

# Examining Guideline-concordant Care for Acute Myocardial Infarction (AMI): The Case of Hospitalized Post-acute and Long-Term Care (PAC/LTC) Residents

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Supported by the U.S. Department of Veterans Affairs Health Services Research & Development Service through the Research Enhancement Award Program (to T.A.R. and C.R.L.) and a Career Development Award Program (C.R.L.) at the Denver VA Medical Center.

Disclosure: Data were provided by StratisHealth, the Quality Improvement Organization for Minnesota, and the University of Minnesota, Twin Cities. Use of the Cooperative Cardiovascular Project (CCP) baseline dataset was initially allowed through a dissertation grant from the Health Care Financing Administration, now the Centers for Medicare & Medicaid Services (30-P-91016/5-01). Approval for subsequent data analysis was extended through a data use agreement until December 31, 2009. We appreciate comments on earlier versions of this manuscript provided by reviewers for the Centers for Medicare & Medicaid Services Regional Offices, participants in a Women's College Research Institute Seminar at the University of Toronto, several anonymous journal reviewers, and the deputy editor, but assume full responsibility for the accuracy and completeness of the ideas presented. T.A.R. was responsible for study design, data acquisition, and analysis. C.R.L. was responsible for study concept. Both authors contributed equally in preparation of the manuscript and interpretation of data. The sponsor's role was not applicable.

**BACKGROUND:** Previous studies have examined differences in care for acute myocardial infarction (AMI) according to patient characteristics such as age, gender, or insurance, but little attention has been given to whether admission source is related to guideline adherence.

**OBJECTIVE:** To investigate: (1) the use of aspirin and reperfusion in the care of post-acute/long-term care (PAC/LTC) patients who are hospitalized for AMI, and (2) 30-day mortality associated with these treatments.

**DESIGN:** Secondary examination of data from the Cooperative Cardiovascular Project (CCP) national baseline data.

**SETTING:** A total of 4013 U.S. hospitals.

**SUBJECTS:** Patients hospitalized with a confirmed AMI admitted from PAC/LTC (n = 8151) or community-dwelling (n = 120,032) settings.

**MEASUREMENTS:** Early administration of aspirin and reperfusion via either thrombolysis or percutaneous intervention.

**RESULTS:** PAC/LTC patients were less likely to receive treatment for AMI, even after adjustment for multiple variables associated with treatment choice. Differences persisted with additional econometric adjustment using seemingly-unrelated regression. Multivariable logistic regression results indicated that aspirin was related to improved 30-day survival for both PAC/LTC and community admissions (odds ratio [OR], 0.50; 95% confidence interval [CI], 0.43-0.58 for PAC/LTC, and OR, 0.57; 95% CI, 0.54-0.60 for community). Reperfusion was associated with higher ORs for mortality for eligible patients admitted from community setting (OR, 1.24; 95% CI, 1.13-1.35), but ideally-eligible candidates had lower ORs for mortality (OR, 0.58; 95% CI, 0.35-0.95 for PAC/LTC, and OR, 0.74; 95% CI, 0.68-0.81 for community).

**CONCLUSIONS:** Patients transferred from PAC/LTC settings were less likely to receive early treatment for AMI than other patients. Future trials should inform which guidelines are applicable to PAC/LTC patients. *Journal of Hospital Medicine* 2010;5:E3–E10. © 2010 Society of Hospital Medicine.

**KEYWORDS:** acute myocardial infarction, clinical practice guidelines, geriatrics, long-term care, nursing home, post-acute care.

