In-Hospital Utilization and Outcomes of Palliative Care Consultation in Patients With Advanced Heart Failure Complicated by Cardiogenic Shock Requiring Mechanical Circulatory Support

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Prior studies have shown that the early inclusion of palliative care (PC) specialist is associated with better end-of-life experiences. The National Inpatient Sample Database was queried from 2012 to 2017 for relevant of ICD)-9 and -10 procedural and diagnostic codes to identify patients above 18 years with advanced heart failure (HF) admitted with cardiogenic shock (CS) requiring mechanical circulatory support (MCS). Baseline characteristics, utilization trends and invasive procedures and complications were compared among patients evaluated by PC and those who were not. There were 65,230 patients hospitalized for advanced HF complicated by CS requiring MCS, of these a PC consult was placed in in 9,200 patients (14.1%) and trended upward from 9.4 to 16.8%, between 2012 to 2017. The majority of patients, (37.3%) from the total population died in hospital. In reference to patients who were discharged alive, PC consultation was associated with a lower incidence of invasive procedures such as mechanical ventilation, pacemaker implantation, defibrillator implantation, insertion of percutaneous feeding tubes and tracheostomies performed (p <0.05 for all) whereas complications such as major bleeding, septic shock, transfusion of any blood product were comparable between both cohorts (nonsignificant p value for all). On the other hand, in those patients who died in hospital PC was associated with a lower incidence of pacemaker implantation, defibrillator implantation and insertion of percutaneous feeding tubes (p <0.05 for all). Despite the high morbidity and mortality associated with advanced HF patients with CS requiring MCS, the overall prevalence of PC consultation is exceedingly low. When utilized, the incidence of invasive procedures was lower. This study highlights the underutilization of PC services in this patient population, precluding any perceived benefit in end-of-life experiences. © 2021 Elsevier Inc. All rights reserved. (Am J Cardiol 2021;148:94−101)

With an aging United States population, the number of patients being diagnosed with heart failure (HF) and by extension advanced HF is increasing, with a median survival after the first HF-related hospitalization of only 2.4 years.[1] Currently, there is a lack of robust evidence from large prospective trials for the use of mechanical circulatory support (MCS) strategies for advanced HF to prolong life, and these short-term MCS devices carry significant complications.[2,3] Although advanced HF patients presenting with cardiogenic shock (CS) may be stabilized with temporcgqz MCS devices, it is important to acknowledge the high burden of co-morbidities (cardiorenal syndrome/ renal dysfunction, liver dysfunction/failure) that prevent candidacy for transplant or left ventricular assist device implantation in a patient population with a low-survival rate.[4-6] Prior studies have shown that the early inclusion of palliative care (PC) is associated with better end-of-life experiences. Currently, North American and European HF societies recommend the early use of PC in advanced HF patients in order to provide care that is congruent with patient values, wishes, and preferences.[7] We sought to evaluate the in-hospital utilization and outcomes of PC consultation in patients with advanced HF complicated by cardiogenic shock requiring MCS.

Methods

Data for analysis were collected from the National Inpatient Sample (NIS) provided by the Healthcare Cost and Utilization Project (HCUP) between 2012 and 2017. The NIS offers the largest database of hospitalizations,

representing a 20% random, stratified, sample of hospital discharges in the United States and contains over 7 million hospital discharge data from about 1000 hospitals annually. To identify the study population, International Classification of Diseases, ninth revision, Clinical Modification (ICD-9-CM) and International Classification of Diseases, tenth revision, Clinical Modification (ICD-10-CM) diagnostic and procedural codes were used. Institutional review board approval was not needed, as all patient information is de-identified within the NIS. We identified all patients aged ≥ 18 admitted with advanced HF and cardiogenic shock who required MCS using ICD-9 and ICD-10 diagnostic codes. Our final study cohort comprised 13,046 patients with advanced HF and cardiogenic shock who required MCS, which, using NIS-provided trend discharge weights, corresponds to an estimated 65,230 overall nationwide hospitalizations during this time period. We separated patients into two cohorts, those in whom PC was consulted (see data supplement for ICD codes) and those in whom PC was not. We analyzed and reported outcomes in those who were discharged alive and those who died in hospital. All the data under the NIS are publicly available. Detailed methods used for statistical analyses are presented under the Data Supplement, which can be used for replication of our results. Baseline characteristics included in this study are listed in Table 1. The primary outcomes of interest were the PC utilization and the number of invasive procedures during the hospitalization. Secondary outcomes of interest included the total cost of hospitalization, length of hospital stay, rates of mechanical ventilation, defibrillator implantation, cardiac surgery, major bleeding, tracheostomy procedures and discharge dispositions. The diagnostic codes of the complications are listed in the online supplemental appendix A. Data analysis was conducted following recommended methodological standards for the NIS [8]. Univariate and multivariate logistic regression analyses were performed to identify independent predictors of in-hospital PC consultation. The Pearson Chi-Squared (χ^2) test was used for categorical variables, independent samples T-testing was used for parametric continuous variables and Mann-Whitney's test for non-parametric continuous variables. A p-value of <0.05 was deemed statistically significant. All statistical analyses were performed using SPSS (IBM SPSS Statistics for Mac, Version 26.0. Armonk, NY: IBM Corp.).

