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Insurance status as a mediator of clinical presentation, type of intervention, and short-term outcomes for patients with metastatic spine disease

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ABSTRACT

Background: It is well established that insurance status is a mediator of disease management, treatment course, and clinical outcomes in cancer patients. Our study assessed differences in clinical presentation, treatment course, mortality rates, and in-hospital complications for patients admitted to the hospital with late-stage cancer – specifically, metastatic spine disease (MSD), by insurance status.

Methods: The United States National Inpatient Sample (NIS) database (2012–2014) was queried to identify patients with visceral metastases, metastatic spinal cord compression (MSCC) or pathological fracture of the spine in the setting of cancer. Clinical presentation, type of intervention, mortality rates, and in-hospital complications were compared amongst patients by insurance coverage (Medicare, Medicaid, commercial or unknown). Multivariable logistical regression and age sensitivity analyses were performed.

Results: A total of 48,560 MSD patients were identified. Patients with Medicaid coverage presented with significantly higher rates of MSCC ($p < 0.001$), paralysis (0.008), and visceral metastases ($p < 0.001$). Patients with commercial insurance were more likely to receive surgical intervention (OR 1.43; $p < 0.001$). Patients with Medicaid < 65 had higher rates of prolonged length of stay (PLOS) (OR 1.26; 95% CI, 1.01–1.55; $p = 0.040$) while both Medicare and Medicaid patients < 65 were more likely to have non-routine discharges. In-hospital mortality rates were significantly higher for patients with Medicaid (OR 2.66; 95% CI 1.20–5.89; $p = 0.016$) and commercial insurance (OR 1.58; 95% CI 1.09–2.27;$p = 0.013$) older than 65.

Conclusion: Given the differing severity in MSD presentation, mortality rates, and rates of PLOS by insurance status, our results identify disparities based on insurance coverage.

1. Introduction

Across the medical field, studies demonstrate that insurance status impacts both treatments and clinical outcomes [1–3]. Given the significant disease burden and debilitating symptoms associated with metastatic spine disease (MSD) [4–8], patients often require frequent healthcare encounters and are thus reliant on insurance coverage throughout their care. As the prevalence of MSD increases secondary to improvements in diagnostic techniques and treatments for primary cancers so does the average age of patients with this diagnosis [9]. With increasing age, patients may also experience shifts in insurance coverage – the impacts of which are important to assess.

There is substantial evidence that patients who have government-funded insurance plans, including Medicare and Medicaid, tend to have worse clinical outcomes than those with commercial insurance, with patients receiving Medicaid at a distinct disadvantage to those receiving Medicare [10–13]. The reasons for these disparities are likely multifactorial and include but are not limited to rapid access to specific medications and procedures, availability of providers who take non-commercial insurance, lower reimbursement rates for

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non-commercial insurance, access to medical and non-medical resources, and patient distrust of the system [14,15]. Regarding neurosurgical patient populations, the effects of different insurance statuses have been documented across many diagnoses and patient populations [12,16–21]; however, they have not been specifically studied in those with MSD.

The purpose of this study is to broadly assess the differences in mortality, clinical presentation, in-hospital complications, and short-term outcomes in patients with MSD, by their insurance status. This study aims to identify vulnerable patient populations who may require additional resources and support navigating their oncology care.

2. Methods

This study used discharge data from the National Inpatient Sample (NIS), Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality from the years 2012–2014. The NIS database is a multi-center database that compiles data on patients admitted to non-federal academic and community hospitals in the United States. With information on approximately 8 million admissions per year, the NIS represents 20% of hospitals that fall within this classification. Data regarding procedures, diagnoses, comorbidities, demographics, and complications are coded using Clinical Classification Software (CCS) diagnostic codes and International Classification of Diseases Classification 9th Revision (ICD-9) codes. The data collected by NIS have undergone quality control measures and have been used in previously published studies [22,23].

