presenting for the SPIN study. Three ICD-9 codes were utilized for the purpose of the SPIN study and therefore the purpose of this practice inquiry, ICD-9-CM 850, ICD-9-CM 852, and ICD-9-CM 853 (World Health Organization, 2013). ICD-9 code 850 includes TBI's quantified as concussion. ICD-9-CM 852 categorizes SDH/SAH/EDH and ICD-9-CM 853 encompasses DAI and unspecified intracranial hemorrhage.

Injury Severity Scale

The ISS is a scoring tool utilized for the purpose of quantifying the degree of injury of presenting trauma patients. The ISS provides for improved pre-hospital triage decision making and provides the practitioner with a predication tool for mortality and resource allocation (Pohlman & Geibel, 2012). The ISS categorizes injury by 6 body regions, the thorax, abdomen, visceral pelvis, head and neck, face, pelvis and extremities, and external structures. Each

category is allowed a single injury and is scored using an Abbreviated Injury Scale (AIS), only the highest AIS is used for each category (Table 1). The top three highest scoring category scores are then squared and added together to achieve the ISS (Table 2). The AIS numerical quantification stems from the International Classification of Disease based classification. The ICD codes are then enumerated using a scale of 1-6, 1 being minor and 6 being maximum injury (Songer, 2008). The ISS values are 0-75, if any of the categories are assigned a 6 the ISS is automatically 75 or considered un-survivable (Table 3) (Pohlman & Geibel, 2012).

A common criticism of the ISS is its lack of specification in regards to TBI. TBI is scored and weighted the same as other bodily traumatic injury despite the fact that TBI is associated with a higher morbidity and mortality (Pohlman & Geibel, 2012).

Table 1
Abbreviated Injury Scale

	Description
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Maximal, Virtually Un-survivable

Adapted from The American Association for the Advancement Of Automotive Medicine (2011). Abbreviated Injury Scale. Retrieved from http://www.aaam.org/ais-index.html

Table 2
Example Injury Severity Score

Injury	AIS Score
Subdural hematoma small	4
Parietal contusion	3
Hepatic laceration grade 4	4
Proximal displaced tibia fracture	3
ISS score	$4^2 + 4^2 + 3^2 = 41$

Adapted from Songer, T. (2008). Measuring injury severity. Retrieved from http://www.pitt.edu/~epi2670/severity/severity.pdf

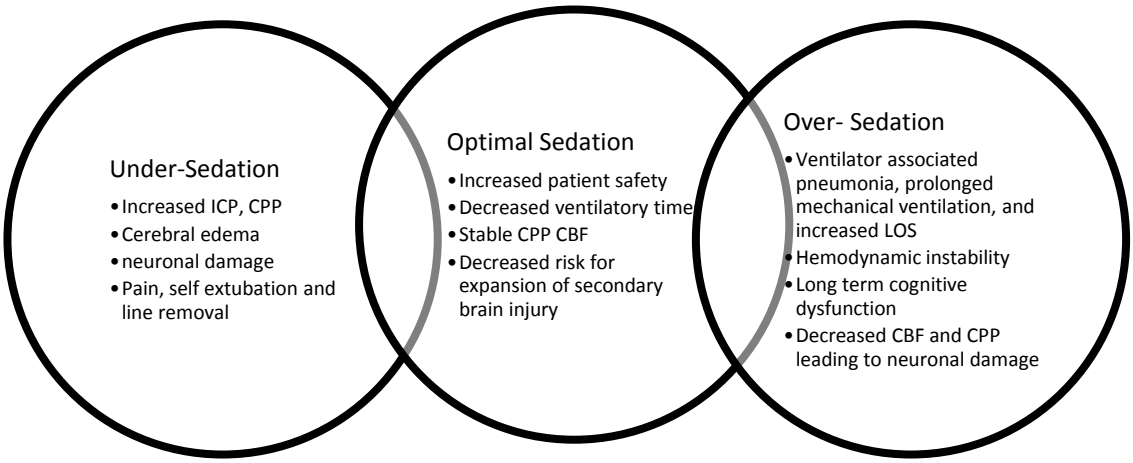
Optimal Sedation and Complications of Sedation in Traumatic Brain Injured Patients

Multiple clinical studies have been performed to determine which medications provide optimal sedation with minimal side effects. Ostermann, Keenan, Seiferling, and Sibbald (2002) reviewed 49 control studies in an effort to identify best sedation practice. The authors concluded that the dosage and drug for optimal sedation remains inconclusive and current practice guidelines should be considered suggestive rather than absolute. What has been unequivocally determined from the clinical trials is that complications are experienced by patients who are over or under-sedated (Figure 3) (Ostermann et al., 2002). Study results have revealed that under-sedation leads to increased potential for self-extubation, catheter removal, ventilator dysynchrony, vital sign instability, and post-traumatic stress disorder (Olsen, Thoyre, Peterson, & Graffagnino, 2009; Ostermann et al., 2002). Neurologically, under sedation causes an increase in CBF, CPP and ICP which can result in cerebral edema and propagation of neuronal damage (Rhoney & Parker, 2001).

Over-sedation exposes patients to extended hospitalization, muscle weakness, prolonged cognitive dysfunction, prolonged ventilation, with increased need for tracheostomy and other complications (Jacobi et al., 2002). Neurologically, over-sedation can lead to decreased CBF and CPP without changes in CMRO2 resulting in neuronal cell death (Rhoney & Parker, 2001).

Sedation of the neurologically injured patient is burdened with additional consequences. Titration of drugs to achieve adequate sedation can mask underlying injury. Agitation can be a result of hypoxia, electrolyte imbalance, temperature dysregulation, hypercapnea, acidosis, infection or hemodynamic shock, all of which result in proliferation of cerebral ischemia (Fraser & Riker, 2010). The use of sedatives can obscure evidence of a pathophysiologic process that can lead to secondary injury. Possible physiological contributions to neurological disturbances should always be considered when there is a need to increase sedation.

Figure 3
Effects of Sedation on TBI



Guidelines for Sedation in Traumatic Brain Injured Patients

The Society of Critical Care Medicine established clinical practice guidelines for the use of sedatives and analgesics based on the premise of optimal sedation with minimal consequence.

It is their recommendation that all critically ill patients be assessed regularly for pain and sedation and that all medications be titrated to a pre-approved sedation level (Barr et al., 2013). Sedation scales, described below, were developed for this purpose. Evidence based research supports the use of the RASS to assess sedation in critically ill population however research regarding the effectiveness of the RASS in the TBI patients is essentially nonexistent (Barr et al., 2013).

The Brain Trauma Foundation and American Association of Neurological Surgeons (2008) established guidelines regarding sedation and anesthesia of the TBI population stating that while they consider their recommendations optimal they cannot be applied to all TBI patients because of the unique physiological requirements of injury. Additionally, because there is limited research of sedation in the neurotrauma patient, the guidelines were based on research of healthy volunteers or elective neurosurgical patients.

Sedation Scales

The vast majority of TBI patients present with varied levels of consciousness. A normal conscious state requires that a person presents with wakefulness which is activated in the brain stem and midbrain, cognizance via the cerebral cortex and projections to and from subcortical brain areas (Maj et al., 2005). A conscious person demonstrates self- awareness and an ability to filter and utilize stimuli as it progresses along the neurological pathway. The TBI patient generally does not present with intact consciousness, impairing the ability to successfully communicate their needs and increasing the risk of self –harm. Sedation scales were formulated to improve sedation related complications by providing a format for evaluating sedation and agitation (Maj et al., 2005).

