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Outcomes of in-hospital cardiopulmonary resuscitation for cardiac arrest in adult patients with metastatic solid cancers: A Nationwide Inpatient Sample database analysis from 2012 to 2014

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Original Article

Outcomes of In-Hospital Cardiopulmonary Resuscitation for Cardiac Arrest in Adult Patients With Metastatic Solid Cancers: A Nationwide Inpatient Sample Database Analysis From 2012 to 2014

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BACKGROUND: Cardiopulmonary arrest is known to have a poor prognosis, further worsened by preexisting comorbidities. With improved treatment, the prevalence of metastatic cancers is rapidly increasing; however, the outcomes of in-hospital cardiopulmonary resuscitation (ICPR) remain to be well described. This study examines the epidemiology, associations, and outcomes of ICPR in these patients. **METHODS:** This is a retrospective cohort analysis of the Nationwide Inpatient Sample database (2012-2014) including patients aged ≥18 years with metastatic cancers. Primary outcome was inpatient mortality following ICPR. Factors associated with the primary outcome were analyzed using univariate/multivariate logistic regression analysis. **RESULTS:** Among all admissions with metastatic cancers (n = 5,500,684), 0.47% (n = 26,070) received ICPR. Inpatient mortality was 81.77% (n = 8905) versus 68.90% among those without metastatic solid cancers and receiving ICPR. Inpatient palliative care encounter was documented in 18.95% of patients with metastatic cancer who received ICPR. On multivariate logistic regression, some of the notable factors associated with higher mortality included being of African American or Hispanic race and hospital admission over the weekend. Factors associated with lower mortality included female sex, elective admission, and head and neck as the primary site. Admissions with ICPR were associated with higher mean total charge of hospitalization (by $48,670) compared with admissions without ICPR. Of those who survived ICPR, 43.82% were transferred to another facility after discharge. **CONCLUSIONS:** Among adult patients with metastatic solid cancers having ICPR, 81.8% died within the same hospital admission. Race and admission type predicted mortality. Despite known poor prognosis, only a minority had palliative care. ***Cancer* 2021;0:1-10**. *© 2021 American Cancer Society*.

LAY SUMMARY:

- Cardiopulmonary resuscitation during hospitalization for patients who have metastatic cancer has a very poor outcome with a mortality rate of 81.77%.
- Inpatient cardiopulmonary resuscitation in these patients is also associated with a significantly higher cost of care, longer length of stay, and high rate of transfer to a different health care facility upon discharge.
- Knowledge of these outcomes is helpful in discussing the pros and cons of pursuing aggressive resuscitative interventions with patients and families.

KEYWORDS: cancer, cardiopulmonary resuscitation (CPR), end-of-life care, health care use, metastatic malignancy, palliative service, resuscitation.

INTRODUCTION

The use of inpatient cardiopulmonary resuscitation (ICPR) has increased over the past few decades. Because of multiple quality initiatives and an algorithm-based approach to resuscitation following inpatient cardiac arrest, the outcomes have also improved. The prevalence of metastatic solid cancers is at an all-time high because of rising incidence and improved treatment modalities for all malignancies, including in the metastatic setting. There is an intersection between older age and greater number of comorbidities in patients with metastatic malignancy leading to increased health care use and multiple encounters with the health care system, especially closer to the end of life. With improved outcomes for metastatic malignancy, the goals and expectations of physicians, patients, and families have shifted, with a greater emphasis on aggressive care. There is a poor understanding of the actual outcomes in patients with metastatic solid cancers who receive ICPR and aggressive interventions. This is all the more important in current times, with the availability of multiple treatment options for cancers and the development of ever-improving technology for critical care interventions. In a recent study, 14% of patients who had in-hospital arrest also had

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advanced cancer.[1] This population had a lower survival rate compared with those without a diagnosis of advanced cancer. Also, they had their code status changed more frequently to Do Not Resuscitate within 48 hours of return of spontaneous circulation.

In our study, we analyzed the National Inpatient Sample (NIS) database to estimate the incidence, outcomes, and length of stay related to CPR during the hospitalization of patients with metastatic solid malignancies. NIS is the largest public database of hospital admissions in the United States, developed for the Healthcare Cost and Utilization Project (HCUP). The large sample size of this database makes it particularly suitable to assess outcomes across different hospital settings and patient demographics.