Our sample included patients with diagnoses of metastasis to the bone (ICD-9 code 198.5) and secondary malignancy (CCS code 42), and those who were over the age of 18. Patients with a concomitant diagnosis of spinal cord compression in cancer (ICD-9 code 336.3) and those with vertebral pathological fracture (ICD-9 code 733.13) were identified. Of note, our sample is a weighted sample. After meeting these criteria, patients were stratified by insurance status: Medicare, Medicaid or Commercial Insurance. Patients with "Other/Unknown" insurance statuses were removed from the analysis. Demographic data including age, race, sex, and median household income quartile using patient's ZIP code as proxy were collected. Baseline health status was recorded using the Charlson Comorbidity Index (CCI); smoking status, primary tumor type, and presence of visceral metastases were also collected. Information about the admitting hospital, including teaching status and size, were noted for each patient.

In-hospital mortality and complication rates, prolonged length of stay (PLOS) (over 75th percentile), and non-routine discharge to a facility other than the patient's home were collected. ICD-9 procedure codes were used to identify patients who underwent surgical intervention (3.01, 3.09, 03.4, 03.53, 81.00–81.08, 81.61) for their MSD. CCS codes delineated patients who underwent radiation therapy (CCS code 211), biopsy (CCS code 37, 38, 76, 83, and 165), and chemotherapy (CCS code 224).

2.1. Statistical analysis

All analyses were performed in STATA SE 12 (StataCorp, College Station, Texas) after application of discharge weights (DISCWT) supplied by the NIS. Discharge weights are used to produce national estimates, and analyses were done using the STATA *survey* commands. Descriptive statistics were used to summarize the data, and group comparisons (based on insurance status) were performed via analyses of variance and chi-squared tests. Multivariable logistic regression was then performed to control for all significant differences found on univariate analyses. Age sensitivity analysis was performed on patients, stratified by those younger than 65 or 65 and older. Medicare patients were excluded from the analysis of patients younger than 65. Significance was defined as a probability value less than 0.05.

3. Results

3.1. Demographics

A total of 9712 admissions were included, which represents a weighted sample of 48,560 admissions for metastatic spinal cord compression (MSCC) or spinal pathological fracture in cancer that were identified and included in this study. The most common primary insurance was Medicare (55.0%), followed by commercial insurance (31.9%) and Medicaid (14.4%). Baseline characteristics are summarized in Table 1. Medicare patients were significantly older ($p < 0.001$) and more likely to be male than patients with commercial insurance and Medicaid ($p < 0.001$). Additionally, Medicaid patients were significantly more likely to be Black and Hispanic, while patients with Medicare and commercial insurance were more likely to be White. Income level, as determined by zip code proxy ($p < 0.001$), and whether or not patients were admitted to a teaching hospital differed significantly by insurance type ($p < 0.001$).

3.2. Clinical presentation of metastatic spine disease

The clinical presentation of patients was significantly associated with

Table 1
Baseline and oncological characteristics of all patients.

Variable	All patients (n = 48,560)	Medicare (n = 26,077)	Medicaid (n = 6993)	Commercial (n = 15,490)	p-value
Average age (years)	64.7	72.4	53.1	57.0	**<0.001**
Age > 65 (%)	48.9	81.5	4.9	13.8	**<0.001**
Male sex (%)	51.9	54.2	49.7	49.0	**<0.001**
Race					
White	71.7	76.8	47.6	74.0	**<0.001**
Black	14.4	12.2	27.9	12.0	
Hispanic	7.3	6.1	15.3	5.6	
Asian	3.2	2.1	4.0	4.7	
Other	3.5	2.8	5.2	3.8	
Income quartile					
1st (%)	26.0	26.6	39.9	19.1	**<0.001**
2nd (%)	23.5	23.9	23.0	22.9	
3rd (%)	25.0	25.0	23.0	25.8	
4th (%)	25.6	45.5	14.1	32.2	
Teaching hospital (%)	69.8	66.5	76.0	72.7	**<0.001**
Large hospital size (%)	66.3	64.9	70.2	66.9	**0.006**
Average Charlson comorbidity index	6.8	7.0	6.6	6.5	**<0.001**
Smoking (%)	35.4	35.4	40.7	33.0	**<0.001**
Primary tumor type					
Lung (%)	25.9	26.4	27.3	24.4	**<0.001**
Breast (%)	18.7	16.6	22.2	20.9	
Prostate (%)	15.0	19.3	9.5	10.4	
Colon (%)	5.0	4.7	5.1	5.4	
Kidney (%)	7.0	6.8	5.1	8.2	
Thyroid (%)	1.2	1.0	1.1	1.6	
Blood (%)	1.9	2.4	1.2	1.5	
Gynecological (%)	3.4	2.8	4.4	4.0	
Other/ unspecified (%)	21.8	20.0	24.2	23.8	
MSCC (%)	36.0	32.8	39.1	40.0	**<0.001**
Vertebral pathological fracture (%)	75.8	76.4	73.0	73.0	**<0.001**
Paralysis (%)	9.4	8.9	11.8	9.1	**0.004**
Visceral metastasis (%)	41.7	37.3	47.3	46.6	**<0.001**