Sedation scales are bedside tools used to determine the level of sedation a patient is exhibiting (Delvin et al., 1999). The greatest benefits derived from the use of sedation scales has been the ability to precisely document a patient's condition, improve communication among providers, titrate sedation therapy to an established goal, maximize patient safety and comfort, and the potential to minimize ICU length of stay and days of mechanical ventilation (Stawicki, 2007) . There are two categories of sedation scales subjective and objective.

Subjective scales rely on the examiner to interpret movement, facial expressions, posture and vital signs of non-communicative patients to establish a determined agitation or sedation level (Maj et al., 2005). Agitation is characterized by non-purposeful mental and physical activity that stems from internal anxiety; usually expressed by excessive restlessness and constant movement (Maj et al., 2005). Based on the examiners analysis medications are titrated to achieve a predetermined sedation level to alleviate the agitated behaviors and internal anxiety.

Physiologic scales rely on external monitors that measure electroencephalogram, or neurologic activity, to display the patient's level of agitation. Sedation medication is titrated to the predetermined level based on electroencephalogram information (Diawai, Thoyre, & Auyong, 2007). The Society of Critical Care Medicine does not currently endorse the use of physiologic scales in the ICU environment based on the lack of evidence to support the benefit of the current monitoring systems (Barr et al., 2013; Sessler, Grap, & Ramsay, 2008)

There are approximately 25 sedation scales available today, many with similar characteristics and few deemed to have good reliability and validity (Rassin et al. 2007). Sessler (2004) states that the optimal features of a sedation scale should include a multidisciplinary development team, administrative simplicity, explicit criteria for each level, sufficient

differentiation among levels, agitation assessment, and excellent inter-rater reliability and validity. The Riker Sedation-Agitation Scale (SAS) and the Richmond Agitation-Sedation Scale (RASS) are the most commonly utilized sedation scales, with the RASS having been the most validated among various populations (Akgun & Siegal, 2007, Pun and Dunn 2007). For the purpose of this paper only the RASS will be discussed in greater detail.

Richmond Agitation Sedation Scale

The Richmond Agitation-Sedation Scale was developed by a multidisciplinary team consisting of critical care physicians, nurses and pharmacists in an effort to create an optimal sedation assessment tool (Sessler et al., 2002). The RASS has 10 levels of agitation and sedation; positive numbers define a level of agitation and negative numbers a level of sedation. A person is given a single score following a sequential 3 step approach of observation, response to auditory stimulus, and response to physical stimulus (Sessler et al., 2002). The RASS offers a more precise grading of the level of consciousness than the preceding scales. The scale offers a greater variation for describing the light-moderate sedation levels than previously developed scales, this is beneficial to the assessor in that the majority of medication titration is to a goal of light-moderate sedation (Barr et. al., 2013). Table 3 provides an example of the RASS scoring system and associated descriptive assessments.

Table 3
Richmond Agitation Sedation Scale (RASS)

	Description
+4	**Combative Overtly combative, violent, immediate danger to staff**
+3	**Very agitated Pulls or removes tube(s) or catheter(s); aggressive**
+2	**Agitated Frequent non-purposeful movement, fights ventilator**
+1	**Restless Anxious but movements not aggressive vigorous**
0	**Alert and calm**
-1	**Drowsy Not fully alert, but has sustained awakening(eye-opening/eye contact) to *voice*** (>10 seconds)
-2	**Light sedation Briefly awakens with eye contact to *voice*** (<10 seconds)
-3	**Moderate sedation Movement or eye opening to *voice*** (but no eye contact)
-4	**Deep sedation No response to voice, but movement or eye opening to *physical* stimulation**
-5	**Unarousable No response to *voice or physical* stimulation**

Adapted from Sessler, C. N., Gosnell, M. S., Grap, M. J., Brophy, G. M., O'Neal, P. V., Keane, A. K., et al. (2002). The Richmond Agitations-Sedation Scale Validity and Reliability in Adult Intensive Care Unit Patients. *American Journal of Respiratory Critical Care, 166,* 1338-1344. doi:10.1164/rccm.2107138

The RASS has been evaluated in multiple critical care settings, with the majority of testing occurring in the medical surgical ICU arena. The RASS has been effective in cost reduction, Awissi, Begin, Moisan, and Lachaine (2012) found a savings of 1,000 dollars per ICU stay among medical surgical ICU populations with incorporation of the RASS into the sedation assessment. The RASS has been validated in sedative titration and improved practitioner/nurse communication in many studies evaluating multiple drugs , allowing for the nurse to titrate medication to the practitioner-set RASS score (Jakob et al., 2012; Jones, Murphy, Gerlach, Goodman, and Pell, 2011; Arnolds, Hollands, Skrupky, and Mice 2010). A study by Vasilevskis et al. (2011) validated the RASS as an effective tool for bedside evaluation of sedation for use by

nursing, stating that the RASS is a reliable source for sedation titration and guidance. Studies have shown that the RASS is effective at monitoring sedation among ventilated populations when compared to sedated non-ventilated populations (Yaman, Ozcana, Kaymak, and Basar, 2012; Pun et al., 2005). Research has demonstrated improved ventilator synchrony and decreased days of mechanical ventilation when the RASS is incorporated into ICU sedation practice (De Wit, Pedram, Best, & Epstein, 2009; Grap et al., 2003; Robinson et al., 2008). Miller et al. (2010) found a reduction in the incidence of ventilator-associated pneumonia when the RASS was used for sedative-agitation assessments among the trauma ICU populations. The RASS has been shown to reduce hospital length of stay and intensive care length of stay among medical surgical populations (Grap et al. 2003; Robinson et al., 2008; Venkat, Grap, and Sessler, 2005).

Researchers seeking to incorporate a sedation scale among their ICU population deemed the RASS to be the most valid and reliable sedation scale (Rassin et al., 2007; Almgren, Lundmark, and Samuelson 2010; Sztrymf et al., 2010). This is attributed to the scales unique approach to assessing verbal stimulus response separate from physical stimulus response. This delineation enhances the detection of level of sedation separate from level of agitation (Ely et al., 2003). The descriptive abilities provided by the multiply levels of light-moderate sedation results in a much higher inter-rater reliability, kappa .91, then previously developed scales (Sessler et al., 2002; Pun and Dunn 2007; Fraser and Riker, 2010). The RASS has been shown to have excellent inter-rater validity as well as good validity when compared to previously tested scales such as the Riker Sedation-Assessment Scale and Motor-Activity Assessment Scale (Sessler et al., 2002).

The RASS has been shown to be effective in reducing days of mechanical ventilation, ventilator associated pneumonia, length of stay and hospital costs among the medical surgical ICU populations. Studies have shown that the RASS has good inter-rater reliability and validity and that it is an effective tool for sedation assessment among nursing within the medical surgical ICU populations. The research findings regarding the use of the RASS among medical surgical ICU populations and the multileveled descriptions of light-moderate sedation and agitation assessment suggest that the RASS would be a favorable sedation assessment scale for the neurologically injured patient.

Sedation Protocol in Neurologic Injury (SPIN)

A prospective, non-randomized open-treatment research study known as the Sedation Protocol in Neurologic Injury (SPIN) was conducted by a team of neurosurgeons, neuro-intensive care nurses, pharmacists and research nurses (Zabramski, 2009). Joseph Zambramski M.D., neurosurgeon and primary investigator of SPIN, formulated the study in response to his daily observations of variable time to wakefulness and propensity for TBI patients to have sedation or anxiolysis mismanaged. These observations lead to a hypothesis statement that the use of a sedation protocol would lessen the amount of medication required to optimize TBI levels of alertness and therefore improve the ability to assess neurologic function on a routine basis.

