Utilization of Palliative Care for Cardiogenic Shock Complicating Acute Myocardial Infarction: A 15-Year National Perspective on Trends, Disparities, Predictors, and Outcomes

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**Background**—This study sought to evaluate the 15-year national utilization, trends, predictors, disparities, and outcomes of palliative care services (PCS) use in cardiogenic shock complicating acute myocardial infarction.

**Methods and Results**—A retrospective cohort from January 1, 2000 through December 31, 2014 was analyzed using the National Inpatient Sample database. Administrative codes for acute myocardial infarction—cardiogenic shock and PCS were used to identify eligible admissions. The primary outcomes were the frequency, utilization trends, and predictors of PCS. Secondary outcomes included in-hospital mortality and resources utilization. Multivariable regression and propensity-matching analyses were used to control for confounding. In this 15-year period, there were 444,253 acute myocardial infarction—cardiogenic shock admissions, of which 4.5% received PCS. The cohort receiving PCS was older, of white race, female sex, and with higher comorbidity and acute organ failure. The PCS cohort received fewer cardiac procedures, but more noncardiac organ support therapies. Older age, female sex, white race, higher comorbidity, higher socioeconomic status, admission to a larger hospital, and admission after 2008 were independent predictors of PCS use. Use of PCS was independently associated with higher in-hospital mortality (odds ratio 6.59 [95% CI 6.37–6.83]; P<0.001). The cohort with PCS use had 2-fold higher in-hospital mortality, 12-fold higher use of do-not-resuscitate status, lesser in-hospital resource utilization, and fewer discharges to home. Similar findings were observed in the propensity-matched cohort.

**Conclusions**—PCS use in patients with acute myocardial infarction—cardiogenic shock is low, though there is a trend towards increased adoption. There are significant patient and hospital-specific disparities in the utilization of PCS.  

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**Key Words:** acute myocardial infarction • cardiogenic shock • critical care • end-of-life care • outcomes research
Clinical Perspective

What Is New?

• In the largest national study evaluating the role of palliative care services, we note palliative care services to be significantly underutilized in the care of patients with cardiogenic shock complicating acute myocardial infarction.

• There appear to be significant variations in patient and hospital-specific factors because of the lack of clear consensus and pre-existing biases.

What Are the Clinical Implications?

• Dedicated qualitative research on patient and provider beliefs and biases on the integration of palliative care services into the comprehensive care of patients with cardiogenic shock complicating acute myocardial infarction are warranted to improve the clinical care and outcomes in this population.

Material and Methods

Study Population, Variables, and Outcomes

The data are publicly available from the Agency for Healthcare Research and Quality Healthcare Cost and Utilization Project (HCUP) for other researchers to replicate the results of this study. The Nationwide/National Inpatient Sample (NIS) is the largest all-payer database of hospital inpatient stays in the United States. The HCUP-NIS contains discharge data from a 20% stratified sample of community hospitals. Information regarding each discharge includes patient demographics, primary payer, hospital characteristics, principal diagnosis, up to 24 secondary diagnoses, and procedural diagnoses. The HCUP-NIS does not capture individual patients, but captures all information for a given admission/hospitalization. No institutional review board approval was sought because of the publicly available de-identified data set used in this research.

Using the HCUP-NIS data from January 1, 2000 through December 31, 2014, a retrospective cohort study of admissions with AMI-CS was identified. AMI in the primary procedure field was identified using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes 410.x and CS using ICD-9-CM 785.51. Validation studies for CS have shown a specificity of 99.3%, a sensitivity of 59.8%, a positive predictive value of 78.8%, and a negative predictive value of 98.1% for the ICD-9-CM code 785.51. Inpatient PCS and do not resuscitate (DNR) status were identified using ICD-9-CM codes V66.7 and V49.86, respectively. The ICD-9-CM for PCS (ICD-9-CM V66.7) has demonstrated moderate sensitivity and high specificity (>90%). Validation studies have demonstrated that when ICD-9-CM V66.7 is documented, >90% patients receive specialist PCS consultation during an inpatient hospitalization. However, the use of ICD-9-CM V66.7 only refers to a PCS consultation but not necessarily the implementation of palliative or hospice care strategies. This methodology has been previously used for studies from the HCUP-NIS database. The Deyo modification of Charlson comorbidity index was used to identify the burden of comorbid diseases. Coronary angiography, percutaneous coronary intervention, mechanical circulatory support (MCS), acute organ failure,

