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# Implementation of a Standardized Tool for Trauma Associated Acute Respiratory Distress Syndrome in Older Adults

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## Abstract

**Introduction:** Advanced aged adults, 65 years old or greater, have a four times greater likelihood of dying after a blunt thoracic traumatic injury (Lotfipour. et al, 2009). Over the last century the number of advanced aged adults in the United States has increased eleven fold and continues to grow annually and double within the next 25 years (Lotfipour. et al, 2009). The elderly population has the highest incidence of hospitalization following a traumatic injury and accounts for the highest percentage of age related deaths across all age groups from complications incurred including pulmonary contusions which may consequently lead to acute respiratory distress syndrome (ARDS) in 50% of patients (Lotfipour et al, 2009; Becher et al, 2012).

**Aim:** To identify, implement, and assess a valid standardized objective thoracic specific tool and diagnostic imaging that may be incorporated in the ER and ICU settings to help decrease the incidence of trauma associated ARDS in advanced aged adults in hopes of reducing hospital length of stay (LOS), required days on ventilator support, morbidity and mortality, and associated costs of care.

**Methods:** Review how the APRN role can positively affect patient outcomes with the use of standardized protocols to decrease morbidity and mortality rates, LOS, and utilization of associated healthcare costs.

**Conclusion:** The use of valid and reliable standardized protocols for patients with blunt thoracic trauma through the use of the Diffusion of Innovations Theory by APRNs will improve patient outcomes, decrease LOS, and associated healthcare expenditures.

**Keywords:** Elderly, Blunt thoracic trauma, Acute respiratory distress syndrome, Advance practice registered nurse, Diffusion of innovations theory

Injury is the leading cause of death in the United States across all age groups (Centers for Disease Control and Prevention, 2008). Advanced aged adults, those 65 years old or greater, have a four times greater likelihood of dying after a blunt thoracic traumatic injury [1,2]. Over the last century the number of advanced aged adults in the United States has increased eleven fold [1]. This number continues to increase annually and will double within the next twenty-five years [1]. The elderly population has the highest incidence of hospitalization after a traumatic injury and accounts for the highest percentage of age related deaths across all age groups [1]. The elderly population has an increased risk of acquiring hospitalized complications from blunt thoracic trauma; such complications include pulmonary contusions leading to Acute Respiratory Distress Syndrome (ARDS) [3].

Acute respiratory distress syndrome occurs in approximately fifty percent of all blunt thoracic trauma patients [3]. It is the most common manifestation occurring after blunt trauma highly associated with pulmonary contusions [4]. Complications, such as ARDS are directly attributed to blunt thoracic trauma and frequently occur within the first twenty-four hour period after being assessed in the hospital [5]. This requires diligence on behalf of the healthcare provider and a keen sense of identification and interpretation of ambiguous assessment symptoms (Table 1) [2].

An astute and accurate assessment completed initially, use of an injury specific objective tool and appropriate diagnostic imaging aids in the prediction of complications that commonly occurs in blunt thoracic trauma patients [6]. Acute respiratory distress syndrome has been previously researched in non-traumatic adult populations with contributing risk factors to include: volume resuscitation, sepsis, and multiple organ

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|---|---|
| Tidal volume (TV) | The volume of air breathed in and out without conscious effort |
| Inspiratory Reserve Volume (IRV) | The additional volume of air that can be inhaled with maximum effort after a normal inspiration |
| Expiratory Reserve Volume (ERV) | The additional volume of air that can be forcibly exhaled after normal exhalation |
| Vital Capacity (VC) | The total volume of air that can be exhaled after a maximum inhalation: VC = TV + IRV + ERV |
| Residual Volume (RV) | The volume of air remaining in the lungs after maximum exhalation (the lungs can never be completely emptied) |
| Total Lung Capacity (TLC) | = VC + RV |
| Minute Ventilation | The volume of air breathed in 1 minute: (TV)(breaths/minute) |
| Forced Exhalation Ventilation (FEV1) | Air exhaled forcefully in one second |
| Forced Vital Capacity (FVC) | Measures total volume of air exhaled form a full lung (TLC) to maximal expiration (RV). |

Source: McCarthy, Dweik, Talavera, & Kamangar, 2016; Vernier Software and Technology, (n.d.).

**Table 1:** Lung Volumes and Capacities.

failure (MODS) [2,4]. Acute respiratory distress syndrome independently has been associated with increased lengths of stay, number of days with ventilator support, morbidity and mortality rates, and utilization costs [4,6].