The SPIN study was formulated to evaluate a sedation administration protocol in TBI patients in efforts to reduce variability in sedation management. The SPIN study sedation protocol consisting of two groups 1) patients receiving sedation medication and dosage based the attending neurosurgeons preference and administered at the discretion of the subjective

assessment of the nurse or 2) a protocol of Propofol and Morphine continuous infusion, which included a continuous Propofol infusion that was started at 20mcg/kg/hr titrated in accordance with the RASS level and a Morphine infusion that was started at 2mg/hr continuous with allowable titration up to 8mg/hr based on the nurses subjective assessment of pain.

Data collected for SPIN included demographic data, every six hour RASS score, sedation medication rate, and days of mechanical ventilation for 65 TBI patients as well as a registered nurse questionnaire of 8 questions querying time spent on medication administration, ease of use and perceived accuracy of assessment. The RASS was utilized as the tool for sedation assessment and guide for titration of sedation medication. The RASS was chosen for the study as it was the established sedation assessment scale for intubated and sedated patients at the institution.

The nursing perspective regarding the use of the RASS has been widely tested among general medical-surgical populations with regards to ease of use, improved communication, and a positive perception for the RASS to guide sedation titration (Sessler, 2008; Stawicki, 2007). Missing from this data is the nurses' perception of the use of the RASS in the TBI populations. This project inquiry seeks to describe the nurses' perception of the use of the RASS in assessing sedation among TBI patients by evaluating two components of the SPIN questionnaire (Table 4);

1. Did the sedation level effect your feeling of accuracy of neurological assessment?
2. Did the patients agitation level effect your feeling of accurate neurological assessment?

Table 4
SPIN Nursing Questionnaire

	1. Strongly disagree	**2. Disagree**	**3. Neutral**	**4. Agree**	**5. Strongly Agree**
Is the patient on Sedation Protocol? Yes or No					
Was the Sedation Order Sheet easy to Understand					
Was adequate sedation provided to perform nursing care					
Were temporary interruptions of sedation required for neurologic assessment					
Did the patient appear comfortable					
Did the sedation level effect your feeling of accuracy of neurological assessment					
Did the patients agitation level effect your feeling of accurate neurological assessment					
The Sedation Protocol was easy to use					
Was it easy to extubated the patient					

The end points of the SPIN study were the hourly amount of sedation medication utilized and ease of weaning mechanical ventilation for extubation between groups, with ease of extubation determined by level of sedation at attempted time of extubation and the nursing questionnaire. The results of the SPIN study were found to be statistically insignificant and therefore were not disseminated beyond the study. The project inquiry discussed in this paper will include a retrospective secondary analysis of the SPIN data for the purpose of describing the use of the RASS in assessing sedation of TBI patients.

CHAPTER THREE: METHODS

Introduction

The purpose of this retrospective study was to impart knowledge gained from a secondary analysis of the previously collected clinical variables of the SPIN study to describe the relationship between the RASS and sedation assessment among TBI populations. The specific aims of this practice inquiry were to perform a secondary analysis of the previously collected data of the SPIN study to:

1) Describe the characteristics of the study TBI population, to include ICD-9 code, age, gender, ethnicity, alcohol and drug use, length of intensive care stay, and ISS.

2) Describe the use of the RASS to guide titration of sedation medication in this population as measured by percent of time spent within the prescribed RASS level, sedation titration in accordance with the RASS, and days of mechanical ventilation.

3) Describe the nursing perspective of a sedation titration protocol that includes the use of the RASS, as measured by the perception of accuracy of neurologic assessment of sedation and agitation.

Experimental Design and Procedures

Study Design- A retrospective, descriptive secondary analysis of previously collected SPIN data was performed in order to describe the use of the RASS in guiding sedation titration among the TBI population.

Methods and Procedure- A retrospective review of electronic medical records collected for the original SPIN study. The SPIN study was conducted in a single trauma center 50 bed ICU. A total of 65 patients were enrolled into the study from September 2009 to July 2010, all

had sustained a TBI or spinal cord injury and required mechanical ventilation with sedation for a period greater than 8 hours. Data was evaluated for differences among patient outcomes when placed on a sedation protocol versus institutional standard of care. Data collection ceased at time of extubation or tracheostomy insertion. Data collected included age, gender, ethnicity, every 6 hour RASS score, every 6 hour sedation medication titration, sedation medication, days of mechanical ventilation, length of intensive care stay, Injury Severity Score, and a brief questionnaire querying time spent on medication administration, ease of use and perceived accuracy of assessment. The study was not sponsored nor have the outcomes been published. Data procured for the SPIN study was de-identified.

Variables reviewed for the purpose of this practice inquiry will include ICD-9 code, age, gender, every 6 hour RASS score and associated sedation medication titration, alcohol or drug use, days of mechanical ventilation, length of intensive care stay, and ISS

Description of Subjects- sample of 65 TBI patients

- Inclusion- SPIN inclusions were adult TBI patient's ages 18-80 years of age, intubated on respiratory support with a Glasgow Coma Scale of 5-15, must have been admitted to trauma service with a consult to neurosurgery for closed head or spinal trauma. (Zabramski, 2009). Additional stipulations for this project inquiry include mechanical ventilation for 24hrs or greater, must have a TBI and continuous sedation with titration based on the RASS score
- Exclusion- SPIN exclusions were patients less than 18 years of age or greater than 80 years of age, Glasgow Coma Scale of 4 with fixed and dilated pupils, penetrating head injury, pregnancy and a history of mental impairment.

Additional exclusions for this project inquiry will include the use of ongoing paralytics as these obscured the ability to perform the RASS assessment.

Investigator Experience- Investigator experience included a Graduate education at the University of Arizona with a Master's Thesis analyzing sedation assessment scales in traumatic brain injured populations. The investigator of the project inquiry was also a co-investigator of the SPIN study, and is an active co-investigator of the PROTECT study which is a multi-center randomized control trial currently enrolling TBI patients for randomized treatment with the hormone progesterone. The investigator also had nine years of registered nursing intensive care experience in critical care and neuro-intensive care and two years of Acute Care Nursing Practice dealing with traumatically injured and TBI populations.

Data Analysis and Data Monitoring- Descriptive statistics, Standard Error of the Mean (SEM) and frequency analysis were used to describe the demographic variables of aim 1. Aim 2 was evaluated using both a Spearman's correlation co-efficient (Spearman's rho) and a Pearson's (r) correlation coefficient to describe the relationship between RASS and sedation medication titration. A univariate frequency analysis and SEM were used to describe the nurses' perception of the use of the RASS among TBI patients. SPSS software version 18 was employed for statistical analysis. A data analyst from AT Stills University subcontracted through Scottsdale Healthcare and free of relationship to the SPIN study, provided independent oversight of the data analysis.

Data Storage and Analysis- Data was stored in an onsite Scottsdale Healthcare computer that was password encrypted. The principle investigator and accompanying statistician had

access to the de-identified data. Data will be released to the University of Arizona and Scottsdale Healthcare in written summary format.

Setting- The study was conducted at Scottsdale Healthcare Osborn. Application to The University of Arizona and Scottsdale Healthcare Institutional Review Board (IRB) was required.