Table 1. Administrative Codes Used for Identification of Diagnoses and Procedures

| Diagnosis/Procedure                  | International Classification of Diseases 9.0 Cl. Mod. Codes |
|--------------------------------------|----------------------------------------------------------|
| Cardiac arrest                       | 427.5                                                    |
| Coronary angiography                 | 36.06, 37.22, 37.23, 88.53 to 88.56                      |
| Percutaneous coronary intervention   | 00.66, 36.01, 36.02, 36.05, 36.07, 88.57                |
| Right heart catheterization          | 37.21, 37.23, 204                                        |
| Intra-aortic balloon pump            | 37.61                                                    |
| Percutaneous mechanical circulatory support | 37.68                                      |
| Extracorporeal membrane oxygenation  | 39.65                                                    |
| Invasive mechanical ventilation      | 96.7, 96.70, 96.71, 96.72                                |
| Noninvasive mechanical ventilation   | 93.90                                                    |
| Hemodialysis                         | 39.95                                                    |
| Acute respiratory failure            | 518.81, 518.82, 518.85, 786.09, 799.1, 96.7, 96.70, 96.71, 96.72 |
| Acute renal failure                  | 584, 584.5, 584.6, 584.7, 584.8, 584.9                  |
| Acute hepatic failure                | 570, 572.2 to 572.4                                      |
| Acute hemolytic failure              | 286.6, 286.7, 286.9, 287.4, 287.5                       |
| Acute neurologic failure             | 293, 293.0, 293.1, 293.8, 293.9, 293.8, 293.9, 293.8, 293.9, 293.9, 348.1, 348.3, 348.30, 348.31, 348.39, 780.01, 780.09, 89.14 |
Table 2. Baseline Characteristics of AMI-CS With and Without PCS Use

| Characteristic                                      | Total Cohort | Propensity-Matched Cohort | P Value | Total Cohort | Propensity-Matched Cohort | P Value |
|-----------------------------------------------------|--------------|---------------------------|---------|--------------|---------------------------|---------|
|                                                     | With PCS (N=19,893) | Without PCS (N=424,360) |         | With PCS (N=1842) | Without PCS (N=1842) |         |
| AMI type                                            |              |                           |         |              |                           |         |
| ST-segment-elevation AMI                            | 61.8         | 68.4                      | <0.001  | 58.1         | 58.0                      | 0.95    |
| Non-ST-segment-elevation AMI                         | 38.2         | 31.6                      | <0.001  | 41.9         | 42.0                      | 0.97    |
| Age, y                                              | 75.3±12.4    | 68.9±13.0                 | <0.001  | 75.5±12.6    | 75.7±11.5                 | 0.70    |
| Age groups, y                                       |              |                           |         |              |                           |         |
| 19–49                                               | 3.3          | 7.7                       | <0.001  | 3.6          | 1.8                       | 0.23    |
| 50–59                                               | 9.1          | 17.3                      |         | 9.4          | 8.4                       |         |
| 60–69                                               | 18.8         | 24.7                      |         | 17.2         | 19.2                      |         |
| 70–79                                               | 24.4         | 26.3                      |         | 24.4         | 26.5                      |         |
| ≥80                                                 | 44.4         | 23.9                      |         | 45.4         | 44.1                      |         |
| Female sex                                          | 44.6         | 38.9                      | <0.001  | 43.9         | 45.0                      | 0.46    |
| Race                                                |              |                           |         |              |                           |         |
| White                                               | 72.0         | 62.7                      | <0.001  | 79.6         | 78.0                      | 0.26    |
| Black                                               | 5.9          | 5.7                       |         | 7.3          | 8.3                       |         |
| Hispanic                                            | 5.3          | 6.4                       |         | 6.4          | 8.1                       |         |
| Asian                                               | 2.7          | 2.4                       |         | 3.0          | 2.4                       |         |
| Native American                                     | 0.4          | 0.5                       |         | 0.4          | 0.4                       |         |
| Others                                              | 3.0          | 3.2                       |         | 3.3          | 2.8                       |         |
| Missing                                             | 10.7         | 19.1                      |         | ...          | ...                       |         |
| Weekend admission                                   | 27.1         | 26.9                      | 0.33    | 27.7         | 27.3                      | 0.75    |
| Primary payer                                       |              |                           |         |              |                           |         |
| Medicare                                            | 60.9         | 74.5                      | <0.001  | 73.9         | 74.8                      | 0.86    |
| Medicaid                                            | 6.4          | 4.7                       |         | 5.2          | 4.9                       |         |
| Private                                             | 24.5         | 14.6                      |         | 14.7         | 15.2                      |         |
| Uninsured                                           | 5.2          | 3.7                       |         | 3.6          | 2.9                       |         |
| No charge                                           | 0.4          | 0.2                       |         | 0.3          | 0.2                       |         |
| Others                                              | 2.5          | 2.3                       |         | 2.3          | 2.0                       |         |
| Quartile of median household income for zip code    |              |                           |         |              |                           |         |
| 0–25th                                              | 24.0         | 23.2                      | <0.001  | ...          | ...                       | ...     |
| 26th–50th                                           | 27.1         | 26.5                      |         | ...          | ...                       |         |
| 51st–75th                                           | 25.9         | 24.9                      |         | ...          | ...                       |         |
| 75th–100th                                          | 23.0         | 25.3                      |         | ...          | ...                       |         |
| Hospital teaching status and location               |              |                           |         |              |                           |         |
| Rural                                               | 7.0          | 7.5                       | <0.001  | 7.2          | 5.7                       | 0.07    |
| Urban nonteaching                                   | 33.5         | 41.0                      |         | 37.1         | 40.2                      |         |
| Urban teaching                                      | 59.5         | 51.5                      |         | 55.7         | 54.1                      |         |
| Hospital bed size                                   |              |                           |         |              |                           |         |
| Small                                               | 8.2          | 7.8                       | 0.05    | 8.5          | 7.4                       | 0.50    |
| Medium                                              | 22.1         | 22.2                      |         | 22.7         | 22.4                      |         |
| Large                                               | 69.6         | 70.1                      |         | 68.8         | 70.2                      |         |
mechanical ventilation, and hemodialysis were identified for all admissions (Table 1).22–24

