Clinical Medicine & Research
Volume 24, Number 1: 9-19

clinmedres.org

Association between Metastatic Cancer, Chemotherapy, and Suicide Risks: An Analysis Across 700 U.S. Trauma Centers

Abdul R. Shour, MS, PhD; Heather X Rhodes, PhD, DHS, MHS; David Puthoff, PhD; and Adedayo A. Onitilo, MD, PhD, MSCR, FACPP

Purpose: We explored the association between metastatic cancer, chemotherapy, and the risk for suicide attempts (suicide injuries) in adult trauma patients.

Methods: We conducted a retrospective analysis of the Trauma Quality Program Participant Use File (2017-2019), comprising 27,474 patients from 700 U.S. Trauma Centers. Self-harm/suicide injury (compared to controls) was the dependent variable; presence of metastatic cancer and current chemotherapy were the key independent variables. We adjusted for age, sex, race/ethnicity, method of payment, facility levels, and discharge year (Model 1), and Model 1 plus trauma type, injury location, stay length, comorbidities, Injury Severity Score, and Glasgow Coma Scale (Model 2). We employed chi-square analysis, Fisher's exact test, and unadjusted and adjusted logistic regression using Stata v18, setting statistical significance at $P \leq 0.05$.

Results: Of 27,474 patients, 249 (0.91%) reported suicide injuries. Significantly higher attempts were noted among patients with metastatic cancer (201 out of 249; 80.72%) and those not receiving chemotherapy (184 out of 249; 73.90%), $P<0.001$. Metastatic cancer was associated with higher odds of suicide injuries (unadjusted OR:2.252, 95%CI: 1.642-3.089; adjusted OR in Model 1:1.925, 95%CI:1.302-2.848). Chemotherapy was associated with lower odds of suicide injuries (unadjusted OR:0.408, 95%CI:0.307-0.541; adjusted OR in Model 1:0.444, 95%CI:0.311-0.636). However, neither metastatic cancer nor chemotherapy was significantly associated with suicide injuries in adjusted Model 2, suggesting the crucial role of other factors in influencing this risk.

Conclusion: Patients with metastatic cancer exhibited notable prevalence of suicide injuries. Findings suggested metastatic cancer was associated with higher odds, and chemotherapy with lower odds, of suicide injuries. Multifaceted factors were associated with suicide risk beyond the presence of metastatic cancer or chemotherapy status, underscoring the importance of mental health assessments and interventions in oncology care, particularly for those with advanced cancer.

Keywords: Chemotherapy; Metastatic Cancer; Suicide Attempts; Trauma Patients

Corresponding Author: Adedayo A. Onitilo, MD, PhD, MSCR, FACP, Marshfield Clinic-Sanford Health, Department of Oncology/Hematology, 3501 Cranberry Blvd, Weston, WI 54476 USA, Tel: (715) 393-1400, Fax: (715) 393-1399, Email: onitilo.adedayo@marshfieldclinic.org, ORCID 0000-0001-9185-060

Funding Disclosures: Funding for this project was provided in part through philanthropic support of Marshfield Clinic Research Institute led by the Marshfield Clinic Health System Foundation (255800-00-RES SUPPT TRAUMA).

Disclosures: The authors report no personal or financial conflicts of interest.

Received: December 4, 2024
Revised: August 28, 2025
Accepted: October 31, 2025

doi: 10.3121/cmr.2025.1990

Suicide among cancer patients has raised concern as researchers develop better understanding of the intricate relationship between cancer, treatment modalities, and mental health outcomes. Rafiei et al.[1] and Zaorsky et al.[2] illuminated the prevalence and demographic complexities of suicide among cancer patients globally and specifically in the United States. Nevertheless, the psychosocial aspect of cancer care, particularly the risk of suicide, remains inadequately addressed. The complex interplay between cancer types, treatment phases, and demographic factors such as age, sex, and race necessitate a comprehensive approach towards understanding and mitigating suicide risk. Our focus on metastatic cancer patients, a particularly vulnerable subgroup, and the examination of chemotherapy's role in suicide risk have been underexplored in existing literature.

Our study explored the association between metastatic cancer, chemotherapy, and the risk for suicide attempts (suicide injuries) in adult trauma patients, using a retrospective cohort analysis using the American College of Surgeons Trauma Quality Program Participant Use File (ACS-TQIP-PUF).[3] With this dataset from 700 U.S. trauma centers, we delved into the demographic and other trauma-related factors influencing suicide risk among cancer patients. To demonstrate how demographic and treatment-related factors interplay in the context of suicide risk, our study findings help inform tailored strategies to address the needs of high-risk groups and guide policy changes for integrated cancer care. We provide valuable guidance for future research, policy development, and clinical practice by offering new insights into the complex dynamics of suicide risk among cancer patients.

Methods

Study Design

Our retrospective cohort study examined the association between metastatic cancer, chemotherapy, and the inclination for suicide attempts (suicide injury) in adults. The extensive ACS-TQIP-PUF dataset comprises anonymized data from over 700 U.S. trauma centers, ranging from Level I to V or undesignated centers, and includes all data transmitted to the National Trauma Data Bank (NTDB).[3] ACS-TQIP primarily includes ACS-verified trauma centers; thus, our analytic cohort comprised patients treated at Level I–III facilities. Data from Level IV, Level V, and undesignated centers were not consistently available and were therefore not represented in the analytic sample. The dataset encompasses relational tables consistent with the National Trauma Data Standard (NTDS) for each admission year. Responsible data access necessitated our adherence to the rigorous TQP PUF Data Use Agreement, which included an online application, obtaining approval from the ACS TQP, and compliance with the data protection standards of both the Health Insurance Portability and Accountability Act (HIPAA) and the ACS TQIP Hospital Participation Agreement. The Multidisciplinary Trauma Research Operations Committee sanctioned our use of the data. Our analysis covered the years 2017–2019. We selected the years 2017–2019 to capture the most recent period available in the dataset with complete coding and data quality checks, to ensure both relevance and reliability of the analyses.