The American College of Cardiology (ACC) and the American Heart Association (AHA) recommend early intervention for older persons with acute coronary syndrome (ACS) to improve prognosis. However, numerous studies demonstrate that elderly patients with acute myocardial infarction (AMI) are less likely than their younger counterparts to receive

guideline-recommended therapies.<sup>1–3</sup> No prior studies specifically demonstrate that adherence to AMI guidelines is effective in patients admitted from post-acute or long-term care (PAC/LTC) settings such as nursing homes, intermediate care facilities, and LTC hospitals. Recognizing that the barriers to guideline-adherent care among the elderly may

also be present for clinically-complex PAC/LTC patients, we examined whether hospitalized patients with AMI admitted from PAC/LTC settings were less likely to receive guideline-recommended therapies and if guideline-concordant treatment was associated with short-term (30-day) survival in this relatively vulnerable subgroup of patients.

Medical decision making, including applicability of guidelines, is not exclusively based on empirical evidence but is also related to morally complex issues such as patient age, social status, and other unknown factors. However, lack of outcome expectancy may limit adherence for AMI care in PAC/LTC populations.<sup>4</sup> In particular, treating physicians may not expect that desired outcomes will result when guidelines are followed in the PAC/LTC group compared to community-based patients. This notion is supported by other research indicating that physicians caring for nursing home residents' chronic health conditions often tailor the care approach according to the patients' functional and cognitive status rather than adhering to recommended guidelines.<sup>5</sup> In a study that used hypothetical scenarios, nursing home patients with a better physical condition, a more obvious social role, and a lower age were more likely to be treated with life-sustaining treatments than were other patients.<sup>6</sup> For AMI care, some physicians provide care that is not guideline-adherent due to concerns that reduced renal function is an absolute rather than relative contraindication to angiography.<sup>7,8</sup> And, because the clinical trials that informed practice guidelines for AMI care did not explicitly include individuals with the chronic complex medical problems prevalent among the PAC/LTC population, treating clinicians may be reluctant to apply acute care guidelines to this subgroup.<sup>9</sup> However, we know of no prior research demonstrating that guideline-adherent care for either chronic or acute conditions results in differential outcomes for PAC/LTC patients cared for in the hospital setting.

For the present study, we examined whether admission source was an independent predictor of AMI treatment and whether guideline-concordant care was related to mortality for those admitted from PAC/LTC and community settings. We hypothesized that rates of guideline-concordant care would be higher for patients admitted from community settings vs. PAC/LTC and that differences between the groups would be greater for more intensive interventions such as reperfusion compared to aspirin. The data included detailed clinical eligibility information for treatments based on contemporary ACC/AHA guidelines,<sup>10</sup> along with numerous other patient demographic and clinical characteristics, thus allowing us to address the presumptive concern that PAC/LTC patients were sicker or otherwise less-suited for treatment than other patients.

## Methods

This retrospective cohort study relied on existing observational data. The primary data source for this research was the Cooperative Cardiovascular Project (CCP) national baseline

data. The CCP was sponsored by the Centers for Medicare & Medicaid Services (CMS) to measure the quality of care provided to a national cohort of Medicare patients hospitalized with AMI. The national data collection and reporting effort was administered through the 53 Medicare Quality Improvement Organization (QIO) contracts established to serve each State, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands. Hospital medical records were requested under QIO authority and then abstracted by centrally-contracted Clinical Data Abstraction Centers (CDACs). Data quality monitoring involved random reabstraction of records with double entry of the information to ensure consistency across personnel, and data were found to be very reliable. Detailed data collection procedures and main findings from these data have been reported elsewhere.<sup>11–26</sup>

The CCP baseline data included an initial sample of 234,754 records abstracted from inpatient medical charts for fee-for-services Medicare beneficiaries hospitalized in 1 of 6684 hospitals located in any of the 50 states, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, American Samoa, Guam, and the Northern Mariana Islands between February 1994 and July 1995. Although the data analyzed for this research relate to hospitalizations for AMI in 1994–1995, the 2008 ACC/AHA report regarding AMI performance measures retains recommendations for both early aspirin and reperfusion treatments.<sup>27</sup> Even though the data are not derived from recent years, the CCP baseline data represent a unique dataset to address questions related to both clinical eligibility and guideline compliance for both community and PAC/LTC patients. The inclusion of PAC/LTC admissions and detailed information regarding clinical eligibility for treatment are particularly important to adequately address the research aim; the CCP baseline data are the single extant U.S. data source we identified that has both features.