The primary outcome was the prevalence, utilization trends, and predictors for PCS during this 15-year period. Secondary outcomes included in-hospital mortality, length of stay, costs, and discharge disposition in patients with AMI-CS that received PCS.

**Statistical Analysis**

As recommended by HCUP-NIS, survey procedures using discharge weights provided with the HCUP-NIS database were used to generate national estimates. Using the trend weights provided by the HCUP-NIS, samples from 2000 to 2011 were reweighted to adjust for the 2012 HCUP-NIS redesign.25 In 2012, the HCUP-NIS was redesigned to sample 20% of the national patient-level sample as compared with 2000 to 2011 wherein it sampled 100% of the discharges from 20% of the hospitals.25 Using trend weights available on the HCUP-NIS database, samples from 2000 to 2011 were retroactively reweighted. The new sampling strategy is expected to result in more precise estimates than the previous HCUP-NIS design by reducing sampling error.15 This methodology has been used by multiple prior studies spanning across year 2012 from the HCUP-NIS.3–5,26,27 Chi-square and 2-sample t tests were used to compare categorical and continuous variables, respectively, for the total cohort. The inherent restrictions of the HCUP-NIS database related to research design, data interpretation, and data analysis were reviewed and addressed.25 Pertinent considerations include not assessing individual hospital-level volumes (because of changes to sampling design detailed above), treating each entry as an “admission” as opposed to individual patients, restricting the study details to inpatient factors since the HCUP-NIS does not include outpatient data, and limiting administrative codes to those previously validated and used for similar studies.3–5,26,27 Univariate analysis for trends and outcomes was performed and was represented as odds ratio with 95% CI. Using a multivariable hierarchical logistic regression analysis, incorporating age, sex, race, admission year, primary payer status, socioeconomic stratum, hospital characteristics, comorbidities, acute organ failure, and cardiac procedures, an analysis was performed for PCS use as the dependent variable. For multivariable hierarchical logistic regression analysis, purposeful selection of statistically and clinically relevant variables was conducted. Additionally, we performed a propensity-matched analysis for patient demographics, comorbidities, hospital characteristics, acute organ failure, and acute care interventions between the 2 cohorts. For the propensity matching, all variables except race had <1% missing variables. For the race category, missing variables were imputed using random sampling from the respective covariate distributions. Using 1:1 nearest neighbor matching, 1842 matching pairs (3684 individual admissions) were
developed for further use. The propensity-matched sample had standardized differences <10% for all baseline characteristics. The McNemar χ² test and paired sample t tests were used to compare categorical and continuous variables, respectively, in the propensity-matched sample. Two-tailed \( P<0.05 \) was considered statistically significant. Given the large sample size, all \( P \) values that are statistically significant may not be clinically significant. All statistical analyses were performed using SPSS v25.0 (IBM Corp, Armonk NY) and R v3.4.2 (https://www.R-project.org/).

