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Does a Surgical Post-Acute Unit Help Elders With Rib Fractures? Definitely Maybe!

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ABSTRACT

A surgical post-acute treatment unit (SPA) was developed for acutely injured elderly patients who no longer warranted acute care in an intensive care setting to decrease complications by focusing increased bedside attention to cognition, nutrition, respiration, and mobilization. A retrospective review was performed comparing patients 65 years and older with isolated rib fractures treated before the SPA was opened with patients treated in the SPA. The 2 populations were comparable except the SPA group had a higher mean Injury Severity Score. Nine complications occurred in the pre-SPA group, and no complications occurred in the SPA patient population. Four patients in the pre-SPA group died compared with zero deaths for the SPA group. The rates of complications and mortality between elderly patients with isolated rib fractures were not statistically different between patients treated with a traditional admission to an inpatient ward and patients admitted to the SPA, even though the SPA patients had significantly more severe chest injuries. Establishing a physical environment to support the needs of elderly trauma patients with isolated rib fractures who no longer need the intensive care unit (ICU) is effective in decreasing the complications and unplanned returns to the ICU.

Key Words

Complications, Elderly, Geriatric, Rib fracture, Surgical post-acute, Trauma

We have previously reported that a surgical post-acute treatment unit (SPA) is effective in decreasing complications for elderly patients after hip fracture by focusing bedside attention to four areas in need of special attention in this at-risk population: cognition, nutrition, respiration, and mobilization (DiGiacomo et al., 2019). It is known that the elderly population is at a significant risk for complications related to pulmonary function and dehydration (DiGiacomo et al., 2019; Norton, McLaren, & Exton-Smith, 1962; Phillips et al., 1984). The presence of any cognitive spectrum disorder, such as preexisting dementia, postoperative cognitive dysfunction, subsyndromal or frank delirium, or other unspecified cognitive impairments, will only contribute to magnify those issues (O'Brien, Mohan, O'Hare, Reynolds, & Kenny, 2017; Reynish et al., 2017). Therefore, increased bedside attention is of the utmost importance in this specific patient population.

The most common types of clinically significant blunt injury to the thorax are rib fractures (Bulger, Arneson, Mock, & Jurkovich, 2000; Omert, Yeaney, & Protetch, 2001; Ziegler & Agarwal, 1994). Between 2006 and 2009, there were 844,383 emergency department (ED) visits with a primary diagnosis of rib fracture in the United States, of which 16% resulted in hospital admission (Kirch, Tadros, Davidov, & Davis, 2013). In elderly trauma patients, rib fractures are third in line of frequency, with 10% attributed to standing-level falls (Bulger et al., 2000; Evans, Pester, Vera, Jeanmonod, & Jeanmonod, 2015).

With an increasing elderly population in the United States and resultant increase in the geriatric trauma cases, it has become an utmost necessity to focus attention to the specific requirements of care for this specific patient population to decrease morbidity and mortality and optimize outcomes in common injuries such as rib fractures (Campbell, Degolia, Fallon, & Rader, 2009; Holcomb, McMullin, Kozar, Lygas, & Moore, 2003; Kelley et al., 2019). Rib fracture protocols have been shown to result in improved outcomes in elderly trauma patients. The fundamental feature of the protocols commonly highlights the need of increased bedside attention to assist in getting the patient out of bed to the chair, incentive spirometry usage encouragement, chest physiotherapy, and the early recognition for increased intervention if needed (Pyke et al., 2017; Sahr, Webb, Hackett-Renner, Sokol, & Swegle, 2013; Winters, 2009).

We have previously showed that the SPA decreased complications compared with a standard medical/surgical floor setting for geriatric patients with hip fractures

Author Affiliation: Division of Trauma, Department of Surgery, Nassau University Medical Center, East Meadow, New York.

Presented as a poster at the Trauma Center Association of America Annual Scientific Meeting, Las Vegas, NV, April 2019.

All authors aver that each has no conflicts of interest to declare.