Risk/Benefit Assessment- The study was considered to be of minimal risk. Data was collected in manner that prevented subject identification as the SPIN data was already de-identified. No direct patient involvement was proposed. Outcome findings did not directly benefit the patients whom the data was extracted but may have clinical impact on future TBI populations.

CHAPTER FOUR: RESULTS

Description of the Sample

A total of 65 SPIN patient charts from the original SPIN study were reviewed for exclusion and inclusion criteria. A total of 27 charts were dismissed secondary to inadequate data collection, short duration of mechanical ventilation, insufficient RASS documentation or insufficient documentation of sedation titration. Therefore for this project inquiry a total of 38 patients met the inclusion criteria of 18-80 years of age, intubated on respiratory support, Glasgow Coma Scale score of 5-15, mechanical ventilation for 24hrs or greater, diagnosis of a TBI and requiring continuous sedation with titration based on the RASS score.

Aim 1

The goal of aim1 was to describe the use of the RASS in assessing sedation of TBI populations as measured by the variables ICD-9 code, age, gender, ethnicity, alcohol and drug use, length of intensive care stay, and ISS. A univariate frequency analysis was performed on the variables ICD-9, age, gender, ethnicity, drugs and alcohol, length of stay, and ISS to determine the characteristics of the 38 patients who met inclusion criteria for this study..

International Classification of Disease

Patients coded to the ICD-9-CM 852 with SAH, SDH, and EDH accounted for 65.8% (25 of 38 cases) of the TBI population included in this study. Concussions accounted for 31.6% (12 of 38 cases) and unspecified ICH/DAI accounted for a total of 2.6% (1 of 38 cases) of the cases.

Age and Gender

The age of the included cohort ranged from 18 to 80 years of age. The most frequently presenting age groups were 18-29 accounting for 36.8% (14) and 61-70 years old accounting for

21.1% (8) (Table 5). Males represented 75% (27) TBI patients. This was congruent with national standards of TBI age and gender presentation with consideration of the inclusion/exclusion criteria of this study (Faul et al., 2010; Roozenbeek et al., 2013).

Table 5
Frequency of Age

Age		Frequency	Percent
Valid	18-29	14	36.8
	30-40	3	7.9
	41-50	3	7.9
	51-60	5	13.2
	61-70	8	21.1
	71-80	3	7.9
	Total	36	94.7
Missing	System	2	5.3
Total		38	100.0

Ethnicity

The ethnicity information recorded in the SPIN data was recorded as Caucasian, Black, Hispanic, Native American and other. Caucasians represented the majority of TBI patients at 73.7% (28). Hispanics represented 10.5% (4) and all other categories accounted for a total of 2.6% (3). Missing ethnicity data accounted for 7.9% (3).

Alcohol and Drug Use

Alcohol and drug use data was collected by a standard urine drug screen (UDS) and blood alcohol level that is procured as a standard of care for all trauma patients. A standard 10 panel UDS includes amphetamines, barbiturates, benzodiazepines, cannabinoids, cocaine, methadone, methaqualone (ecstasy), opiates, phencyclidine (PCP), and propoxyphene (Darvon). For the purpose of this study a positive UDS of any one of the ten categories or a blood alcohol

level of greater than .08 were documented as a positive finding. Of the 38 cases, 62.9% (22) tested positive for drugs or alcohol, 37.1% (13) tested negative and 3 cases did not document a UDS or alcohol level.

Length of Intensive Care Stay

The mean length of intensive care stay for this study was 3.9 days (SD=1.96) (Table 6). The highest percentage of patients required a stay of 3-5 days accounting for 21.1% and 15 or greater days accounting for 34.2%.

Table 6
Length of ICU Stay

Days of ICU Stay	Frequency	Percent
2	8	21.1
3-5	8	21.1
6-8	3	7.9
9-11	4	10.5
12-15	5	13.2
15+	9	23.7
Missing	1	
Total	38	100

Days of Mechanical Ventilation

For this study, mechanical ventilation was required for a minimum of 48 hours with the study cessation at removal of mechanical ventilation or ongoing respiratory failure requiring tracheostomy placement. The mean days of mechanical ventilation was 3.46 (SD= 1.95) The

most frequent length of mechanical ventilation days were days 2-5 at 21.6% (8) and 15+ days at 24.3% (9). Missing cases accounted for 2.6% (1).

Injury Severity Score

The ISS scores for the purpose of this study were grouped for ease of documentation using numerals 1-8 to code in SPSS as follows; 1 is an ISS score of 1-10, 2 equals 11-20, 3 equals 21-30, 4 equals 31-40, 5 equals 41-50, 6 equals 51-60, 7 equals 61-70 and 8 (Table 7) . The mean was calculated as 3.22 (SD=1.17) which indicates moderate degree of injury.

Table 7
Injury Severity Score

ISS Range	Frequency	Percent
1-10	2	5.3
11-20	6	15.8
21-30	16	42.1
31-40	5	13.2
41-50	5	13.2
51-60	1	2.6
Missing	3	
Total	38	100

Richmond Agitation Sedation Scale

The sedation level prescribed by the practitioner for the SPIN was a RASS of -2. This allows for a lightly sedated patient that requires minimal time to wakefulness for neurological examination (Ostermann et. al., 2002) There are circumstances which require a deeper level of

sedation; these circumstances are associated with severe TBI where administration of sedation acts as an adjunct for controlling ICP (Ostermann et. al., 2002). The mean RASS for this population was -2.04 (SD=1.05).

Aim 2

The goal of aim 2 was to describe the use of the RASS to guide titration of sedation medication in this population as measured by percent of time spent within the prescribed RASS level and by the variables of every 6 hour RASS score and associated sedation medication titration, and days of mechanical ventilation.

RASS and Sedation Titration

To assess the ability of the RASS to guide sedation titration in the TBI population in this project inquiry, a two-fold approach was utilized. The first step in evaluating the correlation between the RASS and associated titration was to run each case individually using the non-parametric statistical approach of Spearman's correlation co-efficient (Spearman's rho). The outputs from this data varied significantly. Ten of the 38 short-term mechanically ventilated patients had constant sedation levels without titration, therefore a correlation could not be performed. In the remaining cases, RASS did not significantly correlated with sedation titration in 24 cases, while in 4 cases, the RASS significantly correlated with sedation titration. The significance value for Spearman's rho is 0 .05 or less (Field, 2009).

Due to the variability of this data as well as the number of constant cases in which the patients had constant sedation levels, the data was then run as group mean using Pearson's (r) correlation coefficient, with a Pearson's-r value of 1 or -1 and a significance of less than 0.05 (Field, 2009). The correlation of the mean-RASS and mean-sedation titration was r- .061 and a

significance value of .717. indicating that there is no significant correlation between the RASS and sedation titration.

RASS and Sedation Titration and Descriptive Variables

To determine influencing factors on mean-sedation titration and the mean-RASS a Spearman's correlation coefficient was used to analyze the variables of age, gender, drugs and alcohol, ISS, ICD-9, ICU length of stay and days of mechanical ventilation (Table 8). Of these variables only the ISS and ICD-9 code held statistical significance. The ISS demonstrated a positive correlation with the mean-sedation titration but not the mean-RASS, indicating that as the ISS increased the amount of sedation titration increased without consideration or guidance of a correlating RASS score. The ICD-9 code positively correlates with the RASS indicating that the ICD-9 level increased so did the degree of agitation on the RASS assessment.