*statistically significant result; MSCC: metastatic spinal cord compression

insurance status. Patients with Medicaid were more likely to present with metastatic spinal cord compression (MSCC) and paralysis ($p < 0.001$ and 0.004, respectively); rates of MSCC were also high in patients who were commercially insured. Vertebral pathologic fracture was most common in Medicare patients ($p < 0.001$), while concomitant visceral metastases were least common in these patients ($p < 0.001$) **(**Table 1**).**

3.3. In-hospital complications and mortality rates

Prior to multi-variable regression, in-hospital mortality rates did not differ by insurance status **(**Table 2**).** However, rates of all other in-hospital complications and non-routine discharge were significantly higher in patients with Medicare ($p < 0.001$). Patients with Medicaid were more likely to have a PLOS compared to patients with Medicare or commercial insurance ($p < 0.001$) **(**Table 2**).**

3.4. Interventions

Whether or not patients received surgery, biopsy, radiotherapy, or chemotherapy was associated with their insurance status. Patients with commercial insurance received surgical intervention more often than other patients ($p < 0.001$), while rates of radiotherapy and chemotherapy were highest in patients with Medicaid ($p = 0.001$; $p < 0.001$) **(**Table 2**).**

3.5. Multi-variable logistical regression

After controlling for patient age, race, sex, income, hospital characteristic, baseline health status (Charlson Comorbidity index, smoking status, primary tumor type), clinical presentation, and presence of visceral metastases, odds of in-hospital mortality by insurance status became statistically significant **(**Table 3**).** Specifically, patients with Medicaid and commercial insurance had higher mortality rates (Odds Ratio (OR) 1.41; 95%CI 1.05–1.90; $p = 0.022$ and OR 1.32; 95%CI 1.04–1.66; $p = 0.019$ respectively) than those with Medicare **(**Table 3**).** Additionally, patients with commercial insurance were still more likely to receive surgical intervention for their MSD (OR 1.41; 95%CI 1.20–1.66; $p < 0.001$) and less likely to have non-routine discharge (OR = 0.80; 95%CI 0.7–0.91; $p < 0.001$). Medicaid patients were more likely to have PLOS; however, odds of in hospital complication rates by insurance status were not significant after controlling for external factors **(**Table 3**).**

Table 2
Differences in rates of type of intervention and outcomes by insurance status prior to age sensitivity analysis.

Variable	All patients (n = 48,560)	Medicare (n = 26,077)	Medicaid (n = 6993)	Commercial (n = 15,490)	p-value
Surgical intervention (%)	15.3	12.0	14.9	21.1	**<0.001**
Biopsy (%)	20.2	21.3	20.7	18.2	**0.003**
Radiotherapy (%)	19.3	18.5	22.9	18.9	**0.001**
Chemotherapy (%)	6.6	5.3	9.7	7.6	**<0.001**
In-hospital complication (%)	43.7	46.9	41.4	39.3	**<0.001**
Prolonged length of stay (%)	23.7	21.8	31.4	23.5	**<0.001**
Non-routine discharge (%)	70.6	76.9	63.8	63.1	**<0.001**
In-hospital mortality (%)	7.0	6.7	7.5	7.2	0.523

Table 3
Multivariable associations between insurance status and intervention/outcome.