MATERIALS AND METHODS

Data Source

The NIS was queried to analyze data from January 2012 to December 2014. The NIS is the largest publicly available all-payer inpatient health care database in the United States; it was developed through a federal, state, and industry partnership sponsored by the Agency for Healthcare Research and Quality. The NIS is comprised of a random 20% sample of all inpatient hospitalizations from 46 states in the United States. It contains data from more than 7 million hospital stays each year and can be used to estimate the delivery of approximately 97% of all US inpatient care. Weighted, the database has data on more than 35 million annual hospital admissions nationally.[2] This is a publicly available database and contains de-identified patient data; hence, this study was exempt from institutional review board approval. The NIS data are organized such that each observation in the sample represents a unique hospitalization with information on more than 100 clinical characteristics, including patient demographics (including age, sex, race, median income for zip code), hospital characteristics (including ownership, size, teaching status, census region and division), and primary and up to 29 secondary diagnoses, as well as 15 procedures as administrative codes, diagnosis-related group codes for disease severity, discharge status and disposition, total charges, and length of stay.

Study Population and Methodology

We identified all hospitalizations among adult patients (aged ≥18 years) with an International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) primary or secondary procedure code for in-hospital CPR (99.60, 99.63) to identify the adult patients who received in-hospital CPR from 2012-2014. These codes have been used in prior studies to identify patients receiving in-hospital CPR. We then excluded patients who had a primary diagnosis of cardiopulmonary arrest using the ICD-9-CM diagnosis code 427.5 because these patients may have experienced an out-of-hospital cardiac arrest.[3]

To allow a comparison between patients with and without metastatic solid cancers, we defined the group with metastatic solid cancer from our cohort using the relevant ICD-9-CM diagnosis codes. The control group consisted of those without metastatic solid cancers, including patients with a history of cancer and early-stage cancer. We made our best attempt to adhere to the NIS analysis guidelines recommended by the HCPU and Khera et al.[4] All the ICD-9 CM codes used for this study are listed in the supporting information. No major changes in the NIS sampling methodology occurred during the study period.

Outcomes

The primary outcome was to compare inpatient mortality following ICPR (survival to hospital discharge) in patients with metastatic solid cancer versus those without metastatic solid cancer. Secondary outcomes included comparison between the above-described groups in terms of length of stay and total charge of hospitalization. Among those who survived, the discharge rate to home versus a different nonacute care facility (nursing home or rehabilitation facility) was also compared. In addition, we also obtained patient characteristics (including age, gender, race, insurance coverage, zip code income quartile as a surrogate for socioeconomic status, and Charlson Comorbidity Index score) and hospital-level characteristics (including hospital size, teaching status, and urban or rural location).

Statistical Analysis

All statistical analyses were performed using Stata IC version 15.1 (Stata Corp). Appropriate survey procedures were used to maintain integrity of NIS data. We performed a survey-weighted analysis using the SVY command to account for stratification and clustering of the NIS data. To compare baseline characteristics, we used the χ^2 test for categorical variables and t test for continuous variables. The length of stay was standardized for age, sex, race, and hospital characteristics using multivariate logistic regression. The predictors of inpatient mortality were examined using a multivariate

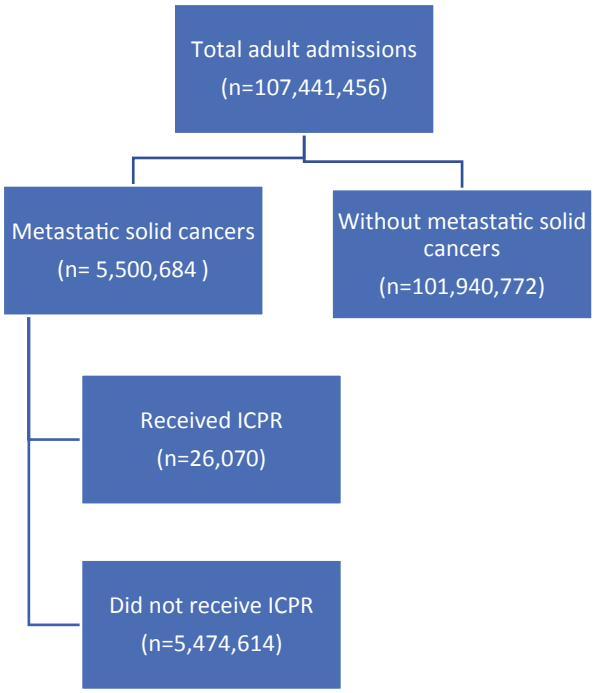

Figure 1. Consolidated standards of reporting trials (CONSORT) diagram of patients included in the analysis. ICPR indicates in-hospital cardiopulmonary resuscitation.

regression model that was standardized for all demographic and hospital characteristics that differed on the univariate logistic regression. Mechanical invasive ventilation was used as a surrogate for use of critical care services. A multivariate logistic regression model was built to determine predictors of inpatient mortality. Missing values of any variable were excluded from the final regression model. All *P* values were 2-sided with .05 as the threshold for statistical significance.