Table 8
Variables Correlation

Variables	Spearman's rho	RASS_Mean	Titration_Mean
Ventilation	Correlation Coefficient	.092	-.107
	Sig. (2-tailed)	.588	.527
	N	37	37
ICU	Correlation Coefficient	.125	.179
	Sig. (2-tailed)	.487	.319
	N	33	33
AGE	Correlation Coefficient	.051	.068
	Sig. (2-tailed)	.770	.694
	N	36	36
Gender	Correlation Coefficient	-.044	-.016
	Sig. (2-tailed)	.800	.928
	N	36	36
Drugs/ETOH	Correlation Coefficient	.009	.116
	Sig. (2-tailed)	.960	.509
	N	35	35
ISS	Correlation Coefficient	.388	.373*
	Sig. (2-tailed)	.21	.028
	N	35	35
ICD-9	Correlation Coefficient	.400*	.078
	Sig. (2-tailed)	.013	.641
	N	38	38

*$p<0.05$

Aim 3

Aim 3 was to describe the nursing perspective of a sedation titration protocol that includes the use of the RASS, as measured by the perception of accuracy of neurologic assessment of sedation and agitation obtained from the questionnaire results regarding the nurses feeling of accuracy of neurologic assessment in relation to sedation and agitation A univariate frequency analysis was performed on the questionnaire variables for the purpose of describing the nursing perspective of sedation titration and accuracy of neurological assessment.

Questionnaire

A univariate frequency analysis Question one asked, "Did the sedation level effect your feeling of accuracy of neurological assessment?" A mean of 1.96 (SD= .89) was reported. Indicating that 28.9% (11) of nurses' evaluation the TBI patient sedation level disagreed that the level of sedation affected their ability to perform a neurological assessment (Table 9). Question two asked "Did the patient's agitation level effect your feeling of accurate neurological assessment?" A mean of 1.98 (SD=.85) was reported, indicating that 31.6% (12) of nurses reported that they disagreed that the patients agitation level interfered with their ability to perform a neurological assessment (Table 10).

Table 9
Question 1

	Frequency	**Percent**
Strongly disagree	9	23.7
Disagree	12	31.6
Neutral	4	10.5
Agree	2	5.3
Missing	11	
Total	38	100

Table 10
Question 2

	Frequency	Percent
Strongly Disagree	9	23.7
Disagree	12	31.6
Neutral	4	10.5
Agree	2	5.3
Missing	11	
Total	38	100

CHAPTER FIVE: DISCUSSION

Introduction

Improper sedation administration is associated with increased morbidity and mortality of TBI patients. Under-sedation leads to increased potential for self-extubation, unintended catheter removal, ventilator dys-synchrony, vital sign instability, and post-traumatic stress disorder (Olsen, Thoyre, Peterson, & Graffagnino, 2009; Ostermann et al., 2002). From a neurological standpoint, under-sedation may result in an increase in CBF, CPP and ICP with associated consequences of cerebral edema and propagation of neuronal damage and cellular death (Rhoney & Parker, 2001).

Over-sedation exposes patients to extended hospitalization, muscle weakness, prolonged cognitive dysfunction, prolonged ventilation, with increased need for tracheostomy and other complications (Jacobi et al., 2002). Over-sedation may lead to decreased CBF and CPP without changes in CMRO2 culminating in neuronal cell death and expansion of neurological injury (Rhoney & Parker, 2001).

Sedation assessment scales were formulated to prevent complications of excessive or insufficient sedation administration (Sessler et. al., 2002). The use of sedation scales have refined the ability to precisely document a patient's condition, improve communication among providers, titrate sedation therapy to an established goal, optimize sedation administration, maximize patient safety and comfort, and has demonstrated a potential for minimizing ICU length of stay and days of mechanical ventilation (Stawicki, 2007).

The RASS is a sedation assessment scale that has been well tested among critical care populations and has demonstrated excellent reliability and validity, it is one of two scales

currently recommended for use in the guidelines published by the Society of Critical Care Medicine (Barr et al., 2013). The RASS has been adopted internationally as an acceptable, valid instrument for assessing sedation of critical care patients (Jakob et al., 2012; Jones, Murphy, Gerlach, Goodman, and Pell, 2011; Arnolds, Hollands, Skrupky, and Mice 2010). The RASS has not been widely tested among TBI populations, yet has been a widely used sedation assessment scale for this population despite the unique presentations that separate TBI patients from other general critical care patients.

This descriptive retrospective study to describe the use of the RASS in TBI populations was formulated to address the gap between practice and literature. A secondary analysis of data previously collected in the SPIN study was utilized for this purpose. A total of 38 TBI patients were included in the study and the variables ICD-9 code, age, gender, ethnicity, alcohol and drug use, length of intensive care stay, and ISS were used to describe the population. The use of the RASS to guide titration of sedation medication in this population was measured by percent of time spent within the prescribed RASS level and by the variables of every 6 hour RASS score and associated sedation medication titration, and days of mechanical ventilation. Additionally, this project inquiry sought to describe the nursing perspective of a sedation titration protocol that includes the use of the RASS, as measured by the perception of accuracy of neurologic assessment of sedation and agitation obtained from the questionnaire results regarding the nurses' perception of accuracy of neurologic assessment in relation to sedation and agitation.

Summary of the Study

The age and gender of the sample population were congruent with the national averages, in that the age 65 and greater and males were the most predominately presenting TBI (Faul et.

al., 2010; Roozenbeek et al., 2013). The ethnicity of this study population is congruent with state based statistics in that it was predominately Caucasian and Hispanic (CLRChoice, 2010). These statistics indicate that the sample population included in this study is a good representation of the general TBI population of Arizona.

Studies have shown that alcohol and drug use increases your risk of suffering a TBI as well as increases the probability of developing a severe TBI (Andelic et al., 2010; Wagner, Sasser, Hammond, Wiercisiewski, & Alexander, 2000). Delerium tremens, or acute alcohol withdrawal, presents with an alteration in mental and cognitive function that can further impair the ability to assess sedation in the TBI patient. (Dugdale, 2011). Of the 38 patients who met inclusionary criteria 62.9% tested positive for drugs or alcohol use upon admission. The variable had no statistically significant impact on sedation titration or time spent at the prescribed RASS level which may indicate a low incidence of alcohol or drug withdrawal or that the use of drugs and alcohol have minimal effect on overall sedation and agitation of the TBI patient.

The ICD-9 code most represented in this study sample was ICD-9-CM 852 or hematoma (SDH/SAH/EDH). However, ICD-9-CM 850, or concussion, is the most frequently reported national statistic for TBI (Faul et. al., 2002). This variation may be accounted for by the fact that the majority of concussive patients do not require mechanical ventilation as concussion is a transitory injury with a short duration of loss of consciousness (Porth, 2005). Thus, most of the concussive patients included in the SPIN data set were not included in this study related to short duration of mechanical ventilation.

The ICD-9 code was noted to positively correlate with mean-RASS indicating that as the ICD-9 code number increased so did the RASS level. ICD-9 codes are not a scale of injury rather

a classification system however in the SPSS software this was coded as a positive scale. ICD-9-cm 850 encompasses concussion, 852 hematoma, and 853 DAI/ICH. The ICD-9 codes do not provide information on the degree of injury, such as a small subdural hematoma or large subdural hematoma. It is known that a hematoma is worse than concussion and DAI is generally worse than hematoma as based on the Glasgow Coma Scale (Pangilinan, Campagnolo, & Kellt, 2012). The information provided by this analysis demonstrated that as the degree of injury increased so did the level of agitation, which correlated with the positive, or agitated levels of the RASS tool.