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DOI: 10.1097/JTN.0000000000000489

(DiGiacomo et al., 2019). The purpose of this study was to determine whether the SPA had a similar impact for geriatric patients with rib fractures.

METHODS

Study Design

This quality improvement study is a retrospective cohort analysis of elderly patients with rib fractures. Using a nonequivalent historical control group design, patients 65 years and older with isolated rib fractures transitioning from intensive care unit (ICU) were compared before and after the opening of the SPA. After receiving institutional review board approval, patients 65 years and older who were admitted to the trauma service with isolated closed rib fractures were identified from the trauma registry and selected for inclusion into the study. Rib fracture and associated injuries were ascertained using the 2005 Abbreviated Injury Scale (AIS) coding system and *International Classification of Diseases, Ninth and Tenth Revisions* (*ICD-9/10*) diagnostic codes. Patients with a rib fracture injury, a chest AIS severity score of 3 or less, and a non-chest AIS severity score that was less than or equal to their chest AIS severity score were defined as having isolated rib fractures. Patients were excluded from the study if their abdominal AIS severity score was greater than 2, if they had a chest tube placement, if they had a pelvic or lower extremity fracture, if they received cardiopulmonary resuscitation, or if they received a major intra-abdominal or lower extremity operation. These patients were excluded because their injuries and interventions were either superior or would be complicating or limiting in their care.

Study Setting and Population

Nassau University Medical Center is an urban public safety net comprehensive medical center and teaching hospital, as well as a Level 1 trauma center verified by the American College of Surgeons in Nassau County, New York, and serves a population of nearly 1.4 million people. The ED sees an average of 75,000 patients a year, and the Trauma Center admits approximately 1,700 patients a year, of which approximately 90% are due to blunt mechanisms of injury. All injured patients are admitted to a surgical specialty service, with the overwhelming majority admitted directly to the Trauma Service of the Department of Surgery, which is primarily responsible for their care and management.

Description of Intervention

A focused Trauma Performance Improvement review was conducted for unplanned ICU admissions from 2012 to 2015. Twenty-three unplanned ICU admissions occurred over that 4-year period, with a marked increase in 2014, coincident with a 30% increase in trauma admissions. Seven of the 23 patients died. The majority of the unplanned ICU admissions were geriatric patients with compromised mobility along with dehydration, hypernatremia, respiratory complications, and renal dysfunction. The causative factors appeared to be the same as those identified by Doreen Norton, R N, in her seminal work of 1962: "The exceptionally low intake … appears to have been due to a combination of these factors with one factor predominant—They could not, or did not, express a desire for drinks and their low intake was not recognized" (p. 50). We theorized that these elderly patients simply needed an increased level of support and attention at the bedside centered on the four core areas of cognition, nutrition, respiration, and mobilization (DiGiacomo et al., 2019).

As a semi-closed six-bed floor equivalent nonmonitored unit, the SPA receives patients from the ICU who no longer warrant care in an ICU setting but, based on our previous experience, are felt to be at an increased risk for complications in a standard floor setting. It is staffed by one registered nurse and two patient care assistants (PCAs) and is supported by Nutrition, Physical and Occupational Therapy, Physical Medicine and Rehabilitation, Respiratory Therapy, and Social Work. Functionally, it is the "floor plus" and utilized for any patient who is felt would benefit from the extra bedside attention, regardless of age or primary diagnoses. Cognition is addressed with environmental modifications; nutrition is addressed by tracking all oral intake and assistance as needed for all meals; respiration is addressed by getting the patient out of the bed to a chair, ambulation, incentive spirometry, and bedside care by a respiratory therapist; and mobilization is addressed through daily physical therapy supplemented by the SPA staff and Occupational Therapy. Primary medical management is provided by the surgical intensive care unit (SICU) physicians and their primary admitting service, which in most cases is the Trauma Service (DiGiacomo et al., 2019).