RESULTS

From 2012-2014, there were 107,441,456 hospitalizations, of which 5.12% (n = 5,500,684) were of patients with metastatic solid cancers. Of those with metastatic solid cancer, 0.47% (n = 26,070) received ICPR (Fig. 1). ICPR in the entire study population was documented among 315,085 admissions from 2012-2014. Of these, 8.27% (n = 26,070) had metastatic solid cancer. Table 1 shows the comparison of baseline characteristics of patients with metastatic solid cancer who received ICPR versus those who did not. Table 2 compares the baseline characteristics of patients who underwent ICPR based on the presence or absence of metastatic solid malignancy.

Same Admission Mortality Among Those With Metastatic Solid Cancer Receiving ICPR

There was a significant difference noted based on primary site of malignancy (Table 3). Head and neck primary cancer had the lowest mortality (62.81% of 390 who received ICPR) compared with other primary sites (gastrointestinal, 83.69%; lung, 80.99%; breast, 82.93%; genitourinary, 82.56%) and this difference was significant (χ^2 *P* value < .001). The proportion of those who died was lower in White (79.07%) compared with African American (86.40%) and Hispanic (85.89%) patients (χ^2 *P* value < .001). Based on insurance status, mortality was documented among 80.31% of Medicare beneficiaries, 83.69% of Medicaid beneficiaries, 83.27% of those with private insurance, and 86.36% of those who were self-pay; χ^2 *P* value < .001.

In contradiction to expectations, younger patients (aged 18-49 years) had worse mortality (89.31%) compared with age groups 50-64 years (80.36%) and ≥65 years (81.18%); χ^2 *P* value < .001. Those with elective admissions had lower mortality (72.06%) compared with nonelective admissions (82.95%); χ^2 *P* value < .001. A higher proportion of patients admitted over the weekend died (85.95%) compared with those admitted on weekdays (80.99%); χ^2 *P* value < .001. There was no difference in mortality by sex, urban or rural location of hospital, teaching or nonteaching status of hospital, and median household income quartile of patient's zip code.

Disposition outcomes

Among the 1985 patients with metastatic solid cancer who survived ICPR, 43.82% were transferred to a different health facility at discharge. These included nursing homes and subacute rehabilitation and inpatient rehabilitation units.

Documented palliative care encounter

When we compared the use of palliative care services among patients with metastatic cancer undergoing ICPR based on presence or absence of comorbidities (congestive heart failure, cerebrovascular accident, dementia, diabetes mellitus, chronic kidney disease, chronic liver disease), no statistically significant differences were noted.

Factors Associated With Receipt of ICPR in Patients With Metastatic Solid Cancer

After adjusting for various factors including patient demographics, comorbidities, and hospital factors, we found that the odds of receiving ICPR was higher among patients with metastatic malignancy who had the following characteristics (Table 4): nonelective admissions, male patients, African American and Hispanic patients

TABLE 1. Baseline Characteristics of Patients With Metastatic Cancer by Receipt of Inpatient Cardiopulmonary Resuscitation