Results

A total of 13,046 hospitalizations for advanced HF and CS who required MCS were identified corresponding to a weighted estimate of 65,230 hospitalizations during the years 2012 to 2017. Women (n=18,920) comprised 29.0% of the total population. Of the total population, PC was consulted in 9,200 patients (14.1%). The proportion of PC consultations trended upward from 9.4 to 16.8%, with an average annual increase rate of +12.9% between 2012 to 2017, see Figure 1. Baseline characteristics are displayed in Table 1.

The majority of patients, (37.3%) from the total population died in hospital.

In reference to patients who were discharged alive, PC consultation was associated with a lower incidence of

Table 1

Baseline characteristics of patients with advanced heart failure and cardiogenic shock who required mechanical circulatory support in whom palliative care was consulted and those in whom palliative care was not

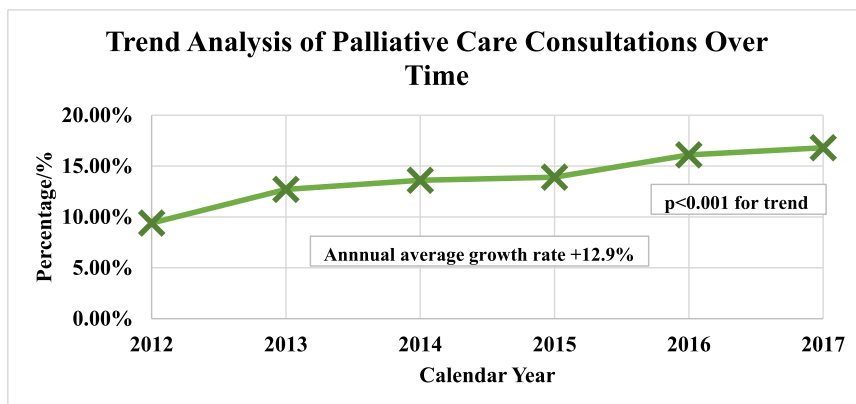| Covariates	Palliative Care Consultation		
	Yes (n=9200)	No (n=56030)	p-Value
Age (years), mean (SD)	66.12±14.6	63.6±14.8	0.853
Women	2855 (31.0%)	16065 (28.7%)	<0.001
White	5970 (71.2%)	36055 (68.8%)	<0.001
Black	1020 (12.2%)	7030 (13.4%)	
Hispanic	680 (8.1%)	4515 (8.6%)	
Asian/Pacific Islander	295 (3.5%)	1840 (3.5%)	
Other	365(4.4%)	2615 (5.0%)	
PRIMARY EXPECTED PAYER			
Medicare	5550 (60.5%)	30070 (53.7%)	<0.001
Medicaid	900 (9.8%)	6270 (11.2%)	
Private Insurance	2120 (23.1%)	15550 (27.8%)	
Self-Pay	350 (3.8%)	2225 (4.0%)	
Other	250 (2.7%)	1680 (3.0%)	
MEDIAN HOUSEHOLD INCOME (Percentile)			
0-25th	2510 (27.8%)	15275 (27.9%)	0.463
26th-50th	2290 (25.3%)	14025 (25.6%)	
51st-75th	2305 (25.5%)	13585 (24.8%)	
76th-100th	1930 (21.4%)	11955 (21.8%)	
Mechanical Circulatory Support Device			
Intra-aortic Balloon Pump	6235 (67.8%)	43655 (77.9%)	<0.001
Percutaneous Ventricular Assist Devices (Impella and Tandem Heart)	2170 (23.6%)	9785 (17.5%)	<0.001
Extracorporeal Membrane Support (ECMO)	1890 (20.5%)	6915 (12.3%)	<0.001
Implantable Ventricular Assist Device	1280 (13.9)	5615 (10.0)	<0.001
Combination of Percutaneous Ventricular Assist Devices (Impella and Tandem Heart), ECMO or Implantable Ventricular Assist Device	4085 (44.4%)	17365 (31.0%)	<0.001
Elective Admission	880 (9.6%)	6580 (11.8%)	<0.001
Diabetes Mellitus	3325 (36.3%)	21865 (39.2%)	<0.001
Hypertension	4525 (62.3%)	26080 (62.1%)	0.760
Atrial Fibrillation	3445 (37.4%)	20065 (35.8%)	0.002
Coronary artery disease	6280 (68.6%)	39140 (70.2%)	0.002
Acute Coronary Syndrome	5280 (58.0%)	34220 (62.1%)	<0.001
Prior Myocardial Infarction	1105 (12.0%)	5750 (10.3%)	<0.001
Prior Percutaneous Coronary Intervention	1000 (10.9%)	5150 (9.2%)	<0.001
Prior Coronary Artery Bypass Grafting	530 (5.8%)	3095 (5.5%)	0.351
Peripheral Arterial Disease	945 (10.6%)	5520 (10.1%)	0.219
Chronic Kidney Disease without Renal Replacement Therapy	6430 (70.5%)	37995 (68.3%)	<0.001
End Stage Renal Disease on Hemodialysis	295 (3.2%)	2325 (4.1%)	<0.001
Prior Stroke	250 (2.7%)	1125 (2.0%)	<0.001