Data Collection

Study subjects were divided into two group. The pre-SPA group comprised patients admitted in the 26 months before the SPA opened (from January 1, 2013, to February 28, 2015). The SPA group comprised patients admitted into the SPA from the SICU in the 31 months after the SPA opened (May 1, 2016, to December 31, 2018). The study sample flowchart is presented in Figure 1.

Demographic, injury, hospitalization, and outcome information was compared between the pre-SPA and SPA groups. Outcomes included ICU and hospital length of stay, reportable in-hospital complications as defined by the National Trauma Data Standard (NTDS) and in-hospital mortality and were obtained from the

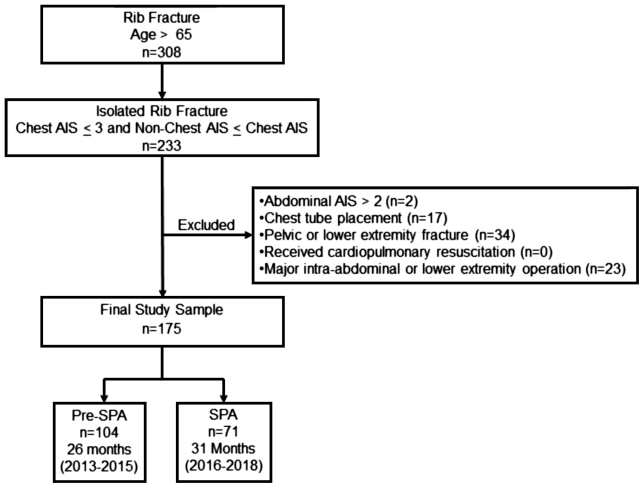

Figure 1. Study flowchart. AIS = Abbreviated Injury Scale; SPA = surgical post-acute treatment unit.

trauma registry supplemented as needed by direct medical record review.

Data Analysis

Means and standard deviations were calculated for continuous variables. Counts and relative frequencies were calculated for categorical variables. Mean and frequency differences between the study groups were assessed using Student's *t* test and Pearson's chi-square test. Student's *t* test was chosen to assess the continuous variables because there were more than 30 patients in each study group, thereby satisfying the assumptions of the central limit theorem. The values of $p < .05$ were considered statistically significant for all statistical tests conducted. SAS Version 9.4 (SAS institute, Cary, NC) was used for all analyses.

RESULTS

Three hundred eight patients 65 years and older were initially identified as having sustained rib fractures. Two hundred twenty-three qualified as having rib fractures as their sole thoracic injury. Patients were then excluded if they received a chest tube; had an abdominal AIS score of greater than 2; had concomitant pelvic or lower extremity fractures; or underwent a major abdominal or lower extremity operative procedure. Some patients had more than one exclusion criterion. In total, 175 patients 65 years and older with isolated rib fractures were identified: 104 in the pre-SPA group and 71 in the SPA group (Figure 1). The demographic, injury, and hospitalization characteristics of the study population are presented in Table 1. The demographic characteristics were comparable between the pre-SPA and SPA populations. The patients' mean age was 82 years, and 58% were female. The injury characteristics were comparable between both populations as well.

TABLE 1 Population Characteristics Comparison of Pre-SPA and SPA Patients

Characteristics	Pre-SPA (*n* = 104)	SPA (*n* = 71)	*p*
Age, mean ±*SD*	81.3 ± 8.8	82.6 ± 8.8	.3345
Gender			.5284
Male	46 (44.2%)	28 (39.4%)	
Female	58 (55.8%)	43 (60.6%)	
Mechanism of injury			.2096
Fall	63 (60.6%)	51 (71.8%)	
Motor vehicle/cycle crash	33 (31.7%)	19 (26.8%)	
Pedestrian struck	4 (3.9%)	0 (0.0%)	
Other[a]	4 (3.9%)	1 (1.4%)	
Injury Severity Score, mean ± *SD*	8.5 ± 4.1	10.4 ± 4.6	.0053*
Glasgow Coma Scale score, mean ± *SD*	14.7 ± 1.0	14.8 ± 0.5	.3488
Revised Trauma Score, mean ± *SD*	7.8 ± 0.3	7.8 ± 0.1	.3164
Mechanical ventilation	4 (3.8%)	0 (0.0%)	.1475
Intensive care unit admission	25 (24.0%)	71 (100.0%)	<.0001*