Our study cohort included 27,474 adult trauma patients (aged ≥18 years) treated at ACS-verified centers from 2017–2019. Within this cohort, suicide injury was the outcome of interest (n=249). Patients without suicide injury (n=27,225) were retained as the comparison group for descriptive and regression analyses. Metastatic cancer and current chemotherapy were coded as binary exposure variables. This design allowed us to estimate the association of metastatic cancer and chemotherapy with suicide injury while adjusting for relevant demographic, clinical, and trauma-specific covariates. The cohort included all adult trauma patients, regardless of cancer status. Presence of metastatic cancer was coded as a binary variable. Patients without metastatic cancer were not excluded and served as the reference group in descriptive and regression analyses, providing a comparator for assessing the relative risk of suicide injuries among those with metastatic disease. We excluded individuals younger than age 18, not diagnosed with metastatic cancer or not receiving chemotherapy, and patients whose data were outside the study period, incomplete, or missing.

Self-harm/suicide injury was the dependent variable or outcome of the study, defined as "no" for absence and "yes" for presence; we identified whether the injury was a suicide injury. The "no" category (controls) encompassed accidents (falls, collisions, animals, explosions), assaults/abuse (intentional injuries inflicted by others), and "others (legal/medical, environmental events). The "yes" category included self-harm/suicide injuries (intentional self-inflicted injuries). The dataset does not reliably differentiate suicide attempts from completed suicides. Although patients who died during hospitalization were coded as deceased/expired, intent coding did not permit attribution specifically to suicide. Therefore, our outcome represents suicide injuries rather than confirmed suicide deaths. The ACS-TQIP dataset does not capture the specific mechanism or lethality of the suicide attempt (e.g., firearm, ingestion, hanging). Glasgow Coma Scale (GCS) reflects neurologic status on arrival after the injury event, but the dataset does not allow determination of whether altered consciousness was due to the suicide attempt itself or to traumatic injury sustained.

The presence of metastatic cancer identified patients with metastatic cancer, categorized as "no" for absence and "yes" for presence. It was the key independent variable in the study.
Currently receiving chemotherapy for cancer indicated whether the patients were currently undergoing chemotherapy at the time of trauma admission, categorized as 'no' for not receiving chemotherapy and 'yes' for those who were. It served as another critical independent variable in the analysis.

We adjusted for covariates using an adapted version of the Anderson Model for Health Care Utilization[4] conceptual framework. The following variables were the predisposing/

enabling factors. For *age*, we divided 18–89 years into younger and middle-aged adults (18–55 years) and senior and elderly adults (56 years and above), and used as continuous. *Sex* was classified as male and female. *Race and Ethnicity* included non-Hispanic White (White), and non-White (non-Hispanic Black, Hispanic, Asian, American Indian, Pacific Islander, and Race Other). We collapsed these into White and Non-White categories due to limited observations in the Non-White categories. We categorized the *method of payment* for medical services such as Medicaid, self-pay, private/commercial, Medicare, and other government, not billed. *Facility Level - Bed Size* categorized facilities into ≤200, 201-400, 401-600, and >600 beds, and was used as a continuous variable. *Facility Level – ACS* (American College of Surgeons) *Verification Level* indicates the trauma care capability of the facility, classified into various levels of trauma centers, and used as continuous. *Year of Discharge* was categorized into 2017, 2018, and 2019, and used as continuous.

The following covariates were conceptualized as need care factors: *Trauma Type* was categorized as blunt, penetrating, burn, and other/unspecified. A refined version condensed these into three categories: blunt, penetrating, and other (e.g., burn). Within the *ICD 10* (International Classification of Diseases) *Place of Injury Code*, where the injury/accident occurred was classified into four categories: home and residential area (Y92.0-Y92.147), sports and athletic area: school (Y92.19-Y92.39), commercial and service areas (Y92.4-Y92.79), and other specified and unspecified non-institutional places (Y92.8-Y92.9). *Total ICU* (Intensive Care Units) *Length of Stay* was categorized into three groups based on duration: Short (1-3 days), moderate (4-9 days), and long ICU stay (10+ days), and used as continuous. *ED* (Emergency Department) *Discharge Disposition* was classified as: Inpatient admissions, outpatient/home, transferred or other facilities, and special circumstances (deceased/expired or left against medical advice), offering a comprehensive view of patient outcomes post-treatment. ED discharge was not included in the final adjusted models due to missing observations.

Meanwhile, a range of comorbid conditions classified as binary, yes/no were examined including alcohol use disorder, anticoagulant therapy (blood clots medication), bleeding disorder, cirrhosis/liver damage, congenital anomalies, chronic obstructive pulmonary disease (COPD), stroke/cerebrovascular accident (CVA), dementia, diabetes mellitus, functionally dependent health status, congestive heart failure, hypertension, myocardial infarction (MI)/heart attack, peripheral arterial disease (PAD) in the legs or lower extremities, mental/personality disorder, chronic kidney/renal failure/disease (CKD), steroid use for hormonal problems, and substance abuse disorder/drug addiction. Additionally, we created a comprehensive variable labeled "Has any comorbid condition" to indicate if any of these conditions were present in a patient. We also included variables about injury severity and traumatic brain injury (TBI) severity, utilizing the Abbreviated Injury Scale (AIS) derived Injury Severity Score (ISS), categorized into two groups: Minor (scores <9) representing less severe injuries and moderate to severe trauma (Scores 9-75) for more serious injuries. Additionally, the Glasgow Coma Scale (GCS) score was employed to assess the severity of TBI; divided into two categories: Mild (Scores 13-15) for less severe brain injuries and moderate to severe trauma (Scores 3-12) for more significant brain injuries. We used ISS and GCS as continuous variables in the adjusted models. Suicide injury was defined using clinician-abstracted intent coding in the trauma registry based on ICD-10 external cause categories for intentional self-harm (i.e., chart-derived coding rather than patient self-report). The outcome does not constitute a psychiatric diagnosis; it captures intentional self-inflicted injury events recorded at the index trauma encounter. GCS represents the patient's acute neurologic status on arrival to the emergency department following the injury and was included to adjust for injury severity/TBI burden, not for metastatic disease status.