The aim of this paper is to identify, implement, and assess a valid standardized objective thoracic specific tool and diagnostic imaging that may be incorporated in the ER and ICU settings to help decrease the incidence of trauma associated ARDS in advanced aged adults in hopes of reducing hospital Length of Stay (LOS), required days on ventilator support, morbidity and mortality, and associated costs of care.

## Setting

Injuries from trauma are often seen in the Emergency Room (ER) initially and are generally transferred to the Intensive Care Unit (ICU) for further observation and continued care [2,4]. Blunt thoracic trauma patients have a multitude of injuries attributing to the multifactorial sequelae that follow initial injury and require immediate decision making on behalf of the provider.

## Significance of Problem

Currently, there are a myriad of assessment standards that are utilized across ER and ICU settings [6]. Global trauma scoring systems, such as the Injury Severity Score (ISS), are used in the ER setting but do not address the thoracic specific scoring differentiating parenchymal from bony injury [6].

More than half of all blunt thoracic trauma patients upon initial assessment have no outward clinical symptoms [5]. Risk factors associated with poor prognosis and high mortality rates affiliated with blunt thoracic trauma include: pulmonary contusions and advanced age [1,2]. Pulmonary contusions alone are an independent risk factor of ARDS and deaths associated with trauma and have an estimated mortality rate of approximately 25% [3]. Together ARDS and pulmonary contusions in the advanced aged population have reported mortality rates as high as 50%-80% [1,3,4,6].

Clinical objective symptoms of pulmonary contusions that lead to ARDS complications can be delayed up to twenty-four hours after the initial blunt thoracic injury has occurred [2,3]. Benign symptoms such as simple dyspnea may be easily overlooked as the general population may have the capacity to compensate [3]. Both parenchymal and bony injuries caused by blunt thoracic trauma have been identified as triggering ARDS complications [3].

Parenchymal lung injury in pulmonary contusions inhibits gas exchange and ventilation/perfusion mismatch to occur and are a significant cause of mortality in patients with thoracic trauma [2,7]. During this time hypoxia, alveolar collapse, and lung consolidation occurs rapidly evolving into ARDS within a short period of time [3]. Acute respiratory distress syndrome is thought to be caused by an inflammatory response that is initiated by pulmonary contusions locally and systemically [3].

Acute respiratory distress syndrome has been shown to increase permeability, causing an influx of fluid to enter the lung spaces contributing to the non-compliant lung status [8]. Although, immediate benign symptoms may occur, exaggerated inflammatory responses can be seen during the first twenty-four hour period requiring immediate ventilator support [3].

Blunt thoracic trauma patients frequently have a multitude of injuries adding to the complexity of diagnosis. The elderly population presents additional challenges as most have co-morbidities, which increase their morbidity and mortality rates [1-4,6,7]. The elderly population has decreased physiologic reserves [9]. This translates to reduced sensitivity to elevated CO2 levels and low PaO2 levels [9]. Decreased chest wall compliance and elastic recoil of the elderly lung tissue coupled with blunt thoracic trauma can exponentially intensify complications eleven fold [1,9].

Due to the nature and complexity of the blunt thoracic trauma patient in the elderly population a multidisciplinary approach must be utilized in order to successfully decrease morbidity and mortality associated with ARDS. The Advance Practice Registered Nurse (APRN) in the acute care settings, such as the ER and ICU, is in an excellent position to implement evidence-based research at the bedside [10]. Advanced practice registered nurses are knowledgeable in researching effective solutions to decreasing cost utilization and LOS to improve patient outcomes [11].

## Advanced Practice Registered Nurse Role

Advanced practice registered nurses are being employed in areas of acute care throughout hospitals and are being utilized in acute care settings including both ERs and ICUs [10,12]. There is an increased demand for APRN's to provide care in the ER and ICU areas due to the influx of ER visits and recurrent hospitalizations of the elderly population and are being utilized more in these settings due to the decreased incidence of readmission rates, improved patient outcomes, and cost effectiveness [12,13]. The role of the APRN in the ER setting for trauma patients is comprised of primary, secondary, and tertiary assessments and they have the ability, training, and education to order laboratory and diagnostic tests in order to properly evaluate trauma patients.

Advanced practice registered nurses are an integral part of the collaborative multidisciplinary team, which coordinates

effective and efficient patient care, improves patient outcomes, and decreases cost utilization in acute care settings [11,12]. The implementation of APRN's in the ER has helped to transform the acute care setting as the APRN has integrated evidence-based practice, and advocated engagement of bedside nurses to practice at the highest level possible based on their educational backgrounds [11,12].