## Results

During the 15-year study period, there were \( \approx 8 \) million admissions for a primary diagnosis of AMI, of which an estimated 444 253 were complicated by CS. PCS use was reported in 19 893 (4.5%) admissions. Baseline characteristics of the cohorts with and without PCS use are detailed in Table 2. The cohort receiving PCS was older (75 versus 69 years; \( P<0.001 \)) with higher rates of white race, female sex, and greater comorbidity. Hospitals in the southern United States had lower rates and large urban teaching hospitals demonstrated greater use of PCS. Patients with a history of prior hypertension, cancer, chronic kidney disease, and heart failure were more likely to receive PCS (Table 2). The temporal trends of PCS use based on patient and hospital characteristics are presented in Figures 1 and 2.

Multiorgan failure, cardiac arrest, and the use of noncardiac interventions such as mechanical ventilation and hemodialysis were greater in patients receiving PCS (all \( P<0.001 \)) (Table 3). Conversely, the use of cardiac procedures, such as diagnostic coronary angiography, percutaneous coronary intervention, MCS, and invasive hemodynamic monitoring were lower (Table 3). Among patients who received MCS, PCS service use was higher in those requiring

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**Figure 1.** Temporal trends in the utilization of palliative care services in AMI-CS classified by patient characteristics. Fifteen-year trends in the use of palliative care services classified by sex (A), age groups (in years) (B), race (C), and median income quartile for zip code (D); all \( P<0.001 \) for trend. AMI-CS indicates acute myocardial infarction complicated by cardiogenic shock.
percutaneous MCS and extracorporeal membrane oxygenation. In a multivariable hierarchical logistic regression model, every increasing decade of age, white race, female sex, greater baseline comorbidity, and higher socioeconomic stratum were independently associated with increasing use of PCS (Table 4). Admission after 2009, large hospital size, and admissions to hospitals in the Midwest and Western United States were associated with higher use of PCS. Respiratory, neurologic, and renal dysfunction and cardiac arrest were independently associated with PCS use (Table 4).

The unadjusted in-hospital mortality (79.2% versus 36.6%; odds ratio 6.59 [95% CI 6.37–6.83]; \( P < 0.001 \)) was significantly higher in the cohort receiving PCS. The cohort with PCS had shorter hospital length of stay, lower hospitalization costs, lower rates of discharges to home, and greater use of DNR status (Table 5). Excluding patients with in-hospital mortality, the mean (±SD) length of stay was shorter in those who received PCS (6.3±8.5 versus 6.4±10.2 days; \( P < 0.001 \)) compared with those who did not. In the propensity-matched cohort of 3684 patients, use of PCS remained independently associated with higher in-hospital mortality (73.8% versus 32.6%; \( P < 0.001 \)). In this propensity-matched cohort, patients who received PCS had shorter hospital length of stay and lower hospitalization costs, but had greater use of DNR status and discharges to assisted-care facilities, consistent with the larger cohort (Table 5).

**Discussion**

In this nationally representative descriptive study evaluating PCS in AMI-CS, we noted very limited use of PCS in only 4.5% of the admissions. There was a serial increase in PCS use during the study period across all patient and hospital categories, but the overall rate remained low. Older age, white race, female sex, higher baseline comorbidity, and greater noncardiac organ failure were predictive of higher PCS use in admissions with AMI-CS. The cohort with PCS use had more than 2-fold higher in-hospital mortality, 12-fold higher use of

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**Figure 2.** Temporal trends in the utilization of palliative care services in AMI-CS classified by hospital characteristics. Fifteen-year trends in the use of palliative care services classified by hospital location and teaching status (A), bed size (B), and region (C); all \( P < 0.001 \) for trend. AMI-CS indicates acute myocardial infarction complicated by cardiogenic shock.
DNR status, lesser in-hospital resource utilization, and lesser discharges to home.

