Rural Residential Status Does Not Impact 1-Year Mortality Rates Following Proximal Femur Fracture Fixation

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Abstract

Background: Proximal femur fractures are a common and serious injury in the geriatric population, often requiring surgical fixation to reduce morbidity and mortality. While previous studies have identified risk factors associated with poor outcomes, the influence of social determinants of health, specifically rural residence and socioeconomic deprivation, remains less clear. Rural patients face unique healthcare access challenges, including longer travel distances and reduced availability of specialized care, potentially affecting outcomes after surgery. Understanding how residential and socioeconomic status influence mortally is essential to improving care for this population.

Objectives: To investigate the relationship between rural residential status and 1-year all-cause mortality rates in geriatric patients following operative fixation of proximal femur fractures.

Methods: A retrospective review was conducted on geriatric patients (≥65 years old) presenting with proximal femur fractures at a midwestern Level 1 trauma center between January 1, 2019, and January 1, 2023. Patient demographics, fracture classification, socioeconomic status (National Area Deprivation Index [ADI] quartile), and residential status (Rural Urban Commuting Area [RUCA]) were collected. Patients were categorized by ADI quartiles and RUCA scores to assess socioeconomic and residential impacts on outcomes. Descriptive statistics were calculated to report means, ranges, standard deviations, and percentages. Demographics were compared between groups, with chi-square or Fisher's exact scores used for categorical variables, and the non-parametric Mann-Whitney U tests used for continuous variables due to lack of data normality. For comparison of continuous variables among ADI quartiles, Kruskal-Wallis tests were used, and Fisher exact tests were used for categorical variables.

Design: Retrospective cohort Analysis

Setting: Academic Level 1 Trauma Center.

Patient Selection Criteria: All geriatric patients presenting with proximal femur fractures who underwent operative fixation between January 1, 2019, and January 1, 2023.

Outcome Measures and Comparisons: The primary outcome was 1-year all-cause mortality. Secondary measures included patient age, sex, length of hospital stay, and differences based on socioeconomic and residential status.

Results: 589 patients were included in the RUCA analysis and 577 in the ADI analysis. One-year all-cause mortality was 15.8% (n=94). There was no statistically significant difference in 1-year mortality based on rural, suburban, or urban residential status (p=0.67), nor across quartiles of socioeconomic deprivation measured by Area Deprivation Index (p=0.55). Rural patients were more likely to reside in areas of higher socioeconomic deprivation (p<.001), but this did not impact 1-year survival.

Conclusions: With the increased closure of rural hospitals, rural patients are required to travel greater distances for orthopaedic care, causing an increased number of rural patients presenting at urban hospitals. The data reported by the current study suggests that rural geriatric patients do not have significantly higher 1-year all-cause mortality rates compared to urban geriatric patients who are operatively treated for proximal femur fractures.

Introduction

Proximal femur fractures contribute to over 500,000 hospitalizations each year, accounting for 26% of orthopaedic fractures in the United States geriatric population.[1–3] The mortality rate for nonoperatively managed proximal femur fractures is 46.1% compared to 18.0% for operatively managed patients[4], leading to most being managed operatively.[5] Several factors are known to be associated with an increased one-year mortality rate including advanced age, medical comorbidities, poor ambulatory status, and male sex.[6–10] As surgeons seek to elucidate other factors that make

contribute to increased mortality risk, social determinants of health (SDOH) such as measures of neighborhood status and measures of rural status may help identify at-risk patients.

Area Deprivation Index (ADI) scores are a socioeconomic neighborhood measures that take into account 17 unique components from the United States census data to provide a metric of income, education, employment, and housing quality for a given area.[11] Previous literature has pointed towards higher levels of socioeconomic deprivation associated with significantly increased risk of mortality at 30, 90, and 365 days following a proximal femur fracture compared to more affluent patients.[12,13] However, these studies do not take into account the rural, suburban, or urban status of a patient's home residence. Rural, suburban, or urban residential status is classified based on rural urban commuting areas codes (RUCA), urban influence codes (UIC), metropolitan statistical area (MSA), and rural urban continuum codes (RUCC).[14–16] Further, rural hospitals across the United States are closing, limiting access to care for people in these areas by requiring them to travel longer distances to receive care.[17,18]

To the authors knowledge, no study has investigated the relationship between rural residential status and outcomes following proximal femur fracture fixation. Our hypothesis is that patients living in rural areas have higher 1-year all-cause mortality rates compared to urban patients. The null hypothesis is that there is no difference in mortality rates for patients living in rural areas.