Outcome	Medicare	Medicaid	Commercial
Surgical intervention			
Odds ratio	1.00	0.90	1.41
95% CI		0.72 – 1.13	1.20 – 1.66
p-value		0.371	**< 0.001** *
In-hospital complication			
Odds ratio	1.00	1.09	0.99
95% CI		0.93 – 1.28	0.88 – 1.12
p-value		0.272	0.916
Prolonged length of stay			
Odds ratio	1.00	1.32	0.98
95% CI		1.11 – 1.57	0.85 – 1.24
p-value		**0.001**	0.767
Non-routine discharge			
Odds ratio	1.00	0.96	0.80
95% CI		0.81 – 1.14	0.70 – 0.91
p-value		0.635	**< 0.001** *
In-hospital mortality			
Odds ratio	1.00	1.41	1.32
95% CI		1.05 – 1.90	1.04 – 1.66
p-value		**0.022** *	**0.019** *

*statistically significant result; Controlling for patient age, sex, race income, teaching hospital, hospital size, Charlson comorbidity index, smoking, tumor type, MSCC, pathological fracture, paralysis, and visceral metastasis

3.6. Age sensitivity analysis

Age sensitivity analyses comparing outcomes by insurance status revealed that observed differences amongst the cohorts were age-dependent. Prior to multivariable logistical regression, outcomes for patients younger than 65 were generally consistent with those observed in the overall cohort. Regarding interventions received, patients younger than 65 with commercial insurance were still more likely to receive surgical intervention ($p < 0.001$), and patients younger than 65 with Medicaid were more likely to receive radiotherapy (0.003) (Table 4). Interestingly, only patients with Medicaid 65 or older were more likely to receive chemotherapy ($p = 0.002$) (Table 4). Additionally, rates of in-hospital complications and PLOS were also significantly higher in patients younger than 65 with Medicaid compared to those with commercial insurance ($p = 0.046$; < 0.001 respectively) (Table 4). While there was no difference in in-patient mortality rates for patients younger than 65, patients with Medicaid 65 or older had significantly higher in-patient mortality rates (Table 4, Fig. 1).

After multivariable logistic regression to control for external variables in patients younger than 65, there were distinct disparities between patients with Medicaid and commercial insurance. Specifically, patients with commercial insurance had lower rates of PLOS and non-routine discharge (OR 0.69 (CI 0.59–0.83); $p < 0.001$; OR 0.82 (CI 0.69–0.97); $p = 0.017$) **(**Table 5**).** In patients older than 65, the only outcome with significantly different rates by insurance status was mortality, with higher rates in Medicaid and patients with commercial insurance (OR 2.72, 95%CI 1.25–5.89, $p = 0.011$) and (OR 1.60, 95% CI, 1.11–2.28, $p = 0.010$ (Table 6).

4. Discussion

The association between differential health outcomes and insurance status has been well established across medical and surgical fields [24,25]. Recent efforts aim to better understand how this dynamic within both oncologic [26–28] and neurosurgical fields impacts patient care [12,29]. In our study, we present the largest national dataset that compares patient demographics, clinical presentation, and short-term outcomes of patients with MSD by insurance status. We found that patient demographics and clinical outcomes differed significantly across insurance status, and certain differences in clinical outcomes were age-dependent.

Table 4
Difference in rates of type of intervention and outcomes stratified by age group (patients younger than 65 years old and those older than or equal to 65 years old).