**PCS in CS**

Despite the high mortality in AMI-CS, there are limited data on the indicators and timing of PCS referral in this population.6 Recommended objective and subjective criteria for PCS referral from the CS complicating end-stage heart failure literature include renal dysfunction, anemia, multiorgan failure (≥3 organ systems), persistent hemodynamic instability, and age ≥80 years.6 In veterans with heart failure with at least 1 hospitalization, Mandawat et al demonstrated only a modest rise in the use of PCS from 6% to 10% between 2007 and 2013.12 These patients had a high 1-year mortality of 73% suggestive of severe morbidity at the time of PCS consultation. In a Swiss registry of 45 091 AMI patients, use of palliative treatments was noted only in 2% to 6% of patients.26 These data are consistent with our study that demonstrated the use of PCS in only 4.5% of the population. In patients with acute-on-chronic heart failure, it appears that PCS care is offered more in the outpatient than in the inpatient setting.12,29 However, given the acute nature of AMI-CS, use of outpatient PCS care is less significant in this population.4 Our results for inpatient PCS referral are consistent with similar literature from acute heart failure.29 The reasons for these disparities remain uncertain, but can be hypothesized to be because of multiple factors. First, there appears to be a knowledge gap on the roles and responsibilities of PCS as demonstrated by Kavalieratos et al.10 Hospice care, end-of-life care, and PCS are presumed to be interchangeable, potentially resulting in late referrals of “actively dying” patients. Secondly, despite a near doubling of PCS physicians in the last 5 years, there is an acute shortage of PCS physicians because of a combination of high burnout and limited number of available training positions that might limit accessibility to all patients.30,31 However, it is important to distinguish that PCS, as measured by the ICD-9-CM code in this study, need not be performed by a trained palliative care physician and could include other medical/allied health professionals. Conversely, the lack of use of this ICD-9-CM code can miss important palliative treatments performed by the treating services. Finally, the course of AMI-CS is complex, and individual organ support measures, either pharmacological or mechanical, might demonstrate slight improvements in clinical status in the short term.

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**Table 3. In-Hospital Course and Management of AMI-CS With and Without PCS**

| Characteristic                                | Total Cohort | Propensity-Matched Cohort |
|----------------------------------------------|--------------|--------------------------|
|                                              | With PCS (N=19 893) | Without PCS (N=424 360) | With PCS (N=1842) | Without PCS (N=1842) |
|                                              | P Value       |                          | P Value |
| Acute organ dysfunction                       |              |                          |          |
| Respiratory                                  | 58.6         | 42.7                     | <0.001   | 58.3 | 56.5 | 0.27 |
| Renal                                        | 57.1         | 34.1                     | <0.001   | 57.8 | 56.6 | 0.42 |
| Hepatic                                      | 16.9         | 7.5                      | <0.001   | 16.6 | 16.4 | 0.90 |
| Hematological                                | 12.5         | 10.9                     | <0.001   | ... | ... | ... |
| Metabolic                                    | 30.0         | 16.1                     | <0.001   | 26.5 | 27.8 | 0.43 |
| Neurological                                 | 30.6         | 12.5                     | <0.001   | 32.8 | 30.8 | 0.24 |
| Cardiac arrest                                | 25.4         | 17.7                     | <0.001   | 21.8 | 21.2 | 0.65 |
| Coronary angiography                         | 50.4         | 68.6                     | <0.001   | ... | ... | ... |
| Percutaneous coronary intervention           | 37.1         | 47.8                     | <0.001   | 39.4 | 38.8 | 0.73 |
| Right heart catheterization                  | 14.8         | 20.2                     | <0.001   | 10.6 | 12.1 | 0.18 |
| MCS                                          |              |                          |          |
| Total                                        | 33.2         | 45.6                     | <0.001   | 33.6 | 32.6 | 0.53 |
| IABP                                         | 30.8         | 44.4                     | <0.001   | 31.2 | 31.4 | 0.90 |
| Percutaneous MCS                             | 2.8          | 1.3                      | <0.001   | ... | ... | ... |
| ECMO                                         | 1.3          | 0.5                      | <0.001   | ... | ... | ... |
| Invasive mechanical ventilation              | 53.9         | 41.5                     | <0.001   | 50.5 | 49.9 | 0.72 |
| Noninvasive ventilation                      | 6.1          | 2.9                      | <0.001   | 5.6  | 6.4  | 0.42 |
| Hemodialysis                                 | 6.2          | 3.3                      | <0.001   | 5.5  | 6.2  | 0.36 |