Methods

Data Collection

The current study was reviewed and approved by the institutional review board of the University of Missouri School of Medicine. A retrospective review of all geriatric (>65 years old) patients who presented to a midwestern Level 1 trauma center with a proximal femur fracture and subsequent operative management between January 1, 2019, and January 1, 2023, was completed. Patients were identified through data pulls for international classification of disease (ICD)-9 and ICD-10 codes. ICD-9 codes, 808-808.54, and ICD-10 codes, S32.4-S32.81B, were used for this study. Patient age at time of admission, admission date, discharge date, sex, race, marital status, insurance type, tobacco use status, proximal femur fracture classification, home zip code, discharge location (home, skilled nursing faculty, transfer), American Society of Anesthesiologists (ASA) score, and complications were gathered from the electronic medical record (EMR). Patients who sustained an acetabular fracture or periprosthetic fracture were excluded. Additionally, patients who died during their inpatient stay were excluded.

Area Deprivation Index Scores

ADI scores are used as a numeric proxy for socioeconomic deprivation.[19,20] Scores are separated into United States percentiles. United States ADI scores range from 0 to 100.[21] Scores near 0 indicate an individual with high socioeconomic standing in society and scores near 100 indicating high levels of socioeconomic deprivation. ADI scores are normalized to the United States population to yield a mean score of 50 with a standard deviation of 10. Patient home addresses are used to calculate US ADI scores. Patients were grouped from US ADI 0-25, 26-50, 51-75, 76-100 for comparison. The grouping of ADI quartiles has been previously described in orthopaedic literature.[22–24] The use of national ADI scores for socioeconomic value is well accepted.[25–28]

Rural Urban Commuting Area Scores

Residential setting is commonly defined using Rural Urban Commuting Area (RUCA) scores by the United States Department of Agriculture based on population density, urbanization, daily commuting, and healthcare access.[14] RUCA scores are calculated based on the patients' home zip code. A RUCA score of 1 to 2 indicates an urban setting, 3 to 5 indicates a suburban setting, and 6 to 10 indicates a rural setting. The use of RUCA scores as a proxy for rural, suburban, and urban status is well accepted.[29–31]

Statistical Analysis

Descriptive statistics were calculated to report means, ranges, standard deviations, and percentages. Patients were first grouped by survival to discharge, and then by survival at 1-year. Demographics were compared between groups, with chi-square or Fisher's exact scores used for categorical variables, and the non-parametric Mann-Whitney U tests used for continuous variables due to lack of data normality. For comparison of continuous variables among ADI quartiles, Kruskal-Wallis tests were used, and for categorical variables, Fisher exact tests were used. Odds ratios were calculated when significant differences were identified. Significance was set *a priori* at $p<.05$.

Table 1. Characterization of proximal femur fracture fixation patients based on residential status

Demographic factor	Urban	Suburban	Rural	p-value
Sex				
Male	95	42	56	*p=0.34*
Female	180	77	139	
Age (mean), sd	80.2 (8.56)	79.4 (9.03)	79.9 (8.82)	*p=0.89*
Race				
White	262	116	190	*p=0.26*
Non-white	11	2	3	
Marital status				
Married	112	39	76	*p=0.35*
Single	160	77	116	
Insurance status				
Commercial	14	5	9	*p=0.89*
Medicaid	2	0	0	
Medicare	237	106	175	
Under-insured	22	8	11	
Tobacco use				
Current	34	21	25	*p=0.37*
None	238	98	165	
Length of stay (mean), sd	6.84 (5.77)	7.67 (4.69)	7.45 (6.04)	*p=0.24*
ASA score				
1	0	0	0	
2	50	14	24	*p=0.07*
3	180	90	131	
4	45	13	39	
Survival at 1-Year				
Survived	235	99	161	*p=0.67*
Did not survive	40	20	34	
Fracture classification				
Intertrochanteric	93	50	79	*p=0.62*
Femur	38	19	21	
Head/neck	126	46	83	
Peritrochanteric	8	2	7	
Subtrochanteric	9	2	5	

Key: ASA Score; American Society of Anesthesiologists Score, sd; Standard Deviation

Results

A total of 605 geriatric patients presented to our level 1 trauma center with proximal femur fractures and underwent operative management. Of the 605 patients who were operatively managed, 589 met inclusion criteria for the residential status cohort and 577 met inclusion criteria for the area deprivation index cohort. Five patients were excluded as they did not survive their initial hospital stay, 11 patients did not have information necessary for a RUCA score determination, and 23 patients did not have information necessary for an ADI score determination. (**Table 1**)

Survival Based on Residential Status

Patients were grouped by living status using RUCA codes to classify them as urban (n=275), rural (n=195), or suburban (n=119). Rural, suburban, and urban patient status was not associated with a difference in 1-year mortality (p=0.67). Rural patients were more likely to live in an area with higher ADI scores compared to suburban and urban patients. No significant differences were identified between rural, suburban, and urban patients in patient's age (p=0.89), tobacco use (p=0.37), length of hospital stay (p=0.24), 1-year survivorship (p=0.67), or fracture type (p=0.62).