Patients n = 5,500,684	No ICPR (n = 5,474,614), No. (%)	Received ICPR (n = 26,070), No. (%)	Pearson χ^2 *P*
Age category, y			.000
≥18-≤49	252,890 (12.60)	1170 (10.74)	
≥50-≤64	711,080 (35.44)	3795 (34.83)	
≥65	1,042,600 (51.96)	5930 (54.43)	
Sex			
Female	1,019,930 (50.83)	4825 (44.29)	.000
Ethnicity			.000
White	1,364,200 (71.68)	6285 (59.43)	
African American	271,400 (14.26)	2795 (26.43)	
Hispanic	147,870 (7.77)	780 (7.38)	
Died during the hospitalization	155,295 (7.74)	8905 (81.77)	.000
Primary site of malignancy			.000
Head and neck	50,650 (2.52)	390 (3.58)	
Gastrointestinal	606,895 (30.25)	3035 (27.86)	
Lung (chest)	547,230 (27.27)	3820 (35.06)	
Breast	224,145 (11.17)	1055 (9.68)	
Genitourinary	453,660 (22.61)	2065 (18.95)	
Other	123,990 (6.18)	530 (4.86)	
Comorbidities			
Congestive heart failure	161,555 (8.05)	1925 (17.67)	.000
Cerebrovascular accident	87,420 (4.36)	680 (6.24)	.000
Dementia	4550 (0.23)	30 (0.28)	.288
Chronic obstructive pulmonary disease	459,205 (22.89)	3125 (28.68)	.000
Diabetes mellitus with complications	38,490 (1.92)	285 (2.62)	.000
Renal disease	211,810 (10.56)	1565 (14.36)	.000
Moderate-to-severe liver disease	41,095 (2.05)	450 (4.13)	.000
Severe protein-energy malnutrition	77,620 (3.87)	760 (6.98)	.000
Admission type			
Admitted over the weekend	361,025 (17.99)	2365 (21.71)	.000
Nonelective admission	1,521,580 (76.11)	9625 (88.63)	.000
Aggressive interventions during admission			
Hemodialysis during admission	24,625 (1.23)	690 (6.33)	.000
Mechanical ventilation during admission	67,185 (3.35)	8030 (73.70)	.000
Cardiac revascularization during admission	10,290 (0.51)	315 (2.89)	.000
Encounter with palliative care during admission	273,770 (13.64)	2065 (18.95)	.000
Transfer in			.000
Not transferred in (admitted from home)	1,852,910 (92.77)	9680 (89.18)	
Transferred in from different acute care hospital	103,780 (5.20)	775 (7.14)	
Transferred in from another type of health facility	40,550 (2.03)	400 (3.68)	
Transfer out (upon discharge)			.000
Not a transfer	1,603,795 (79.95)	9850 (90.45)	
Transferred out to a different acute care hospital	42,430 (2.12)	170 (1.56)	
Transferred out to another type of health facility	359,800 (17.94)	870 (7.99)	
Teaching hospital	1,260,780 (62.83)	6765 (62.09)	.111
Hospital size by number of beds			.000
Small	269,960 (13.45)	1425 (13.08)	
Medium	484,395 (24.14)	3000 (27.54)	
Large	1,252,215 (62.41)	6470 (59.39)	
Insurance type			.000
Medicare	1,047,175 (53.90)	6025 (56.47)	
Medicaid	242,105 (12.46)	1625 (15.23)	
Private insurance	597,810 (30.77)	2690 (25.21)	
Self-pay	55,745 (2.87)	330 (3.09)	
Median household income national quartile for patient zip code			.000
0-25th percentile	531,035 (27.06)	3515 (33.02)	
26th-50th percentile	499,575 (25.46)	2475 (23.25)	
51st-75th percentile	474,685 (24.19)	2295 (21.56)	
76th-100th percentile	457,165 (23.30)	2360 (22.17)	

Abbreviation: ICPR, in-hospital cardiopulmonary resuscitation.

TABLE 2. Baseline Characteristics of Patients Who Underwent Inpatient Cardiopulmonary Resuscitation by Presence or Absence of Metastatic Solid Malignancy

Patients Who Underwent ICPR n = 315,085	Patients Without Solid Metastatic Cancer (n = 289,015), No. (%)	Patients With Solid Metastatic Cancer (n = 26,070), No. (%)	Pearson χ^2 *P*
Age category, y			.000
≥18-≤49	42,160 (13.86)	1170 (10.74)	
≥50-≤64	83,710 (27.52)	3795 (34.83)	
≥65	178,320 (58.62)	5930 (54.43)	
Sex			
Female	133,000 (43.73)	4825 (44.29)	.250
Ethnicity			.000
White	184,370 (63.28)	6285 (59.43)	
African American	59,125 (20.29)	2795 (26.43)	
Hispanic	28,385 (9.74)	780 (7.38)	
Died during the hospitalization	209,540 (68.90)	8905 (81.77)	.000
Comorbidities			
Congestive heart failure	117,245 (38.54)	1925 (17.67)	.000
Cerebrovascular accident	32,375 (10.64)	680 (6.24)	.000
Dementia	2135 (0.70)	30 (0.28)	.000
Chronic obstructive pulmonary disease	85,395 (28.07)	3125 (28.68)	.164
Diabetes mellitus with complications	22,455 (7.38)	285 (2.62)	.000
Renal disease	98,080 (32.24)	1565 (14.36)	.000
Moderate-to-severe liver disease	11,060 (3.64)	450 (4.13)	.007
Severe protein-energy malnutrition	10,470 (3.44)	760 (6.98)	.000
Aggressive interventions during admission			
Hemodialysis during admission	41,950 (13.79)	690 (6.33)	.000
Mechanical ventilation during admission	220,970 (72.64)	8030 (73.70)	.015
Cardiac revascularization during admission	39,730 (13.06)	315 (2.89)	.000
Admission type			
Admitted over the weekend	74,400 (24.46)	2365 (21.71)	.000
Nonelective admission	272,740 (90.00)	9625 (88.63)	.000
Encounter with palliative care during admission	33,630 (11.06)	2065 (18.95)	.000
Transfer in (prior to admission)			.000
Not transferred in (admitted from home)	262,365 (86.72)	9680 (89.18)	
Transferred in from different acute care hospital	26,560 (8.78)	775 (7.14)	
Transferred in from another type of health facility	13,615 (4.50)	400 (3.68)	
Transfer out (upon discharge)			.000
Not a transfer	250,945 (82.51)	9850 (90.45)	
Transferred out to a different acute care hospital	11,595 (3.81)	170 (1.56)	
Transferred out to another type of health facility	41,595 (13.68)	870 (7.99)	
Teaching hospital	173,515 (57.04)	6765 (62.09)	.000
Hospital size by number of beds			.034
Small	37,380 (12.29)	1425 (13.08)	
Medium	85,610 (28.14)	3000 (27.54)	
Large	181,200 (59.57)	6470	
Insurance type			.000
Medicare	195,530 (66.17)	6025 (56.47)	
Medicaid	34,280 (11.60)	1625 (15.23)	
Private insurance	50,115 (16.96)	2690 (25.21)	
Self-pay	15,575 (5.27)	330 (3.09)	
Median household income national quartile for patient zip code			.000
0-25th percentile	97,895 (32.97)	3515 (33.02)	
26th-50th percentile	76,630 (25.81)	2475 (23.25)	
51st-75th percentile	67,170 (22.62)	2295 (21.56)	
76th-100th percentile	55,260 (18.61)	2360 (22.17)	