Represented as percentage or mean±SD. AMI indicates acute myocardial infarction; CS, cardiogenic shock; ECMO, extracorporeal membrane oxygenation; IABP, intra-aortic balloon pump; MCS, mechanical circulatory support; PCS, palliative care services.

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Table 4. Predictors of PCS Use in AMI-CS

| Total cohort (N=444,253) | Odds Ratio | 95% CI                | P value |
|--------------------------|------------|-----------------------|---------|
|                          |            | Lower Limit | Upper Limit |         |
| Age groups, y            |            |            |            |         |
| 19–49                    | Reference category |            |            |         |
| 50–59                    | 1.17       | 1.05        | 1.29        | 0.003   |
| 60–69                    | 1.47       | 1.32        | 1.63        | <0.001  |
| 70–79                    | 1.84       | 1.64        | 2.05        | <0.001  |
| ≥80                      | 3.41       | 3.04        | 3.81        | <0.001  |
| Female sex               | 1.22       | 1.18        | 1.26        | <0.001  |
| Race                     |            |            |            |         |
| White                    | Reference category |            |            |         |
| Black                    | 0.78       | 0.73        | 0.83        | <0.001  |
| Hispanic                 | 0.72       | 0.67        | 0.77        | <0.001  |
| Asian                    | 0.73       | 0.67        | 0.81        | <0.001  |
| Native American          | 0.65       | 0.51        | 0.83        | 0.001   |
| Others                   | 0.74       | 0.68        | 0.81        | <0.001  |
| Year of admission        |            |            |            |         |
| 2000                     | Reference category |            |            |         |
| 2001                     | 0.73       | 0.52        | 1.02        | 0.06    |
| 2002                     | 1.45       | 1.09        | 1.94        | 0.01    |
| 2003                     | 1.84       | 1.39        | 2.43        | <0.001  |
| 2004                     | 3.65       | 2.84        | 4.69        | <0.001  |
| 2005                     | 3.36       | 2.61        | 4.33        | <0.001  |
| 2006                     | 3.80       | 2.96        | 4.88        | <0.001  |
| 2007                     | 4.57       | 3.58        | 5.84        | <0.001  |
| 2008                     | 6.54       | 5.17        | 8.27        | <0.001  |
| 2009                     | 17.76      | 14.19       | 22.24       | <0.001  |
| 2010                     | 19.10      | 15.26       | 23.92       | <0.001  |
| 2011                     | 27.29      | 21.84       | 34.10       | <0.001  |
| 2012                     | 22.86      | 18.28       | 28.57       | <0.001  |
| 2013                     | 30.70      | 24.58       | 38.35       | <0.001  |
| 2014                     | 31.88      | 25.52       | 39.81       | <0.001  |
| Weekend admission        | 1.01       | 0.98        | 1.05        | 0.44    |
| Primary payer            |            |            |            |         |
| Medicare                 | Reference category |            |            |         |
| Medicaid                 | 0.98       | 0.90        | 1.06        | 0.57    |
| Private                  | 0.88       | 0.83        | 0.92        | <0.001  |
| Uninsured                | 1.07       | 0.98        | 1.17        | 0.15    |
| No charge                | 1.02       | 0.75        | 1.39        | 0.90    |
| Others                   | 1.13       | 1.01        | 1.27        | 0.03    |
| Quartile of median income for zip code | Reference category | | | | 
| 0–25th                   |            |            |            |         |
Given the lack of definite predictors and scoring systems for mortality, prognostication is challenging.4