Variable	All patients	Medicare	Medicaid	Commercial	p-value
Young patients < 65					
Surgical intervention (%)	19.8	–	15.2	22.1	**< 0.001**
Biopsy (%)	20.2	–	19.1	20.4	0.804
Radiotherapy (%)	18.4	–	19.1	18.3	0.873
Chemotherapy (%)	3.9	–	11.8	2.6	**< 0.001**
In-hospital complication (%)	49.8	–	51.5	49.5	0.766
Prolonged length of stay (%)	24.5	–	30.9	23.5	0.187
Non-routine discharge (%)	75.5	–	73.5	75.8	0.683
In-hospital mortality (%)	11.2	–	16.4	10.3	0.141
Old patients ≥ 65					
Surgical intervention (%)	11.6	11.4	8.8	14.8	0.084
Biopsy (%)	21.5	21.7	19.1	20.4	0.750
Radiotherapy (%)	18.2	18.1	19.1	18.3	0.976
Chemotherapy (%)	4.5	4.6	11.8	2.6	**0.002**
In-hospital complication (%)	48.3	48.1	51.5	49.5	0.745
Prolonged length of stay (%)	21.3	20.9	30.9	23.5	0.072
Non-routine discharge (%)	78.3	78.6	73.5	75.8	0.260
In-hospital mortality (%)	7.4	7.0	16.4	10.3	**< 0.001**

4.1. Clinical presentation

The reasons for differences in clinical presentation by insurance status are likely multifactorial; however, many of the trends observed within our cohort could be associated with improved access to healthcare [30], more frequent cancer screenings for patients with Medicare and/or development of earlier screening programs prior to Medicare enrollment [31]. A recent study that compared breast, colorectal, and lung cancer screening rates prior to and after age 65 in United States patients showed a significant increase in cancer detection and subsequent decrease in mortality rates in the older population [31]. Similarly, across different types of cancers including but not limited to breast [32], prostate [33], melanoma [34] and colorectal cancer, [35] patients who have Medicaid insurance have been shown to more frequently present at later stages of their disease. In addition to less frequent screenings, the higher prevalence of late-stage cancer in Medicaid patients may be related to the fact that a cancer diagnosis is/has been a qualifying event for Medicaid insurance. [36] These reported trends align with the increased frequency of visceral metastases in Medicaid patients as compared to Medicare patients in our cohort. Additionally, secondary to more frequent contact with the healthcare system, patients with better insurance coverage may be more likely to present earlier after symptom onset. This could explain the lower rates of late stage sequalae of progressive MSD in Medicare patients as compared to Medicaid patients observed in this study.

4.2. Mortality

After multi-variable regression and age sensitivity analysis, patients with Medicaid and commercial insurance older than 65 had increased mortality rates secondary to MSD. Prior to multi-variable logistical regression, there was no significant difference in mortality rates among the different insurance types, which was likely due to the significant influence of age among the Medicare cohort. Once the effect of older age and therefore inherently higher risk of mortality in this patient population was controlled for, differences in mortality rate by insurance status emerged. These results were strengthened by the age sensitivity analysis that revealed the disparity in mortality rates was associated with a survival advantage in patients older than 65 receiving Medicare and a disadvantage for those older than 65 receiving Medicaid and commercial insurance. The presence of higher mortality rates associated with Medicaid insurance is well established across various oncologic diagnoses [37–39]. Additionally, the trend of higher mortality rates in Medicaid and under-insured patients is not limited to oncologic patients but has also been demonstrated in patients undergoing spine surgery including cervical spine procedures [20,40] and interventions after spine trauma [21,41]. Most pertinent to our present study was a report by Dasenbrock et al., 2012 in which the authors investigated the impact of insurance status on patients under age 65 undergoing surgery for MSD [42]. They similarly found higher mortality rates in under-insured and Medicaid patients.

While we were not expecting to observe a survival disadvantage in patients with commercial insurance, it is important to note that this disadvantage was lower than that observed in Medicaid patients and was only observed in those older than 65. Thus, the significant survival disadvantage in patients with commercial insurance could be an artifact of the relatively higher number of patients older than 65 with Medicare in our sample as compared to those with commercial insurance older than 65. This could also reflect a real improvement in mortality for patients who have Medicare insurance or an undetermined variable that is associated with negative outcomes in this population of patients with commercial insurance older than 65. Consistent with these findings, likely secondary to increased early screening, better follow up, and more regular contact with the healthcare system, Medicare at age 65 has been associated with improvements in population-level cancer mortality [42].