Abbreviation: ICPR, in-hospital cardiopulmonary resuscitation.

TABLE 3. ICPR Mortality by Primary Site of Tumor

Primary Site: Metastatic Solid Cancer	No. of Cases	Proportion of Patients Who Received ICPR (%)	Mortality Following ICPR (%)
Head and neck	390	0.76	62.81
Gastrointestinal	3035	0.49	83.69
Lung (chest)	3815	0.69	80.99
Breast	1055	0.46	82.94
Genitourinary	2065	0.45	82.57
Other	530	0.42	84.91

Abbreviation: ICPR, in-hospital cardiopulmonary resuscitation.

TABLE 4. Factors Associated With Receipt of ICPR Among Patients With Metastatic Solid Malignancy

Odds of ICPR Among Hospitalized Patients With Metastatic Solid Cancer	Multivariate Adjusted OR (95% CI)	*P*
Age, y	1.000 (0.998-1.002)	.869
Females vs males	0.796 (0.763-0.831)	.000
Ethnicity		
African Americans vs Whites	2.195 (2.089-2.305)	.000
Hispanics vs Whites	1.214 (1.121-1.314)	.000
Admission type		
Elective vs nonelective admission	0.518 (0.486-0.552)	.000
Weekend vs weekday admission	1.073 (1.023-1.126)	.004
Site of primary malignancy		
Gastrointestinal vs head and neck	0.518 (0.464-0.578)	.000
Lung (chest) vs head and neck	0.702 (0.629-0.783)	.000
Breast vs head and neck	0.567 (0.50-0.642)	.000
Genitourinary vs head and neck	0.467 (0.417-0.523)	.000
Others vs head and neck	0.558 (0.487-0.640)	.000
Teaching vs nonteaching hospital	0.936 (0.897-0.976)	.002
Hospital size by number of beds		
Medium vs small hospitals	1.102 (1.032-1.178)	.004
Large vs small hospitals	0.927 (0.872-0.985)	.014
Insurance type		
Medicaid vs Medicare	1.098 (1.025-1.176)	.008
Private insurance vs Medicare	0.958 (0.906-1.014)	.137
Self-pay vs Medicare	1.061 (0.941-1.196)	.334
Transfer in (prior to admission)		
Transferred in from different acute care hospital vs not transferred in	1.522 (1.409-1.643)	.000
Transferred in from another type of health facility vs not transferred in	1.647 (1.481-1.832)	.000
Comorbidities		
Congestive heart failure: present vs absent	2.183 (2.068-2.305)	.000
Cerebrovascular accident: present vs absent	1.225 (1.129-1.329)	.000
Chronic obstructive pulmonary disease: present vs absent	1.115 (1.064-1.169)	.000
Moderate-to-severe liver disease: present vs absent	1.961 (1.774-2.169)	.000
Severe protein energy malnutrition: present vs absent	1.673 (1.548-1.807)	.000
Diabetes mellitus with complications: present vs absent	1.023 (0.90-1.163)	.726
Renal disease: present vs absent	1.109 (1.046-1.177)	.001
Median household income national quartile for patient zip code		
26th-50th percentile vs 0-25th percentile	0.894 (0.847-0.944)	.000
51st-75th percentile vs 0-25th percentile	0.890 (0.841-0.941)	.000
76th-100th percentile vs 0-25th percentile	0.996 (0.941-1.054)	.889

Abbreviations: ICPR, in-hospital cardiopulmonary resuscitation; OR, odds ratio.