(continued)

Table 1 (*Continued*)

Covariates	Palliative Care Consultation		
	Yes (n=9200)	No (n=56030)	p-Value
Chronic Obstructive Pulmonary Disease	1415 (17.0%)	9145 (17.6%)	0.153
Chronic Liver Disease	720 (8.0%)	3725 (6.8%)	<0.001
Obesity	1195 (13.0%)	8790 (15.7%)	<0.001
Smoker	2475 (26.9%)	16160 (28.8%)	<0.001
Alcohol User	430 (4.7%)	2415 (4.4%)	0.128
Anemia	505 (9.3%)	2545 (8.7%)	0.163
Thrombocytopenia	2635 (28.6%)	14690 (26.2%)	<0.001
Prior Malignancy	475 (5.2%)	2860 (5.1%)	0.803
Malnutrition	170 (1.8%)	580 (1.0%)	<0.001
Do Not Resuscitate (DNR%) Order in Place	2730 (29.7%)	2555 (4.6%)	<0.001

invasive procedures such as mechanical ventilation (43.1 vs 46.6%, p = 0.004), pacemaker implantation (0.3 vs 1.2%, p <0.001), defibrillator implantation (0.9 vs 1.7%, p = 0.008), insertion of percutaneous feeding tubes (2.9 vs 4.3%, p = 0.004) and tracheostomies (6.1 vs 7.9%, p <0.001) performed whereas complications such as major bleeding (21.6 vs 22.1%, p = 0.587), septic shock (5.5 vs 5.7%, p = 0.662), transfusion of any blood product (22.4 vs 22.0%, p=0.704) were comparable between both cohorts (Table 2). Hospital length of stay (22.8±20.7 vs 22.9± 22.9 days, p = 0.642) and total cost of hospitalization ($477,179±536,715 vs $494,733±558,573, p = 0.865) was also similar between patients in whom PC was consulted and those in whom they were not. On the other hand, in those patients who died in hospital PC was associated with a lower incidence of pacemaker implantation (0.5 vs 0.9%, p = 0.001), defibrillator implantation (0.1 vs 0.5%, p<0.001) and insertion of percutaneous feeding tubes (1.6 vs 3.5%, p <0.001) and a similar incidence of major

(A)

(B)