### Trends and Disparities in PCS Use in AMI-CS

PCS were used more often in patients of older age, white race, and female sex. Older age is an independent prognostic factor in AMI-CS as evidenced by nearly 3-fold higher mortality in patients >80 years of age in comparison to those <50 years. This is consistent with the current guidelines from the American Heart Association that list age >80 years as an independent reason for PCS referral.6 Consistent with prior literature, our study demonstrated that nonwhite race was a significant predictor of underutilization of PCS.32 Despite

| Table 4. Continued |
|---------------------|
| **Total cohort (N=444 253)** | Odds Ratio | 95% CI | P value |
|---------------------|------------|--------|--------|
| 26th–50th           | 1.09       | 1.04   | 1.14   | <0.001 |
| 51st–75th           | 1.16       | 1.11   | 1.22   | <0.001 |
| 75th–100th          | 1.13       | 1.07   | 1.19   | <0.001 |

**Hospital teaching status and location**

|                     | Reference category |
|---------------------|--------------------|
| Rural               | 0.81               |
| Urban nonteaching   | 1.05               |
| Urban teaching      | 0.98               |

**Hospital bed size**

|                     | Reference category |
|---------------------|--------------------|
| Small               | 1.12               |
| Medium              | 1.30               |
| Large               | 1.38               |

**Hospital region**

|                     | Reference category |
|---------------------|--------------------|
| Northeast           | 1.29               |
| Midwest             | 0.88               |
| South               | 0.90               |
| West                | 1.34               |

**Charlson comorbidity index**

|                     | Reference category |
|---------------------|--------------------|
| 0–3                 | 1.18               |
| 4–6                 | 1.35               |
| ≥7                  | 1.35               |

**Acute organ dysfunction**

|                     | Reference category |
|---------------------|--------------------|
| Respiratory         | 1.26               |
| Renal               | 1.29               |
| Hepatic             | 1.31               |
| Hematological       | 0.77               |
| Metabolic           | 1.19               |
| Neurological        | 2.17               |
| Cardiac arrest      | 1.08               |
| Coronary angiography| 0.48               |
| Percutaneous coronary intervention | 0.95 | 0.91 | 0.99 | 0.01 |
| Right heart catheterization | 1.14 | 1.08 | 1.21 | <0.001 |
| Mechanical circulatory support | 0.91 | 0.87 | 0.95 | <0.001 |
| Invasive mechanical ventilation | 1.13 | 1.09 | 1.18 | <0.001 |
| Hemodialysis        | 1.04               |

AMI indicates acute myocardial infarction; CS, cardiogenic shock; PCS, palliative care services.
higher adjusted mortality in Hispanic and Native American populations in AMI-CS, these racial/ethnic groups received less PCS.33 The reasons for these disparities are incompletely understood and are likely caused by differences in cultural and religious beliefs, treatment preferences, and incomplete knowledge.32 A smaller single high-volume center study showed nearly 50% of all patients with CS from any cause with a subsequent MCS (short-term ventricular assist device or extracorporeal membrane oxygenation) received PCS.34 Despite the current American Heart Association guidelines recommending the use of PCS for all MCS patients,14 our nationally representative data demonstrate significant practice heterogeneity and disparities. This study noted a large increase in PCS since 2009. Though greater awareness and attention to AMI-CS could have contributed to this increase, it is quite possible that this represents greater application of the ICD-9-CM code for PCS. Greater involvement of the PCS team in multidisciplinary care could have also resulted in increase of this particular service. This is particularly important since there has been a steady increase in the use of MCS in the past decade.26,27,35–37 There were significant variations in the use of PCS based on hospital regions and size, alluding to the lack of clear consensus on the indicators for PCS. In the absence of strong clinical predictors, it may be pertinent to consider alternate methods of ensuring equity such as regionalization of care for CS patients.6,35 Our study noted a small decrease in utilization of PCS in Figures 1 and 2 in the year 2012. Though the HCUP-NIS redesign in 2012 may have influenced these trends, these changes were similar both in the unweighted and weighted samples, making this less likely to be a spurious finding.