Statistical Analysis

Our comprehensive statistical analyses used Stata version 18.[5] Initially, we performed descriptive analysis, bivariate tests for all factors, including predisposing, enabling, and need for care factors, employing the chi-square and Fisher's exact tests (for smaller samples <5). This phase examined associations between suicide injuries (compared to controls) and the wide range of variables listed above. Following the bivariate analysis, we conducted logistic regression analyses—both unadjusted and adjusted to further elucidate these relationships. In the unadjusted analyses, we assessed the association of metastatic cancer and chemotherapy with suicide injuries. Assessing the association of metastatic cancer and chemotherapy with suicide injuries, our adjusted analyses were guided by Anderson's conceptual model. In Model 1, we adjusted for predisposing and enabling factors, while in Model 2, we included all factors: predisposing, enabling, and need for care. Thus, we could discern the individual and combined associations of these factors on the likelihood of suicide injuries. Ultimately, we presented percentages, p-values, and both unadjusted and adjusted odds ratios (OR) with their 95% confidence intervals (CIs), considering p-values of 0.05 or lower as indicative of statistical significance. Our analytic approach was consistent with prior peer-reviewed studies[6,7] using similar methods. Chi-square and Fisher's exact tests were used for categorical comparisons, and logistic regression was employed to estimate unadjusted and adjusted odds ratios, guided by Andersen's behavioral model for health care utilization. This approach ensured methodological rigor, reproducibility, and comparability with established analyses of trauma registry data. We modeled age as both a categorical and continuous covariate. Given the limited number of suicide injury events (n=249), we did not test formal interactions (e.g., age×metastatic cancer or age×chemotherapy) because sparse strata would yield unstable estimates. ED discharge disposition was excluded from Model 2 due to missingness. Analyses used

Table 1. Association of metastatic cancer with suicide attempts

Variables	Unadjusted Analysis				Adjusted Analysis									
					Model 1[»]				Model 2[»»]					
	OR	95% CI		Sig	OR	95% CI		Sig	OR	95% CI		Sig
Metastatic cancer (Exposure/Predictor): No (Ref.)												
Yes	2.252	1.642	3.089	***	1.925	1.302	2.848	***	0.585	0.212	1.617	
Age					0.463	0.284	0.755	***	0.160	0.048	0.534	***
Sex: Male (Ref.)												
Female					0.215	0.140	0.332	***	3.169	1.006	9.985	**
Race and Ethnicity: Non-Hispanic White (Ref.)												
Non-White					0.810	0.513	1.277		0.550	0.153	1.980	
Primary Method of Payment: Medicaid (Ref.)												
Self-Pay/ Private/ Commercial Insurance					1.248	0.612	2.544		1.942	0.324	11.622	
Medicare					1.307	0.642	2.661		5.485	1.004	29.952	**
Other Government, Not Billed					1.550	0.576	4.176		5.221	0.440	61.957	
Facility Level: Bed size					0.963	0.779	1.191		0.851	0.466	1.553	
Facility Level: ACS Verification					0.616	0.426	0.890	***	0.574	0.187	1.767	
Year of Discharge					0.949	0.773	1.165		1.051	0.610	1.811	
Trauma Type: Blunt (Ref.)												
Penetrating									9762.776	2203.4803	43255.050	***
Other (Burn, unspecified)									4.900	0.514	46.661	
ICD10 Place of Injury: Home/Residential Area (Ref.)												
Sports and Athletic Area: School									15.885	1.651	152.835	**
Commercial and Service Areas: Farm, Construction									3.034	0.957	9.624	*
Other Specified & non-institutional (private) places									0.079	0.012	0.538	***
Total ICU Length of Stay									1.007	0.515	1.971	
Has Any Comorbid Condition: No (Ref.)												
Yes									3.033	0.854	10.768	*
Injury Severity Score									1.448	0.464	4.52	
GCS Score TBI Severity									11.313	3.962	32.30	***

Abbreviations: ACS, American College of Surgeons; ED, emergency department; ICU, intensive care unit; GCS, Glasgow Coma Scale; TBI, traumatic brain injury; AIS, Abbreviated Injury Score

[»]***Model 1:*** *To analyze the association of metastatic cancer with suicide attempts, Model 1 was designed to adjust for Predisposing, and Enabling Factors. These include the patient's age, sex, race and ethnicity, the primary method of payment for their medical care, the facility levels (Bed size, ACS Verification) where they received treatment, and the year of discharge.*

[»»]***Model 2:*** *Model 2 was designed to assess the adjusted odds of suicide attempts in metastatic cancer patients, incorporates a Need for Care Factors for adjustment, including all variables in Model 1 and adding trauma type, ICD10 injury location, ICU stay length, comorbidities, AIS Injury Severity Score, and GCS Score for TBI severity. ED Discharge Disposition was omitted due to empty observations.*