(vs White), patients in nonteaching hospitals, small hospitals (vs medium- or large-sized hospitals by bed number), Medicare beneficiaries (vs Medicaid beneficiaries or those with private insurance), weekend admissions, transferred from a different acute care facility, head and neck malignancy (vs other primary site), presence of comorbidities (congestive heart failure, cerebrovascular accident, chronic kidney disease, chronic kidney disease, moderate-to-severe liver disease, severe protein-energy malnutrition), and belonging to the lowest income quartile (vs 26th-50th percentile and 51th-75th percentile).

Factors Associated With Same Admission Mortality Among Patients With Metastatic Solid Cancer Who Received ICPR

After adjusting for various factors including patient demographics, comorbidities, and hospital factors, we found that the odds of same admission mortality among

TABLE 5. Factors Associated With Same Admission Mortality Among Patients With Metastatic Solid Malignancy Who Received ICPR

Odds of Mortality Among Hospitalized Metastatic Solid Cancer Patients Who Underwent ICPR	Multivariate Adjusted OR (95% CI)	*P*
Age, y	1.001 (0.996-1.006)	.667
Females vs males	0.803 (0.72-0.896)	.000
Ethnicity		
African Americans vs Whites	1.515 (1.329-1.727)	.000
Hispanics vs Whites	1.308 (1.05-1.629)	.017
Comorbidities		
Congestive heart failure: present vs absent	0.741 (0.651-0.844)	.000
Cerebrovascular accident: present vs absent	0.575 (0.475-0.696)	.000
Dementia: present vs absent	0.001 (0.297-0.141)	.001
Chronic obstructive pulmonary disease: present vs absent	0.778 (0.691-0.875)	.000
Moderate to severe liver disease: present vs absent	1.934 (1.355-2.761)	.000
Site of primary malignancy		
Gastrointestinal vs head and neck	2.866 (2.257-3.638)	.000
Lung (chest) vs head and neck	2.647 (2.097-3.342)	.000
Breast vs head and neck	2.895 (2.177-3.851)	.000
Genitourinary vs head and neck	3.064 (2.391-3.928)	.000
Others vs head and neck	3.847 (2.762-5.358)	.000
Admission type		
Elective vs nonelective admission	0.582 (0.503-0.675)	.000
Weekend vs weekday admission	1.138 (0.998-1.298)	.053
Hospital size by number of beds		
Medium vs small hospitals	1.181 (0.999-1.398)	.052
Large vs small hospitals	1.19 (1.022-1.387)	.025
Insurance type		
Medicaid vs Medicare	1.237 (1.036-1.478)	.019
Private insurance vs Medicare	1.152 (0.996-1.332)	.057
Self-pay vs Medicare	1.43 (1.02-2.004)	.038
Transfer in (prior to admission)		
Transferred in from different acute care hospital vs not transferred in	1.118 (0.908-1.377)	.292
Transferred in from another type of health facility vs not transferred in	2.301 (1.605-3.297)	.000

Abbreviations: ICPR, in-hospital cardiopulmonary resuscitation; OR, odds ratio.

patients with metastatic malignancy who received ICPR was higher among those with the following characteristics (Table 5): nonelective admission, male, African American and Hispanic patients (vs White), teaching hospital, medium- and large-sized hospitals (vs small hospitals by bed number), Medicaid beneficiaries and those with private insurance (vs Medicare), weekend admissions, transferred in from a different acute care hospital, gastrointestinal/lung/breast/genitourinary malignancies (vs head and neck primary cancer site), presence of moderate-to-severe liver disease, and absence of congestive heart failure, cerebrovascular accident, dementia, and chronic kidney disease.

Admission characteristics

The mean length of stay among patients with metastatic solid cancer was approximately 2 days longer for those who received ICPR compared with those who did not.

TABLE 6. Comparative Outcomes of Patients With Metastatic Malignancy Who Did and Did Not Receive ICPR

Solid Metastatic Cancer	Did Not Receive ICPR	Received ICPR	*t* Test *P*
Length of stay, mean (SD), d	6.46 (6.74)	8.46 (10.89)	.000
Total charge for hospitalization, mean (SD)	$57,507.28 ($76,930.72)	$106,176.81 ($154,104.88)	.000

Abbreviation: ICPR, in-hospital cardiopulmonary resuscitation.