Note. SPA = surgical post-acute treatment unit.
[a]Other: Hit by blunt instrument, bicyclist, pedestrian struck, fight or brawl, other.
**p < .05.*

TABLE 2 Comparison of Outcomes Between Pre-SPA and SPA Patients

Patient Outcomes	Pre-SPA (n = 104)	SPA (n = 71)	p
ICU length of stay, days			
All patients, mean ±*SD*	0.8 ± 2.2	2.0 ± 1.8	.0001*
ICU admits only, mean ±*SD*	3.2 ± 3.4	2.0 ± 1.8	.0896
Hospital length of stay, mean ±*SD*, days	3.3 ± 4.7	3.8 ± 3.3	.4232
In-hospital mortality	4 (3.8%)	0 (0.0%)	.1475

Note. ICU = intensive care unit; SPA = surgical post-acute treatment unit.
**p < .05.*

There was no significant difference in the mean Glasgow Coma Scale score, the mean Revised Trauma Score, or the distribution of mechanism of injuries. However, the SPA population had a significantly higher mean Injury Severity Score (ISS; 10.4 vs. 8.5, $p < .01$). As the SPA is designed to be an intermediate environment between the SICU and the standard inpatient ward, that all SPA patients were initially admitted to the SICU is by design (SPA 100% vs. pre-SPA 24.0%; $p < .0001$). The pre-SPA group had a significantly higher proportion of patients who were mechanically ventilated (3.9% vs. 0.0%).

The comparison of patient outcomes is presented in Table 2. On average, when admitted, SPA patients spent fewer days in the ICU than the pre-SPA patients (2.0 vs. 3.2 days, respectively). The in-hospital mortality rate was lower for SPA patients as well (0.0% vs. 3.8%). In addition, 4.8% of the pre-SPA patients acquired an NTDS reportable in-hospital complication, whereas none of the SPA patients did (Table 3). The reportable complications acquired by the pre-SPA patients included acute respiratory distress syndrome (ARDS; 1.0%), pneumonia (1.9%), urinary tract infection (UTI; 1.0%), unplanned intubation (1.9%), and unplanned return to the ICU (2.9%), all of which were zero for the SPA patients.

DISCUSSION

Compared with nongeriatric trauma patients, geriatric trauma patients have worse outcomes due to comorbid conditions, medications, and frailty, requiring more resource-intensive care and bedside attention (Bergeron et al., 2006; Clegg & Young, 2011; Labib et al., 2011). Often, the only alternative is to keep these patients at increased risk in the ICU until discharge, at a nurse-to-patient ratio of 1:2 (DiGiacomo et al., 2019). By supplying that level of care with a nurse-to-patient ratio of 1:6 and a PCA-to-patient ratio of 2:6, the SPA provides focused attention to the four areas we consider vital to success in these patients: cognition, nutrition, respiration, and mobilization. We believe this essentially 1:2 ratio housed in a single location, supplemented by the aggressive inclusion of support services (i.e., physical therapy, occupational therapy, respiratory therapy), is responsible for decreasing the complications of ARDS, pneumonia, UTI, unplanned intubation, and unplanned return to the ICU from 1.0%–2.9% to 0% and would not be achieved if these component services were spread out across different locations in the medical center (DiGiacomo et al., 2019).