Table 2. Characterization of proximal femur fracture fixation patients based on United States Area Deprivation Index quartiles

Comparisons Based on US ADI Quartiles					
ADI Quartiles, (n)	1	2	3	4	p Value
Number of Patients	6	112	250	209	1.0
Age (sd)	72.8 (7.1)	81.3 (8.2)	80.5 (8.9)	78.6 (8.6)	0.36
Sex					
Male	1	38	86	63	
Female	5	74	164	146	0.67
Race					
White	6	109	243	198	
Other	0	2	5	9	
Unknown	0	1	2	2	0.43
Marital Status					
Single	3	62	145	134	
Married	3	47	104	70	0.07
Insurance Status					
Commercial	0	3	10	14	
Medicaid	0	1	0	0	
Medicare	5	99	227	178	
Uninsured	1	9	13	17	0.23
Length of Hospital Stay					
Day(s) (sd)	4.0 (2.4)	6.8 (6.6)	7.5 (6.3)	7.2 (4.2)	0.50
Tobacco Use					
Yes	0	14	32	33	
No	6	97	217	171	
Unknown	0	1	1	5	0.65
Residential Status					
Urban	6	101	123	40	
Suburban	0	2	51	66	
Rural	0	9	76	103	<.001
ASA Score					
1	0	0	0	0	
2	3	19	28	37	
3	3	74	175	141	
4	0	17	46	31	
5	0	0	0	0	
6	0	0	0	0	0.09
1-Year Survival					
Yes	6	92	206	180	
No	0	20	44	29	0.55

Key: ADI; Area Deprivation Index, ASA Score; American Society of Anesthesiologists Score, sd; Standard Deviation

Area Deprivation Index Quartiles

Patients with higher ADI scores, indicating greater levels of socioeconomic deprivation, were significantly more likely to live in a rural environment (p<.001). There were no significant differences found between ADI quartiles for age

(p=0.36), sex (p=0.67), race (p=0.43), marital status (p=0.07), insurance status (p=0.23), length of hospital stay (p=0.50), tobacco use (p=0.65), ASA score (p=0.09), 1-year survivorship (p=0.55), or fracture type (p=0.85). (**Table 2**)

Patients were grouped by living status using RUCA codes to classify them as urban (n=275), rural (n=195), or suburban (n=119). Rural, suburban, and urban patient status was not associated with difference in 1-year mortality.

Discussion

The results of the current study allow for rejection of the hypothesis that patients undergoing proximal femur fracture fixation and living in rural areas will have higher 1-year all-cause mortality rates compared to urban patients. The current study found that rural patients and urban patients have similar mortality rates of 1-year following proximal femur fracture surgery. Previous literature has reported that rural and urban patients have significantly higher mortality rates among rural patients compared to urban patients at the1-year time point.[32,33] The methodology used to classify patients as urban and rural may be contributing to these reported inconsistencies. The aforementioned studies analyzed patients presenting at hospitals designated as urban or rural hospitals. Classifying a hospital as rural or urban does not accurately reflect the patient population it serves. Many rural patients often travel long distances to urban centers for specialized care, such as treatment for complex fractures. As a result, patients from rural areas may be incorrectly categorized as urban simply because they receive care at an urban facility.

Despite previous studies suggesting socioeconomic deprivation is associated with increased postoperative mortality, the current study found no significant association with 1-year mortality and ADI scores.[12] A possible explanation for this discrepancy is that the current population was treated at a level-1 trauma center with a dedicated orthopaedic trauma service, which may allow for more comprehensive post-operative care that may negate the negative impact of socioeconomic deprivation. These results suggest that when high quality trauma care is provided to patients, socioeconomic deprivation alone may not be a determining factor for 1-year mortality outcomes for geriatric patients undergoing operative fixation of proximal femur fractures.

As rural hospital continue to close across the United States, there is growing concern for the timely and adequate access to care for rural patients involved in traumatic injuries. As a result, more rural patients are forced to present to urban trauma centers. These hospital closures can result in prolonged transport times, delayed surgical intervention, and challenges in coordinating pre- and post-operative care. Existing trauma centers cover patients from rural or socioeconomic challenged areas should be able to provide adequate post-operative care to allow for patients to heal and return to high levels of physical function.

There are limitations to the current study. This study did not assess outcomes in non-operatively managed patients, which may have different findings compared to operatively managed patients. This study may not account for other factors that could contribute to increased mortality. Future studies should examine other factors, such as mental health status, income, and patient health literacy for impact on mortality.

Conclusion

With the increased closure of rural hospitals, rural patients are required to travel greater distances for orthopaedic care, causing an increased number of rural patients who present to urban hospitals. The data reported by the current study suggests that rural geriatric patients do not have significantly higher 1-year all-cause mortality rates compared to urban geriatric patients who are operatively treated for proximal femur fractures.

Ethical Statement

The University of Missouri's Institutional Review Board approved this retrospective patient record study.

Author Credit Statement

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Ashwin R. Garlapaty, Alaina C. Bryson, Drew A. Kasten, Harjeev Singh, Kylee Rucinski and Brett D. Crist. The first draft of the manuscript was written by Ashwin R. Garlapaty and Brett D. Crist and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Disclosures

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