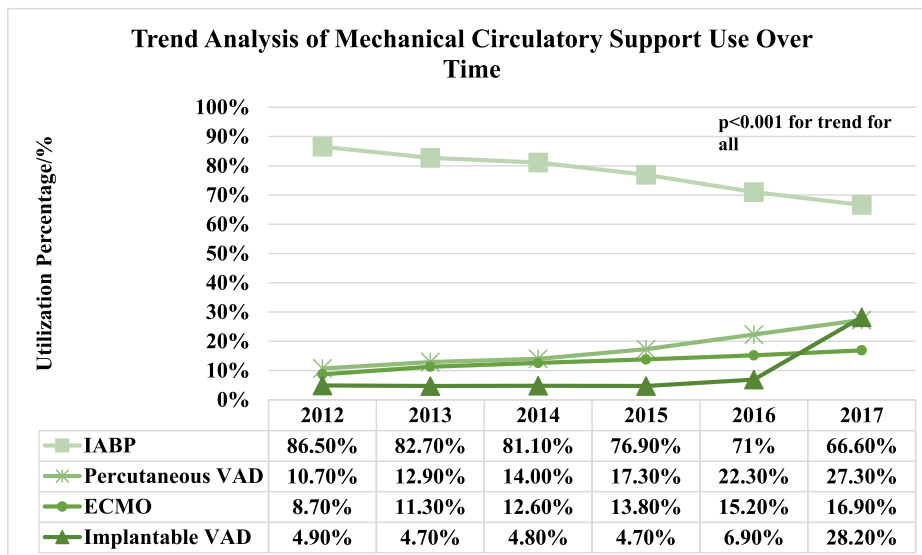|	2012	2013	2014	2015	2016	2017
IABP	86.50%	82.70%	81.10%	76.90%	71%	66.60%
Percutaneous VAD	10.70%	12.90%	14.00%	17.30%	22.30%	27.30%
ECMO	8.70%	11.30%	12.60%	13.80%	15.20%	16.90%
Implantable VAD	4.90%	4.70%	4.80%	4.70%	6.90%	28.20%

Figure 1. Showing the change per year of palliative care consultations (A) and mechanical circulatory support use (B) in patients with advanced heart failure and cardiogenic shock.

Table 2

Comparison of outcomes in patients in whom palliative care was consulted with advanced heart failure and cardiogenic shock who required mechanical circulatory support.

Outcomes	Discharged Alive			Died in Hospital		
	Palliative Care Consultation			Palliative Care Consultation		
	Yes (n=1740)	No (n=39155)	p Value	Yes (n=7460)	No (n=16875)	p Value
Length of Stay (days), mean (SD)	22.8±20.7	22.9±22.9	0.642	13.2±15.6	12.7±17.5	0.046
Total Number of Procedures During Hospitalization	10.6±5.5	11.1±4.7	<0.001	11.1±4.6	11.0±4.7	0.009
Total Cost of Hospitalization	$477,179+536,715	$494,733+558,573	0.865	$423,308+508,094	$424565+511241	0.352
Mechanical Ventilation	750 (43.1%)	18245 (46.6%)	0.004	4625 (62.0%)	10380 (61.5%)	0.472
Pacemaker Implantation	5 (0.3%)	485 (1.2%)	<0.001	35 (0.5%)	145 (0.9%)	0.001
Defibrillator Implantation	15 (0.9%)	660 (1.7%)	0.008	5 (0.1%)	80 (0.5%)	<0.001
Insertion of Percutaneous Feeding Tubes	50 (2.9%)	1675 (4.3%)	0.004	145 (1.6%)	1945 (3.5%)	<0.001
Major Bleeding	375 (21.6%)	8655 (22.1%)	0.587	1975 (26.5%)	4320 (25.6%)	0.151
Transfusion of Any Blood Product	390 (22.4%)	8625 (22.0%)	0.704	1680 (22.5%)	3880 (23.0%)	0.418
Septic Shock	95 (5.5%)	2235 (5.7%)	0.662	655 (8.8%)	1985 (11.8%)	<0.001
Tracheostomy Performed	560 (6.1%)	4440 (7.9%)	<0.001	450 (6.0%)	1000 (5.9%)	0.747
Routine[a]	205 (11.8%)	9510 (24.3%)	N/A	N/A	N/A	N/A'
Short Term Hospital	105 (6.0%)	5185 (13.2%)				
Skilled Nursing Facility/ Intermediate Care Facility	1020 (58.6%)	16390 (41.9%)				
Home Health Care	400 (23.0%)	7900 (20.2%)				