The mean total charge for hospitalization was approximately $48,670 higher among those who received ICPR (Table 6). This increase in hospitalization charge could be accounted for by both increased length of stay and use of intensive care services and interventions. The mean time to ICPR among these patients was 3.28 days from admission. The most common reasons for admission among those patients with metastatic solid cancer who received ICPR and died during the same hospitalization—in decreasing order of frequency—included sepsis (17.29%), acute respiratory failure, malignant neoplasm of bronchus and lung, pneumonia, pulmonary embolism, and infarction.

DISCUSSION

We found that the mortality rate in same admission after ICPR is significantly higher in those who have metastatic solid cancer compared with those who do not. It is important to keep in mind that the no metastatic solid cancer group does include those with malignancy that is not metastatic. This means that despite the comparison group including a diagnosis of malignancy, the mortality is still remarkably different (~82% for metastatic solid cancer and ~69% for those without metastatic solid cancer). The odds of mortality following ICPR in patients with metastatic solid cancer was roughly 50% and 30% higher in African Americans and Hispanics, respectively, when compared with Whites after adjusting for multiple factors including socioeconomic status and comorbidities. Possible confounders (not recorded in the database) that could account for this observation include the extent of metastatic disease, differences in disease biology/aggressiveness, performance status, treatment history, and differences in access to health care. The odds of ICPR were comparatively not higher in African American patients than in White patients. But the odds of ICPR were higher by approximately 20% in Hispanic patients in comparison with White patients. One of the explanations for these findings could be the

cultural differences in relation to goals of care and code status decisions. In a single-institution retrospective study including patients of 7 ethnicities who underwent inpatient palliative consultation, health care use in the last 3 months of life varied widely between groups. It was highest for African American and Hispanic patients with ≥3 emergency room visits in 30% and 25%, respectively. Also, the median time elapsed from palliative care encounter to hospice referral was 4 days for White and 26.5 days for African American patients.[5] These findings highlight the complex interplay of various factors, some of which are hard to quantify and ultimately lead to variations in outcomes.

Head and neck cancers, despite having 30% to 50% higher odds of ICPR when compared with other tumor types, had a surprisingly much lower odds of mortality following ICPR. Although the higher odds of ICPR can be explained possibly by the high risk of sepsis from frequent aspirations, the much lower mortality could be caused by selection bias. Among all cancer subtypes, head and neck cancer was found to be associated with the shortest time interval between a diagnosis of advanced disease and palliative care consultation (2.9 months) in a large retrospective study from Brazil.[6] It is therefore possible that decisions regarding goals of care and code status for the "sicker" patient with head and neck cancer had already been addressed before admission and the cohort receiving ICPR was relatively less sick. In addition, admission over the weekend was associated with 14% higher odds of mortality when compared with weekdays; this could be a reflection of logistical issues over weekends in our hospitals across the nation.

Quality of life is an important outcome in cancer care, especially for patients with incurable metastatic solid cancers. Being at home with family and in familiar surroundings is often expressed as a goal when discussing care strategies and optimal location of care. We noted in this study that 41% of metastatic solid cancer cases who survived the ICPR were transferred to a different facility at discharge. Contrast this with those who did not received ICPR, where only 18.3% needed to be transferred to a different facility at discharge. Different facility here denotes nursing home, rehabilitation center, and other facilities excluding acute care hospitals. Although this would presumably affect the quality of life of patients, it also increases the health care use and total cost of care among patients with metastatic malignancy. We also noted longer length of stay and higher mean total charge of hospitalization among those with metastatic solid cancer receiving ICPR.

A population-based cohort study from Taiwan,[7] which studied 3446 patients with metastatic malignancy, found that there was a very low rate of survival to discharge after cardiopulmonary resuscitation (~7.2%). Even among those who survived to discharge, only 10.1% received anticancer therapy, whereas the median postdischarge survival rate was 22 days. This puts in perspective the gains achieved by resuscitation of patients with metastatic malignancy. Even though resuscitation science has made many strides in the past few years, we need to re-evaluate the burden placed on the patients, relatives, and the health care system for very modest to no gain in quality and length of life with very few patients eventually receiving meaningful cancer–directed therapy. In addition to quality of life, equally important and much more difficult to quantify is the "quality of the dying experience." Based on responses gathered from caregivers, positive ratings in terms of quality of death were highest for home deaths, perhaps because they were associated with fewer complications and/or a more extensive support network at home.[8] Also, in practice we have seen that the quality of death significantly deteriorates among those patients who do not survive CPR and aggressive interventions. Although the definition of medical futility (as discussed by Schneiderman[9]) includes therapy that offers <1% chance of survival, this does not take into account other end points that we have previously discussed.