4.3. In-hospital complications

While there was no significant difference in in-hospital complication rates by insurance status in patients older than 65 after multi-variable analyses, Medicaid patients younger than 65 had both higher rates of non-routine discharge and PLOS. Our findings regarding non-routine discharge are consistent with existing neurosurgical literature that reports patients receiving governmental insurance including Medicare and Medicaid are more likely to be discharged to an inpatient rehabilitation center or non-home discharge after cervical spine surgery [43], subarachnoid hemorrhage [44], and brain tumor resection [45].

The observed higher rates of PLOS amongst Medicaid patients younger than 65 are also consistent with previous reports [46]. It is important to note that the association of Medicaid insurance with PLOS most likely reflects that Medicaid insurance status may act as a proxy for patients who have limited access to resources during post-operative recovery. Anecdotally, medically complex patients with Medicaid may not have the resources to be deemed safe for discharge and from a patient safety perspective, it may be better to keep patients in a medical facility rather than send them home. Alternatively, these patients may need to apply for additional assistance during their hospital stay to have access to rehabilitation facilities upon discharge which would likely also delay discharge.

4.4. Interventions

The observed higher rates of surgical intervention for commercially insured patients are well supported throughout the literature for both neurosurgical and other surgical sub-specialties [17,20,47]. Interestingly, after age sensitivity analysis, the rates of surgical intervention did