We found no statistically significant difference between the group of elderly patients treated in the SPA and those treated before the SPA was implemented, despite

TABLE 3 Comparison of Complications Between Pre-SPA and SPA Patients

Complications	Pre-SPA (n = 104)	SPA (n = 71)	p
Any NTDS-reportable complication	5 (4.8%)	0 (0.0%)	.0813
Acute respiratory distress syndrome	1 (1.0%)	0 (0.0%)	1.0000
Pneumonia	2 (1.9%)	0 (0.0%)	.5150
Unplanned return to the ICU	3 (2.9%)	0 (0.0%)	.2725
Unplanned intubation	2 (1.9%)	0 (0.0%)	.5150
Urinary tract infection	1 (1.0%)	0 (0.0%)	1.0000

Note. ICU = intensive care unit; NTDS = National Trauma Data Standard; SPA = surgical post-acute treatment unit.

the SPA group having a statistically significantly higher ISS. Because a highly focused population of patients with isolated rib fractures was compared, that the outcomes and complications between the two groups were not statistically significantly different are clinically significant and support the efficacy of the SPA. We see significant clinical relevance in the reduction of the need for mechanical ventilation from 3.8% to 0%, of all complications from 4.8% to 0%, and mortality from 3.8% to 0% (Table 3). Of note, while 2.9% of pre-SPA patients had unplanned returns to the ICU, none occurred among the 71 SPA patients.

The increased mortality rate in elderly patients due to the presence of rib fractures and the need for mechanical ventilation is a known risk factor for complications and mortality in this patient population (Carson, Cox, Holmes, Howard, & Carey, 2006; Santa Cruz et al., 2019). We believe the overall impact of the level of care the SPA provides contributed significantly to the reduction in pneumonia, unplanned intubations, and the need for mechanical ventilation in the SPA population despite the higher ISS.

Limitations

We believe our small SPA patient population sample size accounts for the lack of statistical significance in the measures of mechanical ventilation, complications, and mortality. As the pre-SPA study sample is fixed at 104 patients, a power analysis determined that we will need at least 400 SPA patients to reach 80% power to identify a 5% mortality difference. Given how specific this group with isolated rib fractures is, we required 31 months to acquire 71 patients. It will therefore require a number of years before this study group attains sufficient numbers to give statistical significance to the other parameters of improved outcomes that are implied by the raw numbers, especially in the areas of decreased complications and mortality.

Complications were obtained from the trauma registry, which are those complications defined by the American College of Surgeons Trauma Quality Improvement Program (TQIP). These complications are identified concurrently during each patient's in-patient stay by the trauma performance improvement coordinator and on retrospective review of each record after discharge by the trauma registrars when the record is entered into the trauma registry. Although there may be legitimate concerns over the accuracy of the reporting of complications if this study had been mined from the National Trauma Data Bank (NTDB), this current study is a pre- and postintervention retrospective assessment from a single institution (Dente et al., 2016; Kardooni et al., 2008; Phillips, Clark, Nathans, Shiloach, & Freel, 2008). Therefore the acquisition of data would be consistent between the study periods and mitigate such concerns.

We have previously reported preliminary results of the impact of the SPA on geriatric patients with hip fractures, which were also impacted by low patient numbers (DiGiacomo et al., 2019). As the number of patients treated in the six-bed unit continues to increase over time, follow-up studies on geriatric patients with isolated hip fractures and rib fractures will occur, as will focused evaluation of the efficacy of the SPA for geriatric patients with upper extremity fractures and traumatic brain injuries.

CONCLUSION

Establishing a physical environment such as the SPA to support the needs of elderly trauma patients with isolated rib fractures who no longer need ICU services is effective in decreasing the complications and unplanned returns to the ICU. We have seen improved clinical outcomes in our elderly trauma patients since the SPA has been implemented in our institution in patients with isolated hip fractures and now with isolated rib fractures. We believe we will continue to see the trend of improved outcomes with other common isolated injuries in the elderly trauma patients as well and this preliminary study serves to that effect.

KEY POINTS

- Geriatric and elderly patients are at an increased risk for complications after trauma and ICU care.
- An increased delivery of care at the bedside focused on cognition, nutrition, respiration, and mobilization decreases the incidence of complications for these patients with isolated rib fractures.
- The SPA is an enhanced post-ICU environment that provides the necessary bedside care to at-risk patients to decrease complications with a minimal increase in staffing.

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