bleeding (26.5 vs 25.6%, p = 0.151), transfusion of any blood products (22.5 vs 23.0%, p = 0.418) and tracheostomies performed (6.0 vs 5.9%, p = 0.747). Additionally, a comparable occurrence of mechanical ventilation (62.0 vs 61.5%, p = 0.472) was seen in the PC consultation cohort (Table 2). On subgroup analysis, there was a higher rate of discharge to a skilled nursing facility/ intermediate care facility (61.0 vs 42.0%, p <0.001) and a lower rate of routine discharge (8.1 vs 24.2%, p <0.001) in patients with a 'do not resuscitate, order. It is unclear whether the coding for "intermediate care facility" included hospice services.

In the multivariate logistic regression analysis adjusting for relevant variables, older age (adjOR, 1.01; 95% CI, 1.00 to 1.02; p = 0.006), female sex (adjOR, 1.72; 95% CI, 1.40 to 2.13; p <0.001), coronary artery disease (adjOR, 1.54; 95% CI, 1.16 to 2.05; p=0.003) and the number of coded diagnoses during the indexed hospitalization (adjOR, 1.06; 95% CI, 1.03 to 1.09; p <0.001) were independently predictive of PC being consulted (Table 3 and Figure 3). By univariate analysis: the use of percutaneous ventricular assist devices [Impella and Tandem Heart] (OR, 1.34; 95% CI, 1.24 to 1.44; p <0.001), implantable ventricular assist devices [VAD] (OR, 1.14; 95% CI, 1.06 to 1.22; p = 0.001) or extracorporeal membrane support [ECMO] (OR, 1.74; 95% CI, 1.63 to 1.87; p <0.001) as the type of mechanical circulatory support, was associated with a greater likelihood of PC consultation whereas intra-aortic balloon pump (IABP) was associated with decreased odds (OR, 0.87; 95% CI, 0.81 to 0.94; p <0.001).

Discussion

Among major findings which warrant further discussion, the total population had: an upward trend in PC consultations from 2012 to 2017; and an overall high in-hospital mortality of 37.3%. Amongst the PC cohort, we found a lower incidence of invasive procedures and comparable complication rates when compared with no PC use, in those who were discharged alive and those who died in hospital. We found older age, female sex, coronary artery disease, and number of procedures performed at the indexed hospitalization as main predictors for PC consultation. To our knowledge, this is the first and largest retrospective observational study investigating PC consultation compared with usual care in patients with advanced HF complicated by CS requiring MCS.

The MCS strategy largely used in this study was the IABP, in lieu of clinical trials of patients with CS having not shown an improvement in mortality, as well as its ability to provide modest hemodynamic support and myocardial protection.[9-11] Despite an upward trend in PC utilization in our study, the overall usage remains exceedingly low (14.1%). This upward trend in PC utilization may be explained by the concomitant downward trend in IABP use, in favor of more 'invasive' MCS devices such as VADs and ECMO, as demonstrated in Figure 1. Alternatively, there may be an increased availability and awareness of PC among treating physicians. The low prevalence of PC consultations was similar to those seen in the EPICTER cross-sectional study, which reported a 15.1% prevalence.[12,13] Although caution must be exercised in making general statements regarding MCS use in the absence of information specific to the underlying clinical and hemodynamic status of each patient, one cannot ignore that even in those patients expected to have more severe disease (VAD or ECMO use) PC use remained low. We found that the length of stay and cost of hospitalizations were similar between both groups with a lower prevalence

Table 3
Multivariate logistic regression analysis of predictors of palliative care consultation in patients with advanced heart failure and cardiogenic shock who required mechanical circulatory support