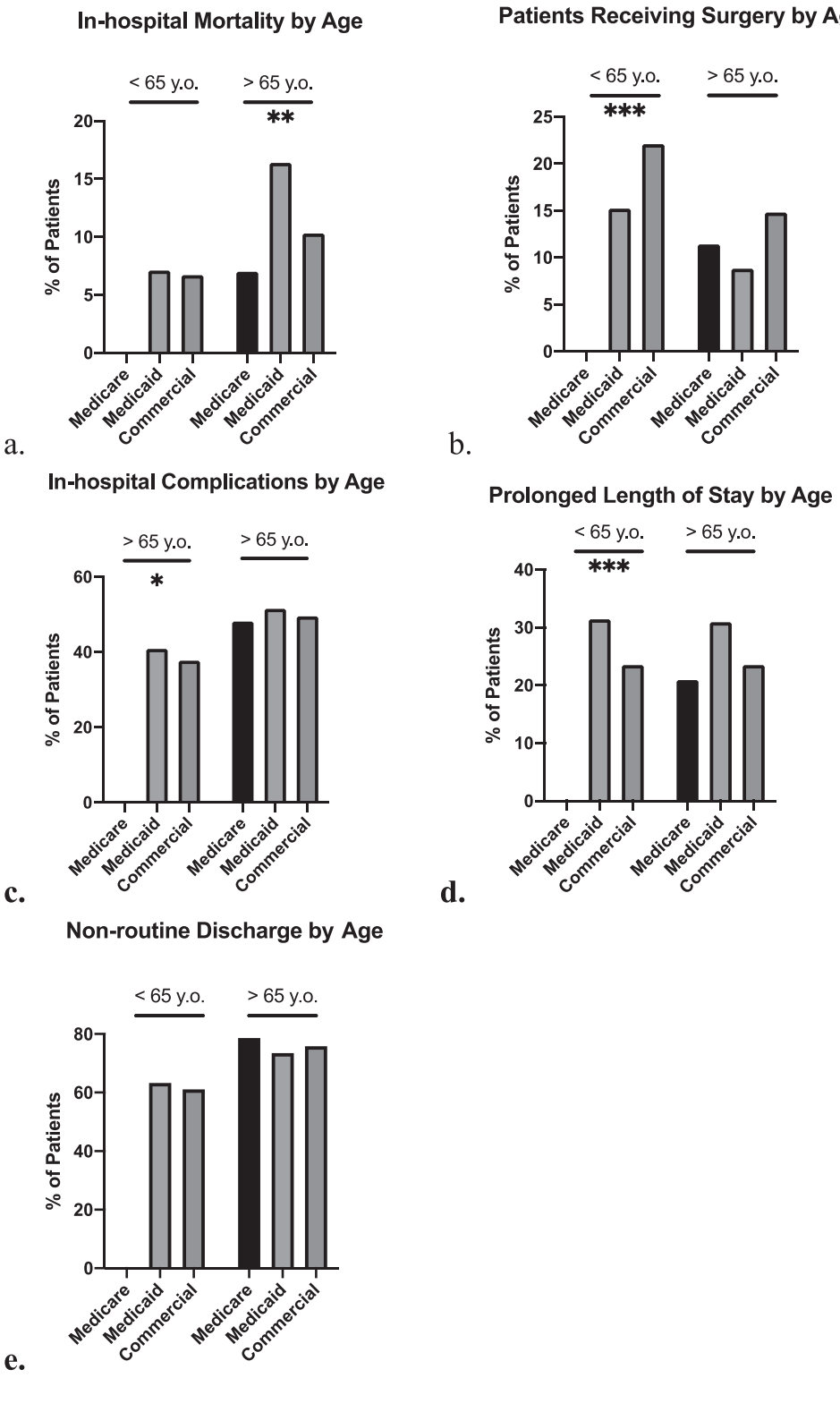

Fig. 1. Outcomes and complications by insurance status stratified by age greater than/equal to or less than 65. **a.** In-hospital mortality rates by insurance status (Medicare, Medicaid, Commercial, Unknown) stratified by age greater/equal to or less than 65. **b.** Surgical rates by insurance status stratified by age greater or less than 65. **c**. In-hospital complications rates by insurance status stratified by age greater/equal to or less than 65**. d.** Prolonged length of stay rates by insurance status stratified by age greater/equal to or less than 65. **e.** Non-routine discharge rates by insurance status stratified by age greater/equal to or less than 65.* = $p < 0.05$ * * = $p < 0.01$ * ** = $p < 0.001$.

not differ significantly for patients older than 65. This is likely due to the decreased overall rates of surgical interventions in older populations and therefore highlights the true disparity in rates of operative intervention by insurance status in younger patient populations. Regarding non-operative interventions, Medicaid patients younger than 65 had higher rates of radiation while those older than 65 had higher rates of chemotherapy. There are data to suggest that after the early Medicaid expansion in 2010–2011 (the year prior to data collection start for our study), availability of treatments including radiotherapy increased for patients who were previously uninsured, so the higher rates of radiotherapy could be secondary to this improved accessibility. Alternatively, as patients who present with more progressive disease are often not viable surgical candidates, the difference in intervention received could reflect the severity of disease by insurance status and/or possible

Table 5
Multivariable associations between insurance and intervention/outcome for patients younger than 65 years old.

Outcome	Medicaid	Commercial
Surgical intervention		
Odds ratio	1.00	1.59
95% CI		1.29 – 1.96
p-value		**< 0.001** *
In-hospital complication		
Odds ratio	1.00	0.89
95% CI		0.76 – 1.04
p-value		0.156
Prolonged length of stay		
Odds ratio	1.00	0.69
95% CI		0.59 – 0.83
p-value		**< 0.001** *
Non-routine discharge		
Odds ratio	1.00	0.82
95% CI		0.69 – 0.97
p-value		**0.017** *
In-hospital mortality		
Odds ratio	1.00	0.87
95% CI		0.64 – 1.17
p-value		0.355

*statistically significant result; Controlling for patient age, sex, race income, teaching hospital, hospital size, Charlson comorbidity index, smoking, tumor type, MSCC, pathological fracture, paralysis, and visceral metastasis

Table 6
Multivariable associations between insurance and intervention/outcome for patients older than or equal to 65 years of age.