** P<0.005., ** P<0.01, *** P<0.001*

Table 2. Evaluating the association of chemotherapy with suicide attempts

Variables	Unadjusted Analysis				Adjusted Analysis							
					Model 1[*]				Model 2[**]			
	OR	95% CI		Sig	OR	95% CI		Sig	OR	95% CI		Sig
Receiving Chemotherapy: No (Ref.)												
Yes	0.408	0.307	0.541	***	0.444	0.311	0.636	***	1.205	0.460	3.157	
Age					0.459	0.282	0.748	***	0.166	0.050	0.554	***
Sex: Male (Ref.)												
Female					0.218	0.141	0.337	***	3.091	0.988	9.674	*
Race and Ethnicity: Non-Hispanic White (Ref.)												
Non-White					0.809	0.513	1.277		0.545	0.151	1.969	
Primary Method of Payment: Medicaid (Ref.)												
Self-Pay/ Private/ Commercial Insurance					1.292	0.633	2.638		2.012	0.333	12.163	
Medicare					1.352	0.663	2.757		5.433	0.976	30.253	*
Other Government, Not Billed					1.593	0.591	4.296		5.272	0.442	62.84	
Facility Level: Bed size					0.966	0.781	1.193		0.849	0.466	1.548	
Facility Level: ACS Verification					0.609	0.422	0.879	***	0.603	0.198	1.839	
Year of Discharge					0.961	0.782	1.180		1.037	.602	1.789	
Trauma Type: Blunt (Ref.)												
Penetrating									8904.865	2074.917	38216.771	***
Other (Burn, unspecified)									4.840	0.511	45.887	
ICD10 Place of Injury: Home/Residential (Ref.)												
Sports and Athletic Area: School									16.349	1.706	156.643	**
Commercial and Service Areas: Farm, Construction									3.063	0.963	9.749	*
Other Specified & non-institutional (private) places									0.075	0.011	0.518	***
Total ICU Length of Stay									1.044	0.535	2.036	
Has Any Comorbid Condition: No (Ref.)												
Yes									2.769	0.792	9.684	
AIS derived Injury Severity Score									1.406	0.453	4.365	
GCS Score TBI Severity									10.828	3.789	30.941	***

Abbreviations: ACS, American College of Surgeons; AIS, Abbreviated Injury Score; ED, emergency department; ICU, intensive care unit; GCS, Glasgow Coma Scale; TBI, traumatic brain injury

[*]***Model 1:*** *To analyze the association of metastatic cancer with suicide attempts, Model 1 was designed to adjust for Predisposing, and Enabling Factors. These include the patient's age, sex, race and ethnicity, the primary method of payment for their medical care, the facility levels (Bed size, ACS Verification) where they received treatment, and the year of discharge.*

[**]***Model 2:*** *Model 2 was designed to assess the adjusted odds of suicide attempts in metastatic cancer patients, incorporates a Need for Care Factors for adjustment, including all variables in Model 1 and adding trauma type, ICD10 injury location, ICU stay length, comorbidities, AIS Injury Severity Score, and GCS Score for TBI severity. ED Discharge Disposition was omitted due to empty observations.*

** P<0.005., ** P<0.01, *** P<0.001*

Table 3. Prevalence of self-harm/suicide attempts metastatic cancer, receiving chemotherapy and in relation study variables, 2017-2019

Variables	Self-Harm/Suicide Attempts			
	No= 27,225 (99.09%)	Yes=249 (0.91%)	Total (N)= 27,474	*P* value
Predisposing, and Enabling Factors:				
Age Categories, 18-89 years range				
Younger and Middle-Aged Adults (18-55 years)	2336 (9.19)	48 (19.67)	2384 (9.29)	<0.001
Senior and Elderly Adults (56 years and above)	23078 (90.81)	196 (80.33)	23274 (90.71)	
Sex				
Male	13352 (49.05)	198 (79.52)	13550 (49.32)	<0.001
Female	13870 (50.95)	51 (20.48)	13921 (50.68)	
Race and Ethnicity				
Non-Hispanic White (White)	22053 (84.67)	197 (85.28)	22250 (84.67)	0.797
Non-White	3993 (15.33)	34 (14.72)	4027 (15.33)	
Metastatic cancer (Exposure/Predictor variable)				
No	9522 (34.98)	48 (19.28)	9570 (34.83)	<0.001
Yes	17703 (65.02)	201 (80.72)	17904 (65.17)	
Receiving Chemotherapy for Cancer (Intervention)				
No	14586 (53.58)	184 (73.90)	14770 (53.76)	<0.001
Yes	12639 (46.42)	65 (26.10)	12704 (46.24)	
Primary Method of Payment				
Medicaid	1519 (5.67)	20 (8.13)	1539 (5.70)	<0.001
Self-Pay	409 (1.53)	21 (8.54)	430 (1.59)	
Private/Commercial Insurance	5824 (21.75)	50 (20.33)	5874 (21.74)	
Medicare	18026 (67.33)	139 (56.50)	18165 (67.24)	
Other Government, Not Billed	993 (3.71)	16 (6.50)	1009 (3.73)	
Facility Level: Bed size				
≤ 200	2337 (8.58)	15 (6.02)	2352 (8.56)	0.004
201-400	7990 (29.35)	52 (20.88)	8042 (29.27)	
401-600	6724 (24.70)	77 (30.92)	6801 (24.75)	
> 600	10174 (37.37)	105 (42.17)	10279 (37.41)	
Facility Level: ACS Verification Level				
I - Level I Trauma Center	11166 (55.71)	115 (67.25)	11281 (55.81)	0.002
II - Level II Trauma Center	7125 (35.55)	51 (29.82)	7176 (35.50)	
III - Level III Trauma Center	1752 (8.74)	5 (2.92)	1757 (8.69)	
Year of Discharge				
2017	7741 (28.77)	71 (30.08)	7812 (28.78)	0.320
2018	9338 (34.70)	71 (30.08)	9409 (34.66)	
2019	9828 (36.53)	94 (39.83)	9922 (36.55)	
Need For Care Factors:				
Trauma Type				
Blunt	26646 (98.06)	18 (7.23)	26664 (97.24)	<0.001
Penetrating	234 (0.86)	226 (90.76)	460 (1.68)	
Burn	175 (0.64)	3 (1.20)	178 (0.65)	
Other/unspecified	118 (0.43)	2 (0.80)	120 (0.44)	
ICD10 Place of Injury Code				
Home and Residential Area (Y92.0-Y92.147)	18576 (68.81)	200 (80.65)	18776 (68.92)	0.001
Sports and Athletic Area: School (Y92.19-Y92.39)	429 (1.59)	3 (1.21)	432 (1.59)	
Commercial and Service Areas: Farm, Construction, Unspecified (Y92.4-Y92.79)	5860 (21.71)	32 (12.90)	5892 (21.63)	
Other Specified and Unspecified non-institutional (private) places (Y92.8-Y92.9)	2131 (7.89)	13 (5.24)	2144 (7.87)	