Beyond the provider role, APRN's guidance of bedside nurses is of utmost importance. This is accomplished through activities, which APRN's can incorporate in order to engage bedside nurses such as: journal clubs, on site research conferences, various in-services, and simulations [11].

With the increasing demands of healthcare, APRN's are also being utilized to help decompress the healthcare system. Healthcare reform policies, decreased residency hours, and increased demand from the enactment of providing national healthcare to all Americans, the APRN's role continues to grow and be in demand [12].

## Critical Analysis

### Clinical

Clinically there are several areas that have been identified in need of change. There are several trauma severity scoring systems in place throughout ER and ICU settings, causing assessment standards to vary across continuums of care [6]. These scoring systems were originally put into practice to aid in the detection, extent, and assist to formulate a definitive plan of care [6]. The most commonly utilized trauma scoring system in the ER is the Injury Severity Score (ISS) [6].

The ISS is a global severity score utilized in trauma patients, which corresponds to nine different body regions [6]. Validity to determine correlation of morbidity, mortality, and hospital LOS when using the ISS are well established and continue to be utilized despite additional scoring systems put into practice [6]. However, despite its frequent utilization, specific injuries of a body region may be underscored, increasing the incidence of delayed detection, complications, and misdiagnoses [6].

The Thoracic Trauma Severity Score (TTS) is a specific objective tool employed for traumatic thoracic injuries combining both anatomical and physiological parameters to assist in the early detection of possible complications [6]. The TTS system is comprised of five categories to include: PaO2/FiO2 ratio, rib fractures, pulmonary contusions, pleural lesions, and age [6]. The seamless implementation and adaptation of TTS in the ER setting have been associated with its simplicity, ease of use, and ability to predict region specific post-traumatic complications with improved outcomes [6]. Utilization of TTS has been shown to have a high predictive value that is superior to other scoring systems, such as the Abbreviated Injury Scale (AIS chest) the Pulmonary Contusion Score (PCS), & the CT dependent Wagner Score [6].

### Socio-economic

Blunt thoracic trauma is often accompanied with multiple injured areas of the body [1,3,4,6,7]. Additional costs may be incurred typically from the number of surgeries which are required, increased hospital and ICU LOS, utilization costs, and ventilator support days and have been shown to be inversely related to blunt thoracic injuries [1,3,4,6,7].

There are a multitude of factors that are associated with the socioeconomic burdens in elderly patients with blunt thoracic trauma leading to the manifestation of ARDS. Trauma associated ARDS, commonly develops from pulmonary contusions, which is complicated by a course of ARDS and advanced age [1,3,4,6,7].

Increased LOS, ventilator support days and associated costs of supportive care are just a few of the socioeconomic factors of trauma associated ARDS in the elderly population [1,3,4,6,7,12]. Due to the unknown course of events that may occur from a blunt thoracic injury, providers are cautious and often conservative in their management [3]. In doing so, may lead to ordering of a myriad of diagnostic images and serial labs to aid in initial diagnosis. Lotfipour and colleagues (2009) concluded that a chest x-ray has shown a decreased incidence of identifying pulmonary contusions leading to a complicated hospitalization.

Although, pulmonary contusions are primarily the instigator for impending complications leading to the development of ARDS, still other complications should not be ruled out prematurely, such as shock [7]. The development of shock may give rise to an immediate surgical intervention in order to properly identify, diagnose, and manage clinical symptoms [7]. Unnecessary costs associated with untoward surgery may two-fold increase hospitalized and ICU LOS, required days of ventilator support adding to the socioeconomic burdens related to blunt trauma [7].

Supportive care in the ICU may require the use of special equipment, which must be ordered, such as a Rotoprone bed or a high frequency oscillatory ventilator in ARDS patients [14]. Although these interventions have been shown to be beneficial in ARDS patients, the total utilization costs remain high [14]. Both supportive care efforts and interventions that are prematurely initiated prior to a definitive diagnosis incur additional costs and drive the costs of care up exponentially [15].

Although hospital and ICU LOS, and ventilator support days are important aspects contributing to the escalating costs of healthcare, providers should focus and emphasize their efforts at ways to formulate earlier accurate detection of a definitive diagnosis and implement interventions accordingly [16]. The majority of high costs of healthcare have been associated with the first three days following admission when the majority of serial diagnostic imaging and laboratory tests are completed to aid in the definitive diagnosis [16]. This remains true in the advanced aged population in blunt thoracic injuries with a complicated hospital course, which requires a multidisciplinary approach due to unforeseen complications [1,4,6,7,16]. Unforeseen complications that may have been detected using a validated objective scoring system, such as TTS, could help to offset costs associated with utilization [16].