Outcome	Medicare	Medicaid	Commercial
Surgical intervention			
Odds ratio	1.00	0.63	1.10
95% CI		0.23 – 1.69	0.80 – 1.52
p-value		0.357	0.550
In-hospital complication			
Odds ratio	1.00	1.27	1.18
95% CI		0.72 – 2.25	0.95 – 1.47
p-value		0.408	0.133
Prolonged length of stay			
Odds ratio	1.00	1.29	1.15
95% CI		0.70 – 2.41	0.90 – 1.49
p-value		0.404	0.267
Non-routine discharge			
Odds ratio	1.00	1.04	0.99
95% CI		0.53 – 2.04	0.76 – 1.27
p-value		0.900	0.918
In-hospital mortality			
Odds ratio	1.00	2.72	1.60
95% CI		1.25 – 5.89	1.11 – 2.28
p-value		**0.011** *	**0.010** *

*statistically significant result; Controlling for patient age, sex, race income, teaching hospital, hospital size, Charlson comorbidity index, smoking, tumor type, MSCC, pathological fracture, paralysis, and visceral metastasis

decision biases by providers treating these cohorts. This would further support the data that suggest patients with Medicaid present with later stage disease that is less amenable to more aggressive treatment options. Finally, there were higher rates of breast cancer within the Medicaid patient population which can more effectively be managed with systemic therapy; given that the higher rates of radiation and chemotherapy were not seen in the multivariable regression that controlled for primary tumor type, the difference in rates of primary cancer type could account for some of this difference.

4.5. Limitations

The limitations of this study include those inherent to national database studies; specifically, while there are quality measures to ensure consistent data collection, there may still be variability in the ways that different variables were collected by sites. Additionally, the NIS database is limited to hospitalized patients and only collects data within one admission. Therefore, we cannot comment on long-term outcomes including 30 and 90-day outcomes, and outcomes may not be applicable to non-hospitalized patient populations. Furthermore, it is important to acknowledge that the NIS database is based on insurance claims, which are often not the most accurate source of information as misclassification errors may occur. Additionally, NIS only allows for one insurance to be documented- thus we cannot know if a patient had Medicaid as the primary payer and Medicare as a secondary. We were also limited by the years of data included in our study (2012–2014) as the advent of ICD-10 codes in 2015 prevented us from incorporating more recent data. Our study is also inherently limited to United States populations as patient insurance status is a factor unique to the U.S. health system. However, the baseline demographics of our cohort were consistent with those presented in the United States Census report published in 2018 [48] which indicates that our data have reasonable external validity. Finally, as with any database study, our results cannot be used for causation but rather for correlation and associations that can guide further institution-based studies.

5. Conclusion

We present the largest database study assessing the impact of insurance status on presentation and outcomes in patients with metastatic spine disease. Given the high healthcare utilization often associated with spine metastases, access to care and insurance status are critical to patients with this diagnosis. Within our dataset, we show that the demographics, clinical presentation, and clinical outcomes of patients with MSD differed significantly by insurance status and age, with Medicaid patients generally presenting with more progressive disease and worse outcomes. However, beyond this awareness, our data underscore the importance of continuing efforts to improve early access to screening and healthcare utilization for patients with non-commercial insurance, specifically Medicaid, to mitigate the number of patients presenting with late stage sequelae of spine metastases.

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CRediT authorship contribution statement

Meghan Price: Conceptualization, Writing – original draft, Visualization, Data curation. **Rafael De la Garza Ramos:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology. **Tara Dalton:** Writing – review & editing, Approval of final manuscript. **Edwin McCray:** Writing – review & editing, Approval of final manuscript. **Zach Pennington:** Writing – review & editing, Approval of final manuscript. **Melissa Erickson:** Writing – review & editing, Approval of

final manuscript. **Kyle Walsh:** Writing – review & editing, Approval of final manuscript. Reza Yassari: Conceptualization, Investigation, Project administration, Supervision. **Daniel M. Sciubba:** Approval of final manuscript. **Andrea N. Goodwin:** Approval of final manuscript. **C. Rory Goodwin:** Conceptualization, Methodology, Project, administration, Supervision.

Conflict of interest

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