Table 3. Prevalence of self-harm/suicide attempts metastatic cancer, receiving chemotherapy and in relation study variables, 2017-2019 (continued)

Variables	Self-Harm/Suicide Attempts			
	No= 27,225 (99.09%)	Yes=249 (0.91%)	Total (N)= 27,474	*P* value
Total ICU Length of Stay				
Short ICU Stay: 1-3 days	4907 (58.87)	74 (57.81)	4981 (58.86)	0.686
Moderate ICU Stay: 4-9 days	2639 (31.66)	39 (30.47)	2678 (31.64)	
Long ICU Stay: 10+ days	789 (9.47)	15 (11.72)	804 (9.50)	
ED Discharge Disposition				
Inpatient Admissions (Floor Bed General Admission, Telemetry; ICU)	23820 (90.89)	197 (79.76)	24017 (90.79)	<0.001
Outpatient/Home (Unit Providing <24 Hour Stays); Home With/ Without Services)	1627 (6.21)	1 (0.40)	1628 (6.15)	
Transferred to other Facilities (Jail, Institutional Care, to Another Hospital)	639 (2.44)	9 (3.64)	648 (2.45)	
Special Circumstances (Deceased/Expired, Left Against Medical Advice	121 (0.46)	40 (16.19)	161 (0.61)	
Has Any Comorbid Condition				
No	4428 (16.26)	70 (28.11)	4498 (16.37)	<0.001
Yes	22797 (83.74)	179 (71.89)	22976 (83.63)	
Injury Severity Score				
Minor (Scores <9)	10556 (38.85)	75 (30.49)	10631 (38.78)	0.007
Moderate to severe trauma (Scores 9-75)	16612 (61.15)	171 (69.51)	16783 (61.22)	
GCS Score TBI Severity				
Mild (Scores 13-15)	23711 (93.73)	113 (47.08)	23824 (93.29)	<0.001
Moderate to severe trauma (Scores 3-12)	1586 (6.27)	127 (52.92)	1713 (6.71)	

Note that frequencies in some variables may not add up to sample size (N=27,531) due to missing observations
Abbreviations: ACS, American College of Surgeons; ED, emergency department; ICU, intensive care unit; GCS, Glasgow Coma Scale; TBI, traumatic brain injury

complete-case data, with model-specific sample sizes reported in Tables 1 & 2.

Results

Of the 27,474 participants (Table 3), 249 (0.91%) reported suicide injuries. We noted a higher prevalence of these attempts among patients with metastatic cancer (80.72%) compared to those without (19.28%). Furthermore, a significant proportion of suicide injuries were reported by individuals not currently receiving chemotherapy (73.90%), as opposed to those who were undergoing chemotherapy (26.10%). With statistically significant P values <0.001, these findings indicate strong associations between metastatic cancer, lack of chemotherapy, and higher suicide injuries.

Our analysis reveals significant associations between various factors and the incidence of suicide injuries among cancer patients. Age emerged as a notable factor - adults 56 years and above had a higher frequency of attempts compared to younger and middle-aged adults ($P < 0.001$). Sex also played a significant role, with males constituting a larger proportion of the suicide injuries than females ($P < 0.001$). The method of payment showed substantial variation in suicide injury rates, with significant differences across categories ($P < 0.001$). Facility level by bed size also varied significantly in terms of suicide injuries ($P = 0.004$), as did the ACS Verification Level of the trauma centers ($P = 0.002$). The type of trauma was significantly associated with suicide injuries, particularly penetrating trauma ($P < 0.001$), as was the place of injury ($P = 0.001$). Furthermore, the presence of comorbid conditions ($P < 0.001$), the severity of trauma as measured by the ISS ($P = 0.007$), and the GCS score for TBI severity ($P < 0.001$) were all significantly associated with the likelihood of suicide injuries.

Table 1 provides a detailed analysis of the association of metastatic cancer with suicide injuries. In the unadjusted model, patients with metastatic cancer have a significantly higher likelihood of suicide injuries compared to those without, with an odds ratio of 2.252 (95% CI: 1.642 - 3.089). These results demonstrate a significant association between the presence of metastatic cancer and increased odds of suicide injuries.

In Model 1 of Table 1, metastatic cancer was significantly associated with higher odds of suicide injuries compared to the absence of such cancer, with an odds ratio of 1.925 (95% CI: 1.302 - 2.848), after adjusting for other factors. However, age, sex, and facility level were also associated with decreased odds of suicide injuries. For every unit increase in age, suicide injuries decreased by 0.463 (95% CI: 0.284 - 0.755), indicating older individuals have lower odds of suicide injuries compared to younger individuals. Sex shows a marked difference, with females having significantly lower odds of suicide injuries than males (OR: 0.215; 95% CI: 0.140 - 0.332). For every unit increase in facility level by ACS verification, suicide injuries decreased by 0.616 (95% CI: 0.426 - 0.890), indicating higher levels of ACS verification are associated with lower odds of suicide injuries.