### Psychobehavioral

Psychobehavioral conditions may occur in the elderly population following blunt thoracic trauma. One such condition is Posttraumatic Stress Disorder (PTSD) [17]. Posttraumatic stress disorder occurs in approximately four percent of the elderly population and is characterized by symptoms following a traumatic event [17]. Traumatic events can include blunt thoracic trauma, intubation, and admission to the ICU. Commonly, PTSD

is grouped into three categories. The first category is the re-experiencing of the traumatic event. The second category is persistent avoidance of the event. The last category is persistent and/or physical reactivity.

Re-experiencing the traumatic event can lead to increased stress levels coupled with elevated cortisol levels [17]. Often anxiety is accompanied with re-experience of the traumatic events [18]. Avoidance of discussing thought processes affiliated with the traumatic event might cause feelings of depression and detachment. Persistent and or physical reactivity causes a sense of heightened awareness, which causes a sympathetic response to occur; increasing both epinephrine and norepinephrine levels [17,18].

Identification of PTSD has been linked to morbidity rates after admission to the ICU [19]. Identification of risk factors for PTSD in the elderly has been linked to pharmacologic agents used in the ICU and future disorders [19]. As described previously the majority of blunt thoracic trauma patients are admitted to ICU. Intensive care unit stays can be prolonged from complications such as pulmonary contusions progressing to ARDS and require a multitude of pharmacologic agents to assist in the healing process [1,3,4,6,7].

Commonly pharmacologic strategies are prescribed for PTSD and accompanying conditions [19]. Analgesics, antipsychotics, typical and atypical antidepressants, and anticonvulsants have been shown to aid in decreasing associated disorders including anxiety, avoidance, nightmares, and hyper-excitability; however are contributors to morbidity after discharge from the ICU [19]. A balance should be achieved in the elderly population to create an environment that is comfortable and evaluated periodically for PTSD.

### Professional

Blunt thoracic trauma is commonly associated with a multitude of injuries and therefore a definitive diagnosis with the extent of injuries is needed in order to implement and treat injuries and assist in predicting complications, which may occur [1,3,4,6,7]. Advanced practice registered nurses, as providers, must be knowledgeable in ordering diagnostic tests in order to decrease utilization costs [12,20]. Guerrero-Lopez and colleagues (2000) agree with Trupka and colleagues (1997) finding which identified Computed Tomography (CT) are highly sensitive and are more reliable than the average chest x-ray in detecting thoracic injuries such as, pulmonary contusions. Thus, the importance of implementing management strategies to decrease hospital and ICU LOS, ventilator support days, and morbidity and mortality rates should be a priority for APRN's [12,21].

Computerized tomography has the ability to accurately delineate the extent of injuries in blunt thoracic trauma patients [21]. The use of one diagnostic modality saves time and decreases the length of time to definitive diagnosis [21]. The demand for advanced diagnostic modalities, such as CT, that save time and have the ability to definitively detect the extent of injuries and complications are a necessity in the acute care settings and decrease the need for additional testing [1,3,4].

Implementation of a standardized protocol including the use of standardized protocols, use of CT, and TTS, have been shown to significantly decrease hospital and ICU LOS, fewer ventilator support days, decreased incidence of unnecessary diagnostic testing, and diagnosis delays [21].

### Practical / Logistical

A multidisciplinary systems approach involving the Diffusion of Innovations Theory may be used during implementation of standardized protocols of TTS and CT use [22]. The Diffusion of Innovations Theory is derived from many disciplines and has been incorporated in a variety of practices, and technologies [22]. In a multidisciplinary approach the Diffusion of Innovations Theory has the ability to implement changes system-wide [22]. Implementations in clusters have shown to more readily and easily adopted when they are complimentary in nature [22].

Logistically the implementation of a severity scoring system can be done throughout the hospital system, but for the purpose of this paper will focus solely on the ER and ICU settings. The APRN has the knowledge and ability to facilitate, implement, instruct, and seamlessly provide care with the standardization of TCC in blunt thoracic trauma in elderly patients. The TCC scoring system has a statistically significant predictive value for determining possible causal relationships between blunt thoracic traumas in the elderly population and the associated prevalence of complications [6].

Diffusion of evidence-based research systematically can occur rapidly and has been identified as the most valuable contribution that hospitals can make to better their organizations and the communities of which they serve [22]. The ability to disseminate new information has been shown to occur with implementers and early adopters and varies with the rates of diffusion down to the late adopters and laggards [22]. However, the rate of adoption of innovations system-wide can be operationalized by accelerating the diffusion process by incorporating the late adopters and laggards early on during the implementation process [22].