AMI cases were identified through inpatient hospital claims using an International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) principal discharge diagnosis of 410 (ACS) for extended chart review to verify AMI and determine clinical eligibility for treatments. CCP records were subsequently linked with the Medicare Denominator File, Area Resource File (ARF), and Medicare PPS cost reports for hospitals (PPS) to obtain additional information regarding patients, local health resources, and admitting hospital.

For the present study, we excluded cases without a confirmed AMI diagnosis; cases with missing geographic information to allow us to control for local practice variation including all cases from outside the Continental U.S.; cases admitted to nonacute facilities or with inadequate information to link with provider data; and cases that originated in states selected for the CCP pilot study due to differences in record abstraction timing and some of the measures. Clinical eligibility for treatments relied on the standardized criteria established by the CCP advisory panel and used in other research.<sup>10,14,28–31</sup>

To test whether admission from a LTC setting was negatively associated with guideline adherence and if the relationship varied according to the intensity of the treatment, we examined 2 guidelines related to early interventions care during the hospital stay: (1) administration of aspirin; and (2) reperfusion through either thrombolytic drugs or percutaneous intervention (PTCA). We chose these measures because they range from a simple and readily-available medical intervention (aspirin), to a clinically complex and costly intervention for a more clinically-select group of patients (reperfusion). The hypothesis that more intensive acute treatment would be less likely for patients admitted from PAC/LTC settings was empirically tested by examining the differences in overall probabilities and adjusted probabilities of receiving each of these interventions. We then modeled the odds ratios (ORs) for survival based on receiving these treatments.

Guideline adherence and clinical eligibility indicators for the CCP data have been presented elsewhere.<sup>10,20,23,29,32</sup> Using these criteria, we divided patients into clinical eligibility groups, including ideal candidates, eligible candidates, and candidates for whom the care was not indicated. For the present research, all eligible patients were included in the sample; with ideal eligibility included as a covariate in the regression models. All patients in the study sample were at least minimally eligible to receive aspirin during their hospital stay. Ideal candidates for aspirin did not have: a gastrointestinal (GI) ulcer, same day admission/discharge, history of bleeding disorder, risk of bleeding, anemia, allergy to aspirin, warfarin, or terminal illness. Eligible candidates for reperfusion via PTCA or thrombolysis were not transferred from another hospital or emergency department. Ideal eligibility for reperfusion required, in addition, that the patient: was under age 80 years; arrived at the hospital within 6 hours of symptom onset; showed evidence of a transmural (Q-wave) MI or ST elevation in 2 contiguous leads on arrival electrocardiogram (ECG); was not taking warfarin; did not have cardiac arrest requiring cardiopulmonary resuscitation (CPR), cardioversion, defibrillation, or chemical cardioversion in the 6 hours prior; did not refuse a thrombolytic; did not have cardiac catheterization without PTCA within 12 hours of arrival; had no evidence of hepatic failure or cirrhosis; had no history of active ulcer disease, internal bleeding, trauma, or injury in the month prior to arrival; and had no bleeding risk, cerebral vascular accident, or surgery/biopsy within 2 months of admission.

Preadmission setting was of particular interest for the present study; this information was derived from the patient's medical chart using a standardized chart abstraction process for the CCP. From the original admission source categories, we created a single dichotomous variable that indicated PAC/LTC vs. community setting prior to arrival. We defined PAC/LTC settings to include patients admitted from either a skilled nursing facility (SNF) or intermediate care facility (ICF), chronic hospital, or other residential care facility. Three categories of admission source were used to identify

the comparison sample: home, noninstitutional setting, and outpatient setting.