In Model 2 of Table 1, the association between having metastatic cancer and the likelihood of suicide injuries was not significant (OR: 0.585, 95% CI: 0.212 - 1.617) after controlling/adding the following variables to Model 1: trauma type, ICD-10 injury location, ICU stay length, comorbidities, ISS, and GCS score for TBI severity. Meanwhile, age remained a significant factor (OR: 0.160, 95% CI: 0.048 - 0.534). However, females were observed to have higher odds of suicide injuries than males (OR: 3.169, 95% CI: 1.006 - 9.985). Medicare users also had a significantly higher odds ratio of 5.485 (95% CI: 1.004 - 29.952) compared to Medicaid users. For trauma type, patients with penetrating trauma had substantially higher odds of suicide injuries compared to those with blunt trauma, with an OR of 9762.776 (95% CI: 2203.4803 - 43255.050). For the ICD-10 Place of Injury, the odds of suicide injuries were significantly higher in sports and athletic areas (OR: 15.885, 95% CI: 1.651 - 152.835) and commercial and service areas like farms and construction sites (OR: 3.034, 95% CI: 0.957 - 9.624), compared to home or residential areas. The presence of comorbid conditions was another significant factor; those having any comorbid condition showed higher odds of suicide injuries (OR: 3.033; 95% CI: 0.854 - 10.768). The GCS score for TBI severity was also notably associated with suicide injuries, where higher severity scores indicated increased odds (OR: 11.313; 95% CI: 3.962 - 32.30).

Table 2 presents an analysis of the association of chemotherapy status with suicide injuries in both unadjusted and adjusted analyses. In the unadjusted analysis, patients currently receiving chemotherapy had lower odds of suicide injuries, as indicated by an odds ratio of 0.408 (95% CI: 0.307 - 0.541). These results demonstrate a significant association between a reduced likelihood of these attempts among patients undergoing chemotherapy. In Model 1 of Table 2, the analysis focused on the association of receiving chemotherapy with suicide injuries, adjusting for patients' age, sex, race, and ethnicity, the primary method of payment for their medical care, the facility levels where they received treatment, and the year of discharge. The findings showed patients receiving chemotherapy had a significantly lower likelihood of suicide injuries compared to those not receiving the treatment (OR: 0.444, 95% CI: 0.311 - 0.636). Furthermore, age, sex, and ACS Verification levels were associated with suicide injuries. As age increased, suicide injuries decreased (OR: 0.459, 95% CI: 0.282 - 0.748). Females exhibited significantly lower odds of suicide injuries than males (OR: 0.218, 95% CI: 0.141 - 0.337). Higher ACS Verification levels were associated with lower odds of suicide injuries (OR: 0.609; 95% CI: 0.422 - 0.879).

In Model 2 of Table 2, the findings showed the odds of suicide injuries were not significantly associated with receiving chemotherapy (OR: 1.205, 95% CI: 0.460 - 3.157) after controlling for all variables in Model 1 of Table 2 and adding the following variables: trauma type, ICD10 injury location, ICU stay length, comorbidities, ISS, and GCS score for TBI severity. However, age remained a significant factor, with older individuals having lower odds of suicide injuries compared to younger ones (OR: 0.166, 95% CI: 0.050 - 0.554). Sex differences also remained evident, as females demonstrated significantly higher likelihood of suicide injuries than males (OR: 3.091, 95% CI: 0.988 - 9.674). Again, Medicare users showed significantly higher odds of suicide injuries compared to Medicaid users (OR: 5.433, 95% CI: 0.976 - 30.253). The type of trauma experienced was a critical factor. Patients with penetrating trauma had dramatically higher odds of suicide injuries compared to those with blunt trauma (OR: 8904.865, 95% CI: 2074.917 - 38216.771). Suicide injuries were notably higher in sports and athletic areas, particularly schools (OR: 16.349, 95% CI: 1.706 - 156.643), and commercial and service areas such as farms and construction sites (OR: 3.063, 95% CI: 0.963 - 9.749), compared to home or residential areas. Other significant findings included the severity of injury as indicated by the GCS score for TBI severity, associated with an increased likelihood of suicide injuries (OR: 10.828, 95% CI: 3.789 - 30.941).

We can summarize our key takeaways as follows. First, we observed a significantly higher prevalence of suicide injuries among patients with metastatic cancer and those not currently receiving chemotherapy. Second, in our unadjusted analysis (Table 1), we found patients with metastatic cancer were significantly more likely to attempt suicide compared to those without, indicating a strong association between metastatic cancer and suicide risk. However, when adjusting for variables such as patient's age, sex, race and ethnicity, primary method of payment, facility levels and year of discharge, the risk association, while still significant, was slightly attenuated. This finding in Model 1 underscores how these demographic and healthcare system factors are associated with the risk of suicide injury.

Furthermore, in Model 2 of Table 1, after including additional variables (trauma type, injury location, ICU stay length, comorbidities, ISS, and GCS score for TBI severity), the direct association between metastatic cancer and suicide injuries lost significance. This highlights the complexity of factors influencing suicide risk in these patients. The loss of significance and change in direction of the metastatic cancer association in Model 2 likely reflects confounding or mediation by trauma type, comorbidities, and severity scores. These factors, which are strongly associated with both metastatic status and suicide injury, attenuated the crude effect observed in earlier models. Notably, older age continued to be associated with a lower likelihood of suicide injuries, and sex differences emerged with females experiencing higher suicide odds than males. Medicare users, patients with penetrating trauma, and those injured in specific locations like sports areas or commercial sites also showed higher odds of suicide injuries.

Regarding the association of chemotherapy (Table 2), our unadjusted analysis indicated patients currently undergoing chemotherapy were less likely to attempt suicide. However, in Model 1, after adjusting for similar demographic and healthcare variables, the association remained significant but less robust. In Model 2 of Table 2, where we controlled for a comprehensive set of variables, including trauma type, injury location, ICU stay length, comorbidities, ISS, and GCS score for TBI severity, chemotherapy status was not significantly associated with suicide injuries. This suggests that while chemotherapy is associated with lower odds, other factors, such as the patient's age, sex, and specific health conditions, were also strongly associated with suicide risk.