| Covariates	Model	Odds Ratio	95% Confidence Interval	p Value
Age	Unadjusted	1.01	1.01-1.01	<0.001
	Adjusted	1.01	1.00-1.02	0.006
Gender	Unadjusted	1.12	1.07-1.18	<0.001
	Adjusted	1.72	1.40-2.13	<0.001
Race	Unadjusted	0.97	0.95-0.99	0.001
	Adjusted	0.94	0.86-1.02	0.151
Median Household Income	Unadjusted	1.00	0.98-1.02	0.959
	Adjusted	0.94	0.86-1.04	0.231
Number of Coded Diagnoses	Unadjusted	1.06	1.06-1.07	<0.001
during Hospitalization	Adjusted	1.06	1.03-1.09	<0.001
Hypertension	Unadjusted	1.01	0.96-1.06	0.760
	Adjusted	1.26	0.93-1.70	0.136
Diabetes Mellitus	Unadjusted	0.88	0.85-0.93	<0.001
	Adjusted	0.85	0.66-1.11	0.238
Coronary Artery Disease	Unadjusted	0.93	0.88-0.97	0.002
	Adjusted	1.54	1.16-2.05	0.003
Chronic Kidney Disease (without	Unadjusted	1.11	1.06-1.17	<0.001
Renal Replacement Therapy%)	Adjusted	1.00	0.73-1.36	0.965
Elective Admission	Unadjusted	0.80	0.74-0.86	<0.001
	Adjusted	0.74	0.52-1.06	0.104
Anemia	Unadjusted	1.07	0.97-1.19	0.163
	Adjusted	0.90	0.68-1.20	0.476
Thrombocytopenia	Unadjusted	1.13	1.08-1.19	<0.001
	Adjusted	0.92	0.71-1.19	0.510

of invasive procedures in the PC group. From these findings, it is plausible that the input of PC services may be occurring late into the disease course for shared decision-making when the possibility of death seems inevitable. On the other hand, if early PC involvement (before MCS insertion) is to be routine in this population, the operational aspects must be considered. The implications of expanding and staffing such services with the perceived patient benefits and healthcare cost saving must be weighed. A recent study reported a favorable impact of a new PC program on the Johns Hopkins Medical Institutions; the total positive financial impact of the PC program was 3.5 million US dollars while cost savings for PC consultations in the hospital were estimated at 2.8 million US dollars.[14] Another study found that PC utilization reduced the use of unnecessary care before death; patients who received PC were less likely to have chemotherapy, intensive care unit admissions, multiple emergency department visits, and hospitalizations near death, compared with standard care.[15] Furthermore, the PAL-HF trial showed that PC intervention in advanced HF patients is associated with consistently greater benefits in quality of life, anxiety, depression, and spiritual well-being when compared with usual care alone.[16]

Based on the predictors of PC consultation, finding the most effective and eventually validated referral criteria at the appropriate time will be a critical factor to ensure that those with the most complex palliative needs are referred to optimize care.[17] Defining 'futility' earlier in these patients may help define the patients most likely to benefit from PC intervention. Althoughthis population remains high risk, treatments are evolving and there is a constant need to update referral definitions/criteria to avoid discouraging

care for persons with potentially salvageable clinical states. Prior research has shown that 20% to 45% of patients with HF die in an acute-care setting, a number that is similar to the proportion of people in our study who died in hospital.[18,19] These findings identify an opportunity to improve end-of-life care for patients with advanced HF complicated by CS requiring MCS, because most people report a preference for death at home.[20]

Utilization of the NIS provides us with an opportunity to analyze a large number of patients, from hundreds of centers nationwide, across a five-year timeframe. However, as the NIS represents hospitalizations and not individual patients, there is a possibility that patients with advanced HF with CS requiring MCS may feature more than once in the data set. One major limitation of our study, by the nature of the database, is the inability to identify the timing of PC consultation during the hospitalization and whether patients were seen by a PC physician in the outpatient setting prior to admission. Although our study provided insight on in-hospital outcomes, data on after discharge follow up was not available. Less than a third of patients were female, and future work to understand whether this is because women present with more advanced stages of shock, are not recognized to be in or decline invasive treatments for shock, would appear to be important goals that must be addressed in future studies. In the absence of these specific parameters (laboratory, echocardiographic and quality-of-life data), we were unable to assess disease severity utilizing the Society for Cardiovascular Angiography and Interventions Classification of CS in those who died in hospital or were discharged alive.