Because differences in care according to admission source could result from observable causes, multiple regression analysis was incorporated to control for observed factors previously shown to be associated with guideline adherence. These included: ideal eligibility for treatment; age; Caucasian (vs. other) ethnicity; gender; limitation of aggressive treatment orders (eg, do not resuscitate, do not intubate, chemical code only, no cardiac monitoring, no invasive procedures, no vasopressor, no antiarrhythmic therapy, no feeding tube, palliative care measures only); Charlson comorbidity index and Acute Physiology, Age, Chronic Health Evaluation assessment (3rd revision) (APACHE III) score, body mass index (BMI), rural hospital location, hospital teaching status, and number of full-time equivalent cardiologists on staff at the treating hospital. The regression methods also included adjustment for clustering of patients within health services area to account for geographic variation in practice patterns.<sup>33</sup>

In developing the regression model, we predicted whether the patient received care in accord with guidelines and 30-day mortality. We also tested whether the regression errors terms ("unobserved variables") for these equations were significantly related to error terms in a regression to predict source of admission, which would indicate rejecting the hypothesis that admission source and treatments were determined independently of each other. In particular, admission source may be a proxy for underlying health status (severity of illness), care preferences, or other unobserved factors that differ systematically between patients admitted from the community vs. those admitted from PAC/LTC. In testing the models, we found that the error terms for both treatments (aspirin and reperfusion) and admission source models were significantly negatively correlated ("rho" or  $\rho$  chi-square  $P$  value <0.001), indicating the need to adjust regression estimates to account for unobserved variables related to both admission source and guideline concordant treatment. Because we rejected the hypothesis that admission source was exogenous to treatments, a seemingly-unrelated regressions (SUR) bivariate probit model was deemed appropriate, as this methodology corrects for correlation between unobserved variables that are related to both admission source and treatment decisions (eg, residual confounding).<sup>34</sup> And, since coefficients from SUR bivariate probit models are not directly interpretable as either ORs or relative risks with respect to the outcome variables, we converted the coefficients to reflect marginal probabilities. The correlation in error terms for models predicting 30-day mortality and admission source was not substantively or statistically significant. As such, we utilized standard logistic regression methods for assessing mortality. Mortality models were predicted separately according to admission source and treatment to allow presentation of ORs associated with each treatment for each group.

**TABLE 1. Characteristics of Sample Admitted for Acute Myocardial Infarction from PAC/LTC and the Community**

Sample Characteristics	Overall	PAC/LTC	Community	P Value (2-sided test)
Number of cases	128,183	8,151	120,032	
Percentage of sample	100	6.4	93.6	
Average age, years (mean ± SD)	76.7 ± 7.4	82.6 ± 7.6	76.3 ± 7.2	<0.001 <sup>‡</sup>
Female (%)	49.6	69.1	48.3	<0.001 <sup>‡</sup>
Non-White (%)	9.7	9.1	9.7	0.09
Length of stay, days (mean ± SD)	7.3 ± 7.2	7.4 ± 7.1	7.3 ± 7.2	0.33
With LAT/DNR order in place (%)	18.1	55.4	15.6	<0.001 <sup>‡</sup>
APACHE III score (mean ± SD)	37.7 ± 17.5	50.8 ± 21.0	36.8 ± 16.8	<0.001 <sup>‡</sup>
Charlson comorbidity index (mean ± SD)	2.2 ± 1.2	2.7 ± 1.3	2.2 ± 1.2	<0.001 <sup>‡</sup>
BMI (mean ± SD)	26.2 ± 5.2	24.2 ± 5.9	26.2 ± 5.2	<0.001 <sup>‡</sup>
Hospital residents, FTE (mean ± SD)	29.3 ± 78.4	29.0 ± 78.7	29.3 ± 78.3	0.75
Hospital cardiologists, FTE (mean ± SD)	11.3 ± 13.5	11.0 ± 13.9	11.3 ± 13.5	0.03*
Admitted to rural hospital (%)	20.1	22.3	20.0	<0.001 <sup>‡</sup>
Number of secondary diagnosis codes (0-8) (mean ± SD)	5.1 ± 2.3	5.8 ± 2.1	5.0 ± 2.26	<0.001 <sup>‡</sup>
30-day mortality (%)	18.9 ± 0.39	39.5 ± 0.49	17.6 ± 0.38	<0.001 <sup>‡</sup>
1-year mortality (%)	33.5 ± 0.47	65.4 ± 0.48	31.4 ± 0.46	<0.001 <sup>‡</sup>