Intensive care length of stay and days of mechanical ventilation for TBI varies greatly depending on the severity of injury. Many studies have shown that the average length of ICU stay for critical care and TBI patients is 3-5 days (Ong et al., 2009; Kejriwal & Civil, 2009). The length of stay for this study population was a mean of 3.90 days. This is consistent with the average length of ICU stay reported in most studies for both general medical surgical patients and TBI patients (Ong et al., 2009; Kejriwal & Civil, 2009). The average days of mechanical ventilation for this study population were a mean of 3.46. A study by Stefan et al. (2013) reviewed the national statistics for acute respiratory failure from 2001 to 2009 and found the average length of mechanical ventilation to range from 2-7 days without accounting for degree of injury. This would imply that this study population follows the mean national standards for length of intensive care stay and mechanical ventilation.

The mean ISS presentation of the study population was group 3(SD=1.17), ISS of 21-30. This classified the mean study participant as having moderate injury, with the standard deviation stratifying the injury classification to moderate and serious injury. The ISS was noted to have

statistical significance to the mean-sedation titration. The correlation indicates that as the ISS increases so does the degree of sedation titration.

The ISS is used to predict morbidity and mortality. As the score increases so does the risk of mortality (Songer, 2008). The mean study participant was at a moderate risk for mortality. A higher ISS score means that the patient is presenting with three areas of significant injury, without the ISS score breakdown it is difficult to differentiate the degree of influence the TBI has on patient presentation. One of the believed faults of the ISS is that it weighs TBI the same as other body regions when TBI has a known associated greater mortality (Pohlman & Geibel, 2012).

The significance of correlation therefore is multifactorial and to what degree the TBI plays a factor is unknown. The results of this practice inquiry indicate that the greater the severity of injury the more difficult it is to keep the patient at a designated RASS, requiring more frequent sedation medication titration to achieve the prescribed goal.

The study populations mean RASS score was -2.04. Indicating that the average study participant was evaluated and scored at a RASS of -2, which was the prescribed sedation goal for the SPIN study. This would imply that the study participants were within the range of appropriate sedation to achieve the prescribed goal.

The two questions isolated from the SPIN questionnaire reflect the assessing nurses' perception of sedation titration. The questions are posed to determine the impact of sedation on neurological assessment. Question one evaluated the impact of sedation. The findings indicated that the nurses' evaluation of the TBI patients sedation level did not affected their ability to perform a neurological assessment using the RASS. Question two evaluated the impact of

agitation on neurological assessment. This would imply that the nurses did not feel that the patients agitation level impaired their ability to perform a neurological assessment using the RASS. This suggests that from the nurses' perception the ability to assess the neurological status of TBI patients was not affected by over-sedation or under-sedation when using the RASS to assess sedation of the TBI patient nor was the use of the RASS a barrier to nursing when assessing sedation.

The RASS is used to assess sedation and agitation and serves the purpose of guiding sedation titration in the critically ill. To determine if the RASS is an effective tool in guiding sedation titration in the TBI population a Pearson's correlation coefficient was performed comparing the mean-RASS and the mean-sedation titration. The statistical correlation of the mean-RASS and mean-sedation titration was found to be statistically insignificant. These findings implied that there was an absence of correlation between these variables and there was no significant relationship between the RASS and sedation titration. This would suggest that the RASS does not, in fact, effectively guide sedation in the TBI population.

Discussion and Limitations

The study population is representative of the general population in that it correlates with the current national statistical descriptive variables (CLRChoice, 2010; Faul et. al,.2002). The sample size is large enough to quantify it as a large sample (N>30), a non-parametric distribution was assumed when running statistical analysis thus allowing the results to be extrapolated to the general TBI population (Field, 2005).

The use of the RASS to guide sedation titration in the TBI population is the primary specific aim of this study. To evaluate this aim we measured three variables; percent of time

spent within the prescribed RASS level, sedation titration in accordance with the RASS, and days of mechanical ventilation. The average time spent at the prescribed RASS was a mean of -2.04, demonstrating that the average TBI study patient was evaluated and scored at a RASS of -2 or the prescribed RASS goal. Days of mechanical ventilation were congruent with the national statistics for acute respiratory failure from 2001 to 2009 which found the average length of mechanical ventilation to range from 2-7 days without accounting for degree of injury (Stefan et al., 2013). One could feasibly infer that utilizing the RASS to assess sedation and agitation in the TBI population is effective in minimizing days of mechanical ventilation and allowing nursing to titrate sedation to achieve the prescribed RASS of -2. Conversely when measuring the mean-RASS with the mean-sedation titration no significant correlation was found, implying that the RASS does not guide sedation titration in the TBI population. When measuring individual cases a significant correlation was found between the RASS and sedation titration in four of the thirty-eight cases.

The individual cases demonstrating a positive correlation lends some credence to the fact that the RASS may be an effective tool for guiding sedation in the TBI population despite the lack of evidence in the mean-scores. The supporting data of a positively correlating time spent at the prescribed RASS and days of mechanical ventilation also suggest that the RASS is an effective tool for assessing sedation and agitation in this population so it is surprising that the correlation to suggest sedation titration guidance is absent. The fact that the RASS and associated sedation titration data is only gathered every 6 hours may account for lack of correlation, as sedation can be titrated several times based on waning agitation and sedation levels of the TBI patient. Additionally the carry-over factor must be added into the equation. To

save time on documentation, many nurses will carry-over the previous 6hr electronically charted assessment and fail to adjust the necessary information, so while the patient's sedation dose has changed during the 6 hour time period the RASS is copied from previous charting and may not reflect the current RASS level.

The ISS and ICD-9 code variables exhibit a significant correlation with the RASS. These findings imply that the degree of injury and type of TBI affect the ability to maintain a patient at the prescribed RASS of -2, this variability in agitation and sedation places the patient with advanced illness at higher risk for sedation related complications. The ICD-9 did not positively correlate with sedation titration indicating that while the ICD-9 code may affect the ability to maintain a RASS of -2 it did not influence the amount of titration. This variability could be related to the fact that severe TBI patients are often kept at a more negative RASS score with higher levels of sedation to ensure adequate CPP and control of ICP's (Ostermann et al., 2002). However there was no significant negative correlation noted on statistical evaluation to support this.

The ISS did have a positive correlation with sedation titration which infers that as the degree of injury increases so does the need to increase sedation titration. This does correlate with the premise of increased sedation administration to control for ICP and CPP. However, the ISS is a composition of 3 separate injured components of the body so the degree of influence the TBI alone has on increased sedation administration cannot be concretely inferred.

The third specific aim was to describe the nursing perspective of a sedation titration protocol that includes the use of the RASS, as measured by the perception of accuracy of neurologic assessment of sedation and agitation. The results infer that neither agitation nor

sedation levels interfered with nursing's ability to assess neurological status using the RASS. It can be inferred from this data that the nurses' perception of instituting the RASS to evaluate sedation and agitation is positive and that instituting its use in the TBI population to assess and guide sedation titration may not be a barrier.