(A)
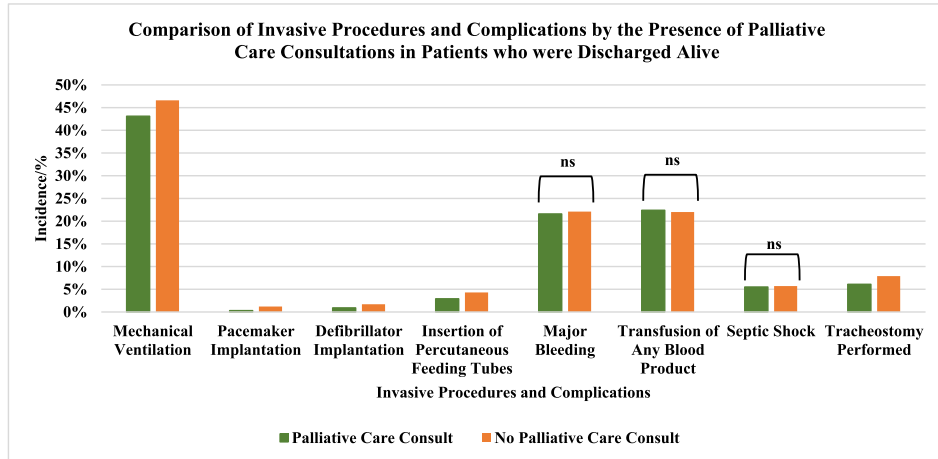
ns- non-significant p value, p>0.05

(B)
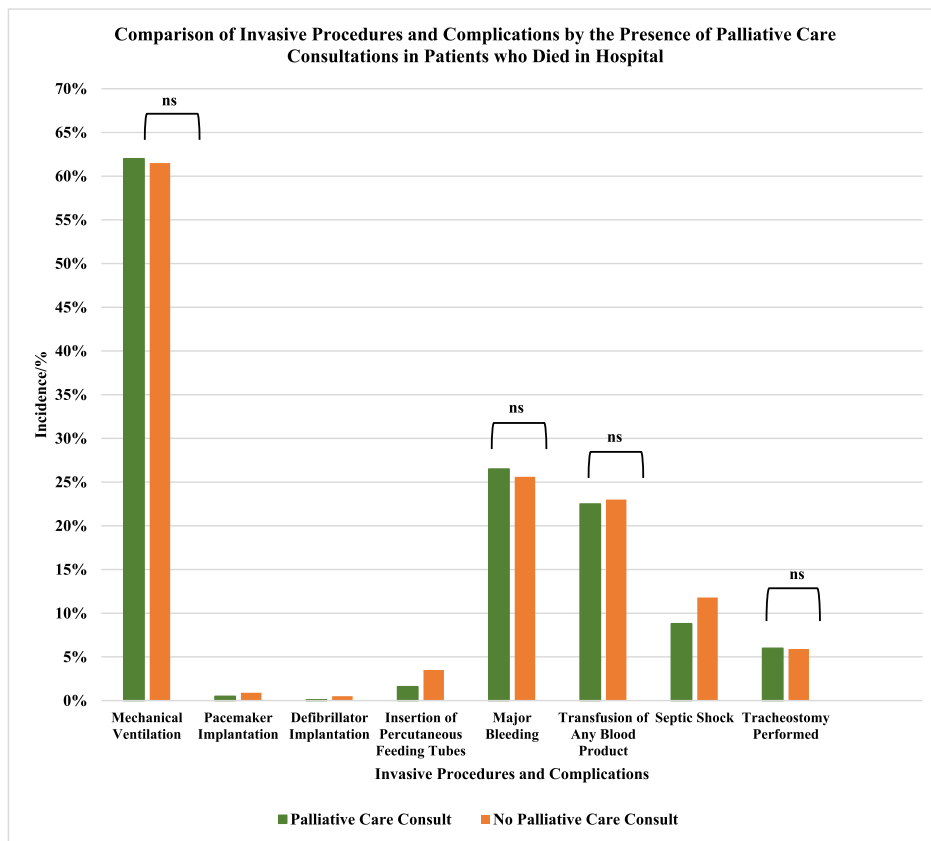
ns- non-significant p value, p>0.05

Figure 2. (A) Comparison of invasive procedures and complications by the presence of palliative care consultations in patients with advanced heart failure and cardiogenic shock who required mechanical circulatory support who were discharged alive. (B) Comparison of invasive procedures and complications by the presence of palliative care consultations in patients with advanced heart failure and cardiogenic shock who required mechanical circulatory support who died in hospital.