NOTE: Source: CCP Baseline data. Sample inclusive from February 1994 to July 1995.

**Abbreviations:** APACHE III, Acute Physiology, Age, Chronic Health Evaluation assessment (3rd revision); BMI, body mass index; CCP, Cooperative Cardiovascular Project; FTE, full-time equivalents employed by the treating hospital; LAT/DNR, limitation of aggressive treatment/do-not-resuscitate; PAC/LTC, post-acute/long-term care; SD, standard deviation.

\*  $P < 0.05$ .

<sup>†</sup>  $P < 0.01$ .

<sup>‡</sup>  $P < 0.001$ .

Analyses used the Stata statistical package (version 10.1 SE).<sup>35</sup> Approval for this use of the CCP data was received from the CMS. Approval for the data analysis protocol was received from the authors' institutional review board.

## Results

Of the 128,183 patients in the analytic sample, 7.6% ( $n = 8151$ ) were admitted from PAC/LTC (Table 1). The members of the PAC/LTC cohort were older on average than the community-dwelling cohort (83 vs. 76 years,  $P < 0.001$ ) and more likely to be female (69% vs. 48%,  $P < 0.001$ ). Limitation of aggressive treatment orders (LAT/DNR) were in place for 55% of the PAC/LTC cohort compared to only 16% of the community-dwelling cohort ( $P < 0.001$ ). Severity of illness scores were higher among the PAC/LTC cohort with APACHE III scores of 50.8 in the PAC/LTC cohort vs. 36.8 in the community-dwelling cohort ( $P < 0.001$ ). The PAC/LTC cohort also had lower BMI ( $P < 0.001$ ). Mortality at 30 days and 1 year was 39.5% and 65.4%, respectively, in the PAC/LTC cohort vs. 17.6% and 33.4%, respectively, in the community-dwelling cohort. These differences across groups were significant at both time points ( $P < 0.001$ ). PAC/LTC admissions were significantly more likely to be admitted to a hospital located in a rural area ( $P < 0.001$ ), though the numbers of full-time equivalent residents and presence of cardiologists in the treating hospitals were similar across groups.

Table 2 provides overall unadjusted data comparing eligibility and treatment information for PAC/LTC and community admissions. Rates of guideline adherence were uni-

**TABLE 2. Unadjusted Guideline Adherence by Admission Source**

	Aspirin (ASA) [n (% received)]	Reperfusion (PTCA or thrombolysis) [n (% received)]
Eligible sample*		
PAC/LTC	8151 (60)	1418 (13)
Community	120,032 (79)	34,501 (45)
Ideal sample*		
PAC/LTC	4370 (69)	214 (30)
Community	78,973 (86)	16,557 (60)

NOTE: Source: CCP Baseline data. Sample inclusive from February 1994 to July 1995.

**Abbreviations:** ASA, acetylsalicylic acid; CCP, Cooperative Cardiovascular Project; PAC/LTC, post-acute/long-term care; PTCA, percutaneous intervention.