Recommendations for Future Studies

Several aspects of this study support the use of the RASS as a sedation and agitation assessment tool to guide sedation titration in the TBI population. The time spent in the prescribed RASS score would strongly indicate that sedation was titrated in accordance with the RASS score despite the lack of statistical correlation. Future studies could evaluate the effectiveness of the RASS to guide sedation by accounting for the RASS and associated sedation titration with each sedation adjustment made as well as a five minute post sedation titration RASS score. This should improve the ability to accurately determine the relationship of the RASS and sedation titration in the TBI population. The ICD-9 and ISS categorization system utilized in this study lacked detail in regards to the severity of TBI a patient presented with, this made it difficult to account for the degree of influence the TBI had on the RASS and sedation titration. The addition of an objective TBI scale, such as the Hunt and Hess scale to quantify the severity of the TBI would provide greater detail to the ISS and ICD-9 categorization of injury and potentially allow for statistical inference regarding the influence of TBI on the RASS and sedation titration (Hunt & Hess, 1968). The prescribed RASS should also be included as a variable to account for variations in prolonged negative or positive RASS documentation. Controlling for the carry over feature should be incorporated into future studies to effectively evaluate the relationship between the RASS and sedation titration. Future studies could also include a more detailed exploration of

a nurse's perspective on ease of use and effectiveness of the RASS for assessing sedation in the TBI population as this practice inquiry finding would suggest the use of the RASS would not be considered a barrier to assessing sedation among this profession.

The lack of statistical significance in this study regarding the use of the RASS to guide sedation titration in TBI patients should encourage researchers to identify a sedation assessment tool that is effective in the TBI population, if not the RASS than another sedation assessment tool. The lack of current research in this area leaves a vulnerable population at significant risk for increased morbidity and mortality. In effort to improve long term outcomes and quality of life for our TBI patients we must identify a sedation assessment tool that is effective in guiding sedation assessment in this population.

REFERENCES

Akgun, K., & Siegal, M. D. (2007). Sedation and neuromuscular blockade in the ICU. *Chest Journal, 21*.

Almgren, M., Lundmark, M., & Samuelson, K. (2010). The Richmond Agitation-Sedation Scale: translation and reliability testing in a Swedish intensive care unit. *ACTA Anesthesiology Scandinvacia, 54*(6), 729-35.

American Association for The Advancement of Automotive Medicine (2011). Abbreviated Injury Scale. Retrieved from http://www.aaam.org/ais-index.html

Andelic, N., Jerstad, T., Sigyrdardottir, S., Schanke, A., Sandik, L., & Roe, C. (2010). Effects of acute substance use and pre-injury substance abuse on traumatic brain injury severity in adults admitted to a trauma center. *Journal of Trauma Management Outcomes, 4*(6).

Arnolds, H. M., Hollands, J. M., Skrupky, L. P., & Mice, S. T. (2010). Optimizing sustained use of sedation in mechanically ventilated patients: focus on safety. *Current Rug Safety, 5*(1), 6-12.

Awissi, D., Begin, C., Moisan, C., & Lachaine, J. (2012). I-SAVE study: Impact of sedation, analgesia, and delirium protocols evaluated in the intensive care unit: An economic evaluation. *The Annals of Pharmacotherapy, 46*(1), 21-28.

American Society Of Anesthesiologists. (2004, 6). *Continuum of Depth of Sedation: Definitions of General Anesthesia and Levels of Sedation/Analgesia*. Retrieved August 24, 2009, from American Society of Anesthesia Web site: http://www.asahq.org/patientEducation/SedationBrochure.pdf

Barr, J., Fraser, G. L., Puntillo, K., Ely, W. E., Gelinas, C., Dasta, J., Jaeschke, R. (2013). Clinical Practice Guidelines for the Management of Pain, Agitation, and Delirium in Adult Patients in the Intensive Care Unit. *Critical Care Medicine*, 41(1), 263-306.

Brain Trauma Foundation, & American Association of Neurological Surgeons. (2010). *Guidelines for the Management of Severe Traumatic Brain Injury. Anesthetics, Analgesics, and Sedatives*. Retrieved June 12, 2009, from National Guideline Clearinghouse Web site: http://www.guideline.gov

Brain and Spinal Cord Organization (2012). Diffuse Axonal Injury. Retrieved March 2, 2013, from http://www.brainandspinalcord.org/traumatic-brain-injury-types/diffuse-axonal-injury/index.html

CLRChoice (2010). Phoenix Population by Race and Ethnicity. Retrieved from http://www.clrsearch.com/Phoenix-Demographics/AZ/Population-by-Race-and-Ethnicity

Corte, D. F. (n.d.). *Pathophysiology of Brain Injury*. Retrieved August 24, 2009, from Foundation For Education and Research of Neurological Emergency Web site: http://www.ferne.org/Lectures/bis01%20pathophysiology.htm#I

Dasta, J. F., McLaughlin, T. P., Mody, S. H., & Piech, C. T. (2005). Daily cost of an intensive care unit day: the contribution of mechanical ventilation. *Critical Care Medicine, 33*(6), 1266-71.

De Wit, M., Pedram, S., Best, A. M., & Epstein, S. K. (2009). Observational study of patient-ventilator asynchrony and relationship to sedation level. *Journal of Critical Care, 24*(1), 74-80.

Diawai, O. M., Thoyre, S. M., & Auyong, D. B. (2007). Perspectives on Sedation Assessment in Critical Care. *Advanced Critical Care, 18*(4), 380-395. doi:10.1097/01AACN.0000298630.53276

Dray, S. (2012). History: Anesthesiology. Retrieved from http://www.ehow.com/about_4674462_history-anesthesiology.html

Dugdale, D. C. (2011, March 20). Delerium Tremens. Retrieved from http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0001771/

Faul, M., Xu, L., Waid, M. M., & Coronado, V. G. (2010, 03). *Traumatic Brain Injuries in the United States*. Retrieved April 2, 2010, from Centers for Disease Control and Prevention Web site: http://www.cdc.gov/traumaticbraininjury/pdf/blue_book.pdf

Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). Olivers Yard, London: Sage Publication.

Fraser, G. L., & Riker, R. R. (2010). Central nervous system syndromes in critically ill adults. *American College of Clinical Pharmacology,* 129-140. http://www.opus12.org/uploads/O12-SCI-V01-N02-P10.pdf

Grap, M. J., Strickland, D., Tormey, L., Keane, K., Lubin, S., Emerson, J., Sessler, C. N. (2003). Collaborative practice: development, implementation, and evaluation of a weaning protocol for patients receiving mechanical ventilation. *American Journal of Critical Care, 12*(5), 454-60.

Hunt, W.E., Hess, R.M. (1968). Surgical risks related to time of intervention in repair of intracranial aneurysms. *Journal of Neurosurgery,* 28(1), 14-20.

International Brain Injury Association (2011). Brain injury facts. Retrieved from https://www.internationalbrain.org/?q=Brain-Injury-Facts

Jacobi, J., Fraser, G. L., Coursin, D. B., Riker, R. R., Fontaine, D., Wittbrodt, E. T., et al. (2002). Clinical Practice Guidelines for the Sustained Use of Sedatives and Analgesics in the Critically Ill Adult. *College of Critical Care Medicine, 30*(1), 119-141. Retrieved from OvidSP Web site: http://ovidsp.tx.ovid.com/spa/ovidweb.cgi?QS2

Jacobi, J., Fraser, G. L., Coursin, D. B., Riker, R. R., Fontaine, D., Wittbrodt, E. Jakob, S., Esko, R., Grounds, M., Sarapohja, T., Garratt, C., Pocock, S. J., Takkala, J. (2012). Dexmedetomidine vs Midazolam or Propofol for Sedation During Prolonged Mechanical Ventilation. *The Journal of American Medical Association, 307*(11), 1151-1160.