Lastly, though not the focus of this study, PCS use in our study identified an extremely high-risk cohort with ≈80% mortality. Attempts to control for confounding by using multivariable regression and propensity-matching did not influence the mortality results, suggestive of unmeasured confounders. The use of PCS was associated with greater use of DNR status, lower hospitalization costs, shorter hospital length of stay, and greater dismissal to skilled nursing facilities. Taken in combination, these results might suggest that patients with PCS use received futile care less often, adopted life-limiting decisions more frequently, and sought nonhospitalization care during end-of-life.38 However, these hypothesis-generating data should be interpreted with caution since higher severity of illness and mortality in this high-risk cohort could present a similar picture.

In summary, we believe that the challenges in engaging PCS in AMI-CS arise from a combination of delayed recognition of deserving patients, waxing and waning clinical course of CS, acute shortage of PCS physicians, and misrepresentation of the role of PCS in contemporary practice. Use of more granular risk prediction models, “shock teams” that include PCS professionals, and regionalization of AMI-CS care are potential system-based practices that may aid in greater recruitment of PCS.35,39–41

Limitations

This study has several limitations, some of which are inherent to the analysis of a large administrative database. The HCUP-NIS attempts to mitigate potential errors by using internal quality and external quality-control measures. The ICD-9-CM codes for AMI, CS, and PCS have been previously validated, which reduces the inherent errors in the study. The timing of PCS consultation and services could not be reliably established in this administrative database. It is possible that early and

Table 5. Clinical Outcomes of AMI-CS With and Without PCS Use

| Characteristic                      | Total Cohort Without PCS (N=424 360) | Total Cohort With PCS (N=1 893) | Propensity-Matched Cohort Without PCS (N=1 842) | Propensity-Matched Cohort With PCS (N=1 842) | P Value |
|------------------------------------|--------------------------------------|---------------------------------|-----------------------------------------------|-----------------------------------------------|---------|
| In-hospital mortality              | 36.6                                 | 79.2                            | 32.6                                          | 73.8                                          | <0.001  |
| Median length of stay (d)          | 10.3±11.7                            | 7.3±10.7                        | 11.1±11.3                                     | 7.7±10.1                                      | <0.001  |
| Median hospitalization costs (US dollars) | 126 594±154 355                    | 118 690±172 621                 | 171 562±185 080                               | 129 087±176 236                               | <0.001  |
| Do-not-resuscitate status          | 2.9                                  | 35.9                            | 5.9                                           | 24.2                                          | <0.001  |
| Discharge disposition              |                                      |                                 |                                               |                                               |         |
| Home                               | 42.8                                 | 7.6                             | 27.2                                          | 7.2                                           | <0.001  |
| Transferred to other hospitals     | 11.6                                 | 3.4                             | 7.7                                           | 1.4                                           |         |
| Skilled nursing facility           | 28.5                                 | 66.0                            | 47.1                                          | 66.3                                          |         |
| Home with home health care         | 16.5                                 | 21.3                            | 17.4                                          | 22.8                                          |         |
| Against medical advice             | 0.4                                  | 0.0                             | 0.2                                           | 0.0                                           |         |

Represented as percentage or mean±SD. AMI indicates acute myocardial infarction; CS, cardiogenic shock; PCS, palliative care services; US, United States.
timely consultation may result in higher quality of life and lower in-hospital mortality; however, further data are needed. Important factors such as terminal extubation, quality of life, and posthospitalization mortality could not be reliably identified in this hospital admissions database. Also, the reasons for obtaining PCS referral, the role of PCS on symptom mitigation, and improvement of quality of life and relationships could not be assessed in this administrative database. It is possible that these patients could have previously seen PCS in the outpatient setting or a different inpatient encounter that was not captured on this admission. However, the relatively acute and unpredictable onset of AMI-CS could have made this less likely in this population. Lastly, the marital status, annotation of a surrogate decision-maker, and religious/cultural beliefs that play a significant role in determining involvement of PCS could not be ascertained from this database. Despite these limitations, this study addresses an important knowledge gap highlighting the national use of PCS in patients with AMI-CS.

Conclusions

In this large, nationally representative cohort, use of PCS service was documented in only 4.5% of all admissions for AMI-CS despite the high mortality associated with this condition. Despite increasing trends in the adoption of PCS, there remain significant patient and hospital-specific barriers to implementation. Further dedicated studies evaluating patient and provider beliefs and biases on the integration of PCS into the comprehensive care of AMI-CS patients are warranted.

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Disclosures

None.

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