\*  $P < 0.0001$  for all 2-sided  $t$  tests of mean difference in treatment % (PAC/LTC vs. community).

formly higher for patients admitted from the community. Guideline adherence rates were higher for aspirin compared to reperfusion, and followed the predicted pattern that more resource-intensive treatments would be less common for both groups and that PAC/LTC admissions would be less likely to receive treatments compared to patients admitted from community settings. Though all 8151 PAC/LTC patients were eligible to receive aspirin, only 4370 were ideally eligible and 3015 (69%) received acetylsalicylic acid (ASA). There were 1418 PAC/LTC patients (17% of the PAC/LTC sample) meeting at least minimal eligibility requirements for reperfusion. Among the 214 PAC/LTC cases that were ideally

eligible for reperfusion, 65 (30%) received the treatment; 12 patients received PTCA and 53 received thrombolytic agents. Eligibility and treatment rates for reperfusion were substantially higher for the community sample, with almost 27% meeting minimum eligibility requirements and 60% of the ideally-eligible group receiving the treatment.

**TABLE 3. Adjusted Guideline Adherence Probability by Admission Source**

	Aspirin (ASA)	Reperfusion
PAC/LTC (%)	64	12
Community (%)	77	23
Rho ( <i>P</i> value)*	-0.069 (<0.001)	-0.17 (<0.001)

NOTE: Bivariate probit regression model predicting treatment among all eligible patients and nursing home admission sources, adjusting for: ideal eligibility, gender, age, race, smoking status, body mass index, LAT/DNR status, APACHE III score, Charlson score, transfer status, hospital teaching status, rural vs. urban hospital location, and number of cardiologists on staff at the treating hospital. Models were adjusted to reflect clustering of patients within Health Service Areas (ie, geographic variation in local practice patterns).

**Abbreviations:** APACHE III, Acute Physiology, Age, Chronic Health Evaluation assessment (3rd revision); ASA, acetylsalicylic acid; COPD, chronic obstructive pulmonary disease; LAT/DNR, limitation of aggressive treatment/do-not-resuscitate; PAC/LTC, post-acute/long-term care.

\*The equation predicting admission source was predicted simultaneously and adjusted for a similar list of covariates, but was identified using specific diagnoses of cancer, diabetes, dementia, heart failure, renal failure, hypertension, and COPD rather than the summary measures of health status (APACHE III and Charlson). The Rho statistic reflects the correlation between the error terms for the 2 equations, with significance detected using a chi-square test.

Table 3 presents the adjusted probability of treatment based upon the SUR bivariate probit regression model. As with the unadjusted results presented in Table 2, PAC/LTC patients had a lower probability of treatment even after controlling for important patient and hospital characteristics. Compared to the unadjusted results, the adjusted probabilities calculated with the SUR bivariate probit model indicated a relatively higher predicted probability of treatment for the PAC/LTC patients and a relatively lower predicted probability of treatment among the community patients. In other words, the probability of treatment becomes more similar across groups once the adjustments for both observed and unobserved differences in patient characteristics are considered. Nonetheless, a difference in probability of treatment remains across the 2 groups.

To determine whether there was survival difference associated with treatment in these data, we conducted a logistic regression analyses to predict 30-day mortality for both groups (Tables 4 and 5). Table 4 presents results (ORs) of our models emphasizing the relationship between aspirin and 30-day mortality, while Table 5 presents the models with reperfusion. Model discrimination was tested using a C-statistic and was at least 0.70 for all models, indicating good predictive validity. However, for the reperfusion models (Table 5) there were relatively few PAC/LTC patients ideally eligible for treatment, which limited statistical power. There was an association between aspirin provision and improved survival for both the PAC/LTC and community admissions (95% confidence intervals [CIs] were less than