Jones, G. M., Murphy, C. V., Gerlach, A. T., Goodman, E. M., & Pell, L. J. (2011). High-dose dexmedetomidine for sedation in the intensive care unit: an evaluation of clinical efficacy and safety. *The Annals of Pharmacotherapy, 45*(6), 740-747.

Kejriwal, R., & Civil, I. (2009). Time to definitive care for patients with moderate and severe traumatic brain injury—does a trauma system matter? *The New Zealand Medical Journal, 122*(1302).

Kumar, V., Abul, K. A., & Fausto, N. (2005). *Pathologic basis of disease* (7th ed.).

Langlois, J. A., Rutland-Brown, W., Marlena, M., & Rosenthal, M. (2006). The epidemiology and impact of traumatic brain injury: A brief overview. Journal of Head Trauma and Rehabilitation, 21(5), 375-378.

Maj, M. J., Burns, S. M., Cambell, M. L., Chulay, M., Grap, M. J., Pierce, L. N., & Simpson, T. (2005) Development of the American association of critical-care nurses sedation assessment scale for critically ill patients. *American Journal of Critical Care 14(6):531-44.*

Miller, R. S., Norris, P. R., Jenkins, J. M., Talbot, T. R., Starmer, J. M., Hutchinsin, S. A., Morris, J. A. (2010). Systems initiatives reduce healthcare-associated infections: a study of 22,928 device days in a single trauma unit. *Journal of Trauma* (2008). An analgesia-delirium-sedation protocol for critically ill trauma patients reduces ventilator days and hospital length of stay. *Journal of Trauma, 65*(3), 517-26.

Mirski, M. A., Muffelman, B., Ulatowski, J. A., & Hanely, D. F. (1995). Sedation for the Critically Ill Neurologic Patient. *Critical Care Medicine, 23*(12), 2038-2053.

Moore, E. E., Cogbill, T. H., Malangoni, M., Jurkovic, G. J., & Champion, H. R. (2005). Scaling system for organ specific injuries. *The American Association for the Surgery of Trauma.*

Olson, D. M., Thoyre, S. M., & Auyong, D. B. (2007). Perspectives on Sedation Assessment in Critical Care. *Advanced Critical Care, 18*(4), 380-395. doi:10.1097/01.aacn.0000298630.53276.be

Ostermann, M. E., Keenan, S. P., Seiferling, R. A., & Sibbald, R. J. (2002). Sedation in the Intensive Care Unit: A systematic Review. *Journal of American Medical Association, 284*(4), 441-442.

Pangilinan, P. H., Campagnolo, D. I., & Kellt, B. M. (2012, October 26). Classification and Complications of Traumatic Brain Injury. Retrieved March 13, 2013, from http://emedicine.medscape.com/article/326643-overview#aw2aab6b4

Papadakis M A & McPhee, S. J. (2013). *Current medical diagnosis & treatment* (52nd ed.). San Francisco, CA: Mcgraw Hill Lange.

Pohlman, T. H., & Geibel, J. (2012, August 22). Trauma scoring systems. Retrieved from http://emedicine.medscape.com/article/434076-overview#aw2aab6b3

Porth, C. M. (2005). *Pathophysiology: Concepts of altered health states* (7th ed.). Philidelphia, PA: Lipincott Williams & Wilkiins.

Pun, B. T., & Dunn, J. (2007). The sedation of citically ill adults. *American Journal of Nursing*
Pun, P. T., Gordon, S. M., Peterson, J. F., Shintani, A. K., Jakson, J. C., Foss, J., & Ely, E. (2010). Beneficial effects of loxapine on agitation and breathing patterns during weaning from mechanical ventilation. *Critical Care, 14*(3).

Rhone, D. H., & Parker, D. (2001). Use of Sedative and Analgesic Agents in Delirium and sedation recognition using validated instruments: reliability of bedside intensive care unit nursing assessments from 2007 to 2010. *Journal of American Geriatric Society, 59*(2), 49-55.

Robinson, B. R., Mueller, E. W., Henson, K., Branson, R. D., Barsoum, S., & Tsuei, B. J. Sedatives and analgesics in the critically ill adult. *Critical Care Medicine, 30*(1), 119-141.

Roozenbeek, B., Maas, A. I., & Menon, D. K. (2013). Changing patterns in the epidemiology of t traumatic brain injury. Nature Reviews Neurology, 9, 231-236.

Sessler, C. N., Gosnell, M. S., Grap, M. J., Brophy, G. M., O'Neal, P. V., Keane, A. K., et al. (2002). The Richmond Agitations-Sedation Scale Validity and Reliability in Adult Intensive Care Unit Patients. *American Journal of Respiratory Critical Care, 166,* 1338-1344. doi:10.1164/rccm.2107138.

Sessler, C. N. (2004). Sedation scales in the ICU. *Chest Journal, 126*(6), 1727-1730.

Sessler, C. N., Grap, M. J., & Ramsay, M. (2008). Evaluating and monitoring analgesia Simpson, T. (2005). Development of the American Association of Critical-Care Nurses' Sedation Assessment Scale for Critically Ill Patients. *American Journal of Critical Care, 14*(6), 531-544.

Songer, T. (2008). Measuring injury severity. Retrieved from http://www.pitt.edu/~epi2670/severity/severity.pdf

Stawicki, S. P. (2007). Sedation scales: Very useful, very underused. Retrieved from http://www.opus12.org/uploads/O12-SCI-V01-N02-P10.pdf

Stefan, M. S., Meng-Shiou, S., Pekow, P. S., Rothberg, M. B., Steingrub, J. S., Lagu, T., & Lindernauer, P. (2013). Epidemiology and outcomes of acute respiratory failure in the United States, 2001 to 2009: A national survey. *Journal of Hospital Medicine, 8*(2), 76-82.

Sztrymf, B., Chevrel, G., Bertrand, F., Margetis, D., Hurel, D., Ricard, J. D., & Dreyfuss, Vasilevskis, E., Mrandi, A., Boehm, L., Pandharipande, P. P., Girard, T. D., Jacson, J. C.,Wesley, E. E. (2011). Delirium and sedation recognition using validated instruments: reliability of bedside intensive care unit nursing assessments from 2007 to 2010. *Journal of American Geriatric Society, 59*(2), 49-55.

Venkat, R., Grap, M. J., & Sessler, C. N. (2005). Protocol-directed weaning: a process of Large-scale implementation of sedation and delirium monitoring in the intensive care unit: a report from two medical centers. *Critical Care Medicine, 33*(6), 1199-205.

Wagner, A. K., Sasser, H. C., Hammond, F. M., Wiercisiewski, D., & Alexander, J. (2000). Intentional traumatic brain injury: epidemiology, risk factors, and associations with injury severity and mortality. *Journal of Trauma, 49*(3), 404-410.

World Health Organization (2013). Internation classification of diseases. Retrieved from http://www.who.int/classifications/icd/en/

Yaman, F., Ozcana, N., Kaymak, C., & Basar, H. (2012). Assessment of correlation between bispectral index and four common sedation scales used in mechanically ventilated patients in ICU. *European Review of Medical and Pharmacological Science, 16*(5), 660-666.

Zabramski, J. (2009, November). [Clinical utility of Propofol sedation with and without a formal "ICU sedation protocol" in intubated neurotrauma patients: The SPIN study.] Unpublished raw data