Discussion

Our study contributes a detailed analysis of the complex relationship between metastatic cancer, chemotherapy, and suicide risk, while also considering a broad spectrum of influencing factors. It underscores the need for tailored mental health strategies in cancer care, especially for patients with metastatic disease and during gaps in chemotherapy treatment. Our contribution lies in examining suicide injuries among cancer patients treated across 700 trauma centers, jointly evaluating metastatic status and current chemotherapy while adjusting for trauma-specific factors (ISS, GCS, trauma type, place of injury). This complements prior population-based mortality studies by focusing on injury presentations and integrating granular trauma covariates that are rarely available in cancer cohorts.

Our analysis yielded several key insights. Firstly, the higher prevalence of suicide injuries among patients with metastatic cancer and those not receiving chemotherapy echoes findings in other studies, but with a novel focus on metastatic cancer. For instance, the study by Simpson et al.[8] on penile cancer highlighted the psychological impacts of cancer treatment, though they reported lower suicide rates compared to other urologic malignancies. This contrast underscored the unique psychological burden associated with metastatic cancer in our study. Moreover, our analysis of the mitigating role of chemotherapy, as reflected in the decreased suicide injuries in patients currently receiving treatment, aligns with the findings of Ma et al.[9] and Shen et al.[10], who identified chemotherapy as associated with lower odds of suicide in pancreatic and Kaposi's sarcoma patients, respectively. The apparent chemotherapy association with reduced suicide injury risk should be interpreted cautiously. Chemotherapy itself may not directly prevent suicide; rather, it likely reflects selection of patients well enough to receive treatment, greater engagement with oncology services, and stronger perceptions of treatment intent. These contextual factors may lower suicide risk, independent of the pharmacologic effect of chemotherapy. This alignment suggests our findings might apply broadly across various cancer types, underscoring that continuous treatment engagement was associated with lower odds of suicide injuries. Our study's thorough analysis of demographic, clinical, and psychosocial variables furthermore extends beyond the scope of most previous studies, such as those by Sun et al.[11] and Lee et al.,[12] which focused on head and neck cancer and general cancer patients, respectively. Our study also highlights the intricate relationship between specific cancer types, treatment modalities, and suicide risk, similar to Jiang et al.,[13] who examined suicide rates in first and second primary cancer patients. Our findings on the association of factors such as age, sex, and trauma type resonate with studies such as that by Chen et al.,[14] who also identified demographic factors as significant in suicide risk among esophageal cancer patients.

Study Strengths and Limitations

Utilizing the ACS-TQIP-PUF[3] provided our study with a diverse patient population, enhancing the generalizability of our findings across healthcare settings. Moreover, our adherence to the TQP PUF Data Use Agreement and compliance with HIPAA and ACS TQIP Hospital Participation Agreement standards ensured the reliability and ethical integrity of our data. Another strength lies in our methodological rigor. Employing comprehensive statistical analyses, we effectively isolated the association between various factors and suicide risk, allowing for a detailed interpretation of the data, which aligns with Anderson's well-established conceptual model for healthcare utilization.[4]

The limitations of our study must also be noted. The retrospective nature of its design restricts our ability to establish causation (although not the aim of our study), only allowing for the identification of associations. Additionally, the ACS-TQIP-PUF dataset is extensive but not nationally representative; it primarily includes data from trauma center participation and may introduce a selection bias. Furthermore, its lack of specific geographical variables and detailed temporal data curtails geographical or seasonal trend analyses, which could provide more context. Exclusion of certain research project types, per the TQP PUF Data Use Agreement, also restricts the scope of our analysis. Reliance on de-identified data under HIPAA meant we could not access specific patient identifiers, which could have enriched our understanding of individual patient trajectories and outcomes. Also, although the ACS-TQIP database employs rigorous quality control measures and standardized abstraction from hospital records to ensure accurate capture of cancer diagnoses and treatment status, these data are not linked to population-based registries such as SEER. This limits external validation of metastatic status and chemotherapy coding, though internal reliability within TQIP has been well documented. Another limitation is that the ACS-TQIP dataset captures metastatic cancer status as a binary variable and does not distinguish by primary organ site. As such, we were unable to evaluate organ-specific variations in suicide risk that have been reported in population-based registry studies. Our findings, therefore, reflect the overall association of metastatic disease, irrespective of organ site, with suicide injuries in trauma patients. Another limitation is that our study did not formally test for effect modification by age or other covariates, because of the small number of suicide injury cases (n=249). While age was included as both a categorical and continuous covariate in all models and remained independently associated with risk, the limited number of events prevented reliable interaction testing. Larger datasets are needed to determine whether the association of metastatic cancer or chemotherapy with suicide injuries differs by age groups or other modifiers. In some covariates, notably penetrating trauma, sparse data produced extremely large odds ratios with wide confidence intervals. These values reflect statistical instability rather than precise effect estimates and should be interpreted cautiously. Furthermore, ascertainment of suicide intent relies on clinical documentation and ICD-10 external cause coding within participating centers, which may vary by culture, region, or provider and could introduce under- or misclassification. Since intent coding is not based on patient self-report surveys, classic social desirability bias is less likely, but documentation practices could still bias estimates—most plausibly toward the null if non-differential. The dataset lacks validated psychiatric screening instruments and formal diagnoses; thus, we cannot characterize depression, anxiety, or suicidality severity. Temporality between cancer treatment dynamics and psychological symptoms cannot be established (e.g., initiation/cessation of chemotherapy relative to evolving psychiatric status). Accordingly, associations between chemotherapy and suicide injuries should not be interpreted as causal and may reflect selection of healthier patients and greater engagement with oncology care. Finally, we were unable to differentiate suicide attempts by method or lethality, and GCS could not distinguish between altered consciousness from the suicide attempt versus trauma-related causes. These constraints may limit interpretability of neurologic severity and intent.