There are several studies that show the benefits of involving a palliative care team in the care of patients with malignancy. Despite this, there has been an increasing trend of offering and implementing aggressive cancer–directed therapy near the end of life. Primary physicians and oncologists are not always well trained in end-of-life care and the discussion of goals of therapy and death. There are many barriers to such a discussion, and this is an area of ongoing study. There have been multiple randomized prospective studies that have shown that the involvement of specialty palliative services leads to significant improvement in the quality of life and a decrease in the use of futile and aggressive end-of-life care, along with a survival benefit.[10] In our study of those with metastatic solid cancer and receiving ICPR between 2012 and 2014, we did not see a substantial increase in the proportion of patients with a documented palliative care encounter over the years. It should be noted that documentation of a palliative care encounter does not include use of palliative care services before admission and hence may be subject to a selection bias. It is also subject to documentation bias, because occasionally palliative services are not coded for. Despite not being the primary goal of treatment, cost

of care,[11] and length of stay,[12] admissions to the intensive care unit have been found to be lower in those who are evaluated and treated by a specialty palliative team. A single-center study showed that the most significant barriers to discussing goals of care as perceived by oncology providers were family members' difficulty accepting poor prognosis, disagreement among family members, difficulty understanding the limitations of life-sustaining treatments, and the lack of patients' capacity to make decisions.[13] Through our study, we hope to address, to some extent, the difficulty in understanding the limitations of life-sustaining treatments. Being able to provide actual probabilities of survival after ICPR in a patient with metastatic solid cancer, along with insight into the quality of life and death after resuscitation, will hopefully help family members to make more informed decisions.

Surprisingly, we noted that patients with metastatic solid cancer receiving ICPR who had an inpatient palliative care consultation ended up with a longer length of stay and higher total charge for admission. We previously discussed evidence that palliative care decreases cost of care, but that is true for early involvement of palliative care services, usually in the outpatient setting (information not available in our database). A possible explanation for this could be late involvement of palliative care services in the course of hospitalization, especially at a time when end of life is imminent or at the time of death, thus leading to a selection bias. This is a phenomenon that is frequently seen in clinical practice too. Our observation agrees with a study by Earle et al,[14] which reported that among those who receive hospice care, an increasing proportion had such care initiated in the last 3 days of life.

There has been excellent ongoing work and tools developed to better stratify patients who will not benefit from ICPR, one of which is the Good Outcome Following Attempted Resuscitation (GO-FAR) score.[15] One of the variables included in the score is the presence of metastatic malignancy. The use of such simple clinical scores in a discussion of goals of care and resuscitation status with patients integrated with patient and provider awareness of low survival as described in many studies, including ours, will be instrumental in informing end-of-life decisions. Although we cannot say that any ICPR is fruitless in patients with metastatic malignancy, we encourage patients and providers to tailor code status discussion and decisions based on a better understanding of the expected outcomes and anticipated benefit.

This study has several limitations based on its retrospective design using an administrative database. As expected from an administrative database, there may be coding and data entry errors in the NIS database. The NIS database only contains in-hospital data, thus survival and complications occurring after discharge are largely unknown. We do not have quality-of-life indicators available from the patients or long-term survival data. Although the Charlson Comorbidity Index was used, the ability to accurately control for different baseline comorbidities is limited when administrative data are used. The cost analyzed was in-hospital and did not provide a reflection of out-of-hospital costs and costs after transfer to rehabilitation services or nursing home. A larger registry trial, which provides data regarding long-term survival outcomes of patients with metastatic malignancy who receive ICPR, would provide us with invaluable information that we can use while weighing clinical decisions and counseling our patients on expected outcomes. Palliative care consultation, though coded for inclusion in the database, may be an underestimation because if the physician providing such care is not palliative board certified, this would not be reflected in an administrative database. Regardless, this comprehensive large sample-size study using a national, regionally diverse, and all-payer database provides a real-world picture of inpatient cardiopulmonary resuscitation in hospitalized patients with metastatic solid cancer across the Unites States.

In this era of rapid evolution of treatments and frequent approval of new therapies—though maintaining optimism is healthy—we must understand the global picture of expected outcomes while discussing the goals of care with our patients with metastatic solid cancers. We hope this study will add to the existing knowledge base and aid in providing patients with accurate information when they are deciding on code status and goals of care.

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AUTHOR CONTRIBUTIONS
Sindhu Malapati: Conceptualization, data curation, methodology, project administration, writing–original draft, and literature review. **Sunny R. K. Singh:** Formal analysis and writing–review and editing. **Rohit Kumar:** Validation, software, and data curation. **Tarik Hadid:** Supervision and writing–review and editing.

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