When those that are undertaking the challenge can conceptualize benefits of the change, the need for change is seen and is practical to implement [22]. The implementation of CT diagnostic imaging is practical for trauma patients as the majority currently undergo a score of diagnostic testing [1,3,4,7].

## Comprehensive Multidisciplinary Approach

Research, is the initial step in implementing changes at the bedside. The need for a change to occur can be obvious and easily accessible when calculating morbidity and mortality rates. Deficiencies in the ER and ICU setting are frequently overlooked due to the persevering efforts toward the ongoing emergencies in these areas. However, there is a need for continued improvement efforts to augment patient outcomes.

After analyzing areas in need of change and evidence based findings to enhance patient outcomes a multidisciplinary approach is quintessential to efficacious outcomes. Key stakeholders in the ER and ICU settings as well as administration must be identified. Gaining hospital administrations approval is pivotal to implementing and sustained change in the acute care setting [12].

Hospital administration must see the value financially in implementing change. For obvious reasons hospitals must maintain a budget and are cautious when making changes, which may affect them financially. However, APRN's have the knowledge

to utilize current resources without adding costs. Changing ventilator settings prophylactically with lower tidal volumes to decrease the incidence of ARDS occurring is one such example of utilizing current resources.

Trauma patients are brought initially into the ER and make contact with the ER provider. Generally, bedside nurses carry out the orders given by the provider and provide the majority of care to those admitted in the acute care settings. Bedside nurses are proponents of implementing change at the bedside and play a crucial role. Transferring the patient to an alternate acute care setting such as an ICU where the appropriate continuum of care can be maintained is routine. The needs of the patient and complications, which may occur, are continually assessed. The nurses in both the ER and ICU settings should be taught the TCC scoring system so that they are competent in its use.

Pharmacists, laboratory personnel, respiratory therapists, pulmonologists, and radiologists are also key stakeholders and must be encompassed in the change project. Buy in from all multidisciplinary teams is imperative to successful integration of a standardized protocol. Although each role is different in the patient exchange, all levels must know the intricacies of how these roles are intertwined for successful standardization of protocols to occur.

Advanced practice registered nurses can integrate simulation into teaching methodologies for nurses, physicians, and other healthcare providers alike. Simulation has been shown to increase awareness of numerous conditions, which require immediate actions [12,23]. Competence gained through simulation has been shown to both increase awareness and confidence levels simultaneously [23]. One of the integral parts of simulation is the debriefing process and is a necessary component of simulation where areas of improvement can be recognized [23]. Use of simulation in the hospital setting is critical when competence is required for favorable outcomes [23]. Simulation can be utilized throughout the hospital organization to help prevent complications from occurring, decrease utilization costs, increase confidence levels of healthcare providers, and increase positive patient outcomes [23].

## Evaluation

A retrospective review during two time periods will help to determine improvement in the ER and ICU settings. The first time period must be completed prior to the implementation of the standardized protocol, the second following. Percentage of ARDS complications occurring can be evaluated by computing the data using the Fisher's exact test to compare differences in proportions of variables [3]. A multivariate regression analysis of TTS, CT, and contributing factors for ARDS associated with blunt thoracic trauma in the elderly can be computed.

These research findings can be analyzed in periods at six months to one year and changes implemented based on the results. The results should be disseminated to all disciplines and acute care settings in which the implementation occurred [24-27]. This will allow key stakeholders to take ownership of their efforts. Results providing improved patient outcomes will greatly increase moral, confidence levels, and competence in providing care in the acute care setting.

Change is a revolving continuum that must be re-evaluated throughout the implementation process. Progress of sustained implementation must also be reanalyzed periodically. The Diffusion of Innovation Theory can help identify early adopters from laggards. This can help target certain groups in need of additional education and possibly simulation experience. Re-evaluating current data helps to establish which implementations are working and which ones are in need of additional augmentation. The APRN has the professionalism to effectively overcome challenges and alter specific areas while working in a collaborative manner within multiple disciplines.

## Conclusion

Blunt thoracic trauma in the elderly population presents with a multitude of co-morbidities, increased rates of morbidity and mortality, increased utilization costs, and complicated hospital courses. The implementation of a standardized protocol including TTS and use of CT can help to detect and decrease complications, decrease associated utilization costs, and ultimately improve patient outcomes with the use of the Diffusion of Innovation Theory will assist in standardization and will identify early adopters and laggards alike. These efforts of APRNs are one of a collaborative and multidisciplinary team working towards early detection and definitive diagnosis with decreased incidence of associated complications and conditions attributing to positive patient outcomes [12].

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