In conclusion, despite the high morbidity and mortality associated with advanced HF patients with CS requiring MCS, the overall prevalence of PC consultation is exceedingly low. When utilized, the incidence of invasive procedures was lower. This study highlights the underutilization of PC services in this patient population, precluding any perceived benefit in end-of-life experiences. Further research is needed to identify the right time and indication
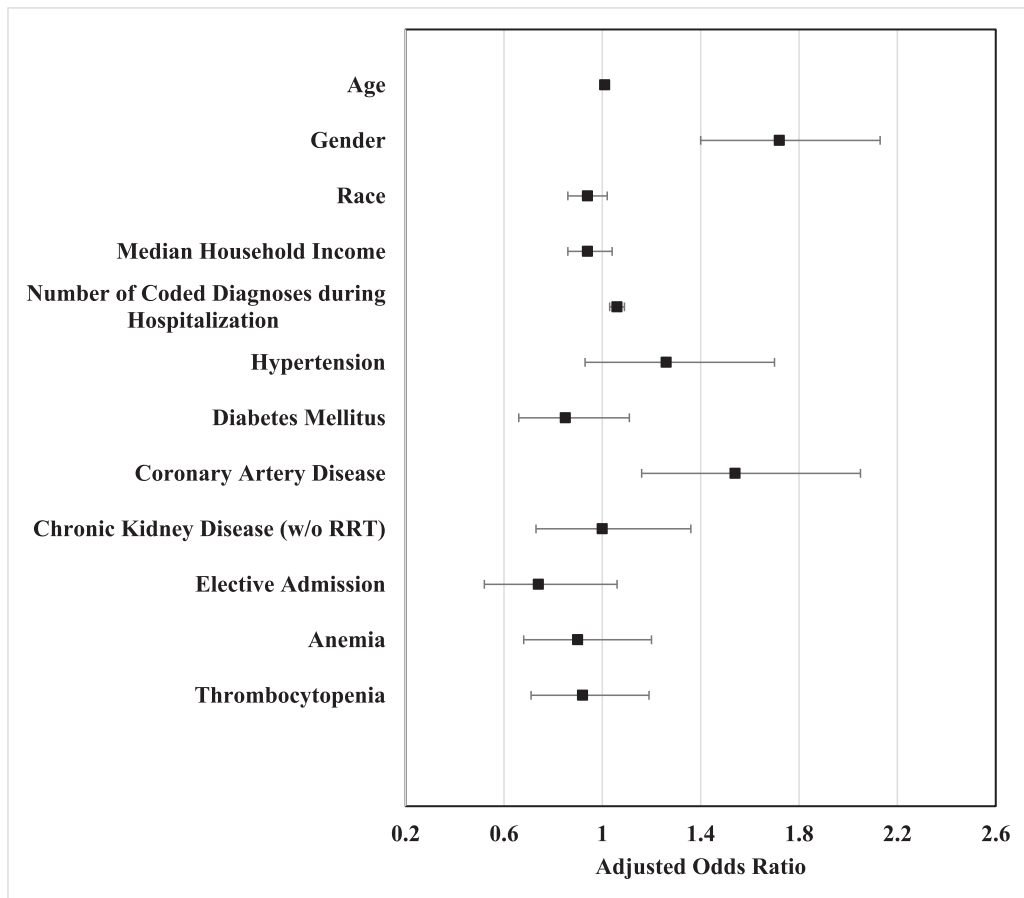
Figure 3. Box plot showing the odds ratios of independent predictors of in-hospital palliative care consultation.

for referral to PC with focus on improving physician comfort with involving PC for patients with advanced HF with CS requiring MCS.

Credit Author Statement

Jelani K. Grant: Conceptualization, Methodology, Software, Writing- Original draft preparation, Writing- Reviewing and Editing. Louis Vincent: Methodology, Software, Writing- Reviewing and Editing. **Bertrand Ebner:** Methodology, Software, Writing- Reviewing and Editing. **Jennifer Maning:** Methodology, Software, Writing- Reviewing and Editing. **Harjit Singh:** Writing- Original draft preparation. **Odunayo Olorunfemi:** Writing- Reviewing and Editing, Supervision. **Neal I. Olarte:** Writing- Reviewing and Editing, Supervision. **Gerardo Zablah:** Writing- Reviewing and Editing, Supervision. **Rosario Colombo:** Writing- Reviewing and Editing, Supervision. **Khin Zaw:** Writing- Reviewing and Editing, Supervision. **Joao Braghiroli:** Writing- Reviewing and Editing, Supervision.

Declaration of Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.amjcard.2021.02.024.

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