Conclusion and Implications

Our study emphasizes the associations of metastatic disease and treatment discontinuities with patient well-being, highlighting a significant prevalence of suicide injuries among metastatic cancer patients, especially during chemotherapy breaks. It underscores the critical need for integrating individualized mental health strategies and continuous assessments into standard oncology care, aimed at addressing the unique challenges and vulnerabilities of these patients.

The findings indicate chemotherapy was associated with lower odds of suicide injuries, which may reflect treatment engagement rather than a direct effect of therapy. By leveraging a robust methodological approach and utilizing data from a diverse, multi-center database, the study offers valuable insights and guidance for enhancing research, policy, and clinical practices to mitigate suicide risks among cancer patients.

Acknowledgments

We are particularly grateful for the use of the Trauma Quality Programs Participant Use File (TQP PUF) provided by the American College of Surgeons. The TQP remains the full and exclusive copyrighted property of the American College of Surgeons. The American College of Surgeons is not responsible for any claims arising from works based on the original Data, Text, Tables, or Figures. Special thanks to the trauma centers and their dedicated staff across the United States for their invaluable role in data collection and patient care, which formed the foundation of our research. We also acknowledge the support of the Marshfield Clinic Health System Multidisciplinary Trauma Research Operations Committee for their approval and oversight of our use of the data.

References

1. Rafiei S, Pashazadeh Kan F, Raoofi S, et al. Global Prevalence of Suicide in Patients With Cancer: A Systematic Review and Meta-Analysis. Arch Suicide Res. 2024;28(3):723-736. doi:10.1080/13811118.2023.2240870 . Published online 2023.
2. Zaorsky NG, Zhang Y, Tuanquin L, Bluethmann SM, Park HS, Chinchilli VM. Suicide among cancer patients. Nat Commun. 2019;10(1):207. doi:10.1038/s41467-018-08170-1. Zaorsky NG, Zhang Y, Tuanquin L, Bluethmann SM, Park HS, Chinchilli VM. Author Correction: Suicide among cancer patients. Nat Commun. 2020;11(1):718. doi:10.1038/s41467-020-14506-7
3. American College of Surgeons. Trauma Quality Programs Participant Use File. Published 2023. Available at: https://www.facs.org/quality-programs/trauma/tqp/center-programs/ntdb/datasets Accessed December 12, 2023.
4. Andersen RM. Revisiting the behavioral model and access to medical care: does it matter? J Health Soc Behav. 1995;36(1):1-10. doi:10.2307/2137284.
5. StataCorp. 2023. Stata Statistical Software: Release 18. College Station, TX: StataCorp LLC.
6. Shour A, Garacci E, Palatnik A, et al. Association between pregestational diabetes and mortality among appropriate-for-gestational age birthweight infants. J Matern Fetal Neonatal Med. 2022;35(25):5291-5300. doi :10.1080/14767058.2021.1878142.

7. Shour AR, Muehlbauer A, Anguzu R, Weeks F, Meurer J. Examining the Association Between Racial Bias Exposure and Postpartum Depression Among Women in Wisconsin. WMJ. 2021;120(S1):S24-S30.
8. Simpson WG, Klaassen Z, Jen RP, Hughes WM V, Neal DE Jr, Terris MK. Analysis of Suicide Risk in Patients with Penile Cancer and Review of the Literature. Clin Genitourin Cancer. 2018;16(2):e257-e261. doi:10.1016/j.clgc.2017.09.011.
9. Ma Y, Lyu J, Yang B, et al. Incidence and risk factors of suicide among patients with pancreatic cancer: A population-based analysis from 2000 to 2018. Front Oncol. 2022;12:972908. doi:10.3389/fonc.2022.972908.
10. Shen J, Zhu M, Li S, et al. Incidence and risk factors for suicide death among Kaposi's sarcoma patients: A surveillance, epidemiology, and end results analysis. Med Sci Monit. 2020;26:e920711. doi:10.12659/MSM.920711.
11. Sun LM, Lin CL, Shen WC, Kao CH. Suicide attempts in patients with head and neck cancer in Taiwan. Psychooncology. 2020;29(6):1026-1035. doi:10.1002/pon.5373.
12. Lee SJ, Park JH, Park BY, et al. Depression and suicide ideas of cancer patients and influencing factors in South Korea. Asian Pac J Cancer Prev. 2014;15(7):2945-2950. doi:10.7314/APJCP.2014.15.7.2945.
13. Jiang Y, Wang Y, Cheng X, et al. Suicide rates among patients with first and second primary cancer. Epidemiol Psychiatr Sci. 2023;32:e57. doi:10.1017/S2045796023000690.
14. Chen C, Lin H, Xu F, et al. Risk factors associated with suicide among esophageal carcinoma patients from 1975 to 2016. Sci Rep. 2021;11(1):18766. doi:10.1038/s41598-021-98260-w.

Author Affiliations

Abdul R. Shour, MS, PhD[*]; Heather X Rhodes, PhD, DHS, MHS[†]; David Puthoff, PhD[‡]; and Adedayo A. Onitilo, MD, PhD, MSCR, FACP[δ,⁋]

[*]Essentia Institute of Rural Health, Essentia, Duluth, MN
[†]Center for Clinical Epidemiology and Public Health, Marshfield Clinic Research Institute, Marshfield Clinic Health System, Marshfield, WI
[‡]Office of Research and Sponsored Programs, Marshfield Clinic Health System, Marshfield, WI
[δ]Cancer Care & Research Center, Marshfield Clinic Research Institute, Marshfield Clinic Health System, Marshfield, WI
[⁋]Department of Medicine, University of Wisconsin School of Medicine and Public Health, Madison, WI