**TABLE 4. Logistic Regression Predicting 30-day Mortality Related to Aspirin for PAC/LTC and Community Admissions**

Explanatory Variables	PAC/LTC Admissions		Community Admissions	
	OR	95% CI	OR	95% CI
Aspirin (ASA) given during hospital stay	<b>0.50</b>	<b>0.43-0.58</b>	<b>0.57</b>	<b>0.54-0.60</b>
Ideal eligibility for ASA	0.88	0.76-1.01	<b>0.70</b>	<b>0.67-0.73</b>
Female (vs. Male)	<b>0.85</b>	<b>0.73-0.99</b>	<b>0.94</b>	<b>0.90-0.98</b>
Patient age, 5-year increments	0.99	0.94-1.04	<b>1.04</b>	<b>1.02-1.05</b>
Non-white Ethnicity (vs. White)	0.98	0.76-1.28	0.95	0.89-1.03
Current Smoker (vs. non-smoker)	0.93	0.71-1.22	0.97	0.91-1.03
Body mass index <sup>†</sup>	0.99	0.97-1.00	0.99	0.99-1.00
LAT/DNR Order	<b>4.09</b>	<b>3.53-4.73</b>	<b>7.83</b>	<b>7.46-8.21</b>
APACHE 3 Score, 5 point increments <sup>†</sup>	<b>1.10</b>	<b>1.08-1.12</b>	<b>1.13</b>	<b>1.12-1.13</b>
Charlson Index, 3 point increments <sup>†</sup>	0.87	0.74-1.03	<b>1.06</b>	<b>1.00-1.11</b>
Patient received in transfer	0.99	0.65-1.51	1.18	0.95-1.46
Number of hospital residents, 5 FTE increments <sup>†</sup>	1.00	1.00-1.00	1.00	1.00-1.00
Hospital located in rural area	1.10	0.92-1.31	<b>1.09</b>	<b>1.03-1.15</b>
Number of cardiologists on staff, 5 FTE increments <sup>†</sup>	0.97	0.94-1.00	1.00	1.00-1.02
C-statistic	0.76		0.79	
Number of observations	4,559		92,004	

NOTE: Source: CCP Baseline data. Sample inclusive from February 1994 to July 1995. Bold values indicate statistically significant ORs.

**Abbreviations:** APACHE III, the Acute Physiology, Age, Chronic Health Evaluation assessment (3rd revision); ASA, acetylsalicylic acid; BMI, body mass index; CCP, Cooperative Cardiovascular Project; CI, confidence interval; FTE, full-time equivalents employed by the treating hospital; LAT/DNR, limitation of aggressive treatment/do-not-resuscitate; OR, odds ratio.

\*CIs were adjusted to reflect robust standard errors.

<sup>†</sup>ORs are presented at the mean value of continuous variables.

**TABLE 5. Logistic Regression Predicting 30-day Mortality Related to Reperfusion for PAC/LTC and Community Admissions**

Explanatory Variables	PAC/LTC Admissions		Community Admissions	
	OR	95% CI*	OR	95% CI*
Reperfusion via thrombolytics or PTCA	1.33	0.85-1.10	<b>1.24</b>	<b>1.13-1.35</b>
Ideal eligibility for reperfusion	<b>0.58</b>	<b>0.35-0.95</b>	<b>0.74</b>	<b>0.68-0.81</b>
Female (vs. male)	0.92	0.66-1.29	1.05	0.97-1.14
Patient age, 5-year increments	0.97	0.85-1.10	1.03	0.99-1.06
Non-White ethnicity (vs. White)	1.11	0.59-2.10	1.10	0.95-1.28
Current smoker (vs. nonsmoker)	1.13	0.66-1.94	<b>0.87</b>	<b>0.78-0.98</b>
BMI <sup>†</sup>	1.01	0.98-1.04	1.00	0.99-1.01
LAT/DNR order	<b>3.41</b>	<b>2.48-4.70</b>	<b>8.26</b>	<b>7.52-9.06</b>
APACHE III score, 5-point increments <sup>†</sup>	<b>1.13</b>	<b>1.07-1.19</b>	<b>1.15</b>	<b>1.14-1.17</b>
Charlson comorbidity index, 3-point increments <sup>†</sup>	0.84	0.58-1.22	<b>1.30</b>	<b>1.17-1.44</b>
Patient received in transfer	1.08	0.27-4.43	1.49	0.85-2.60
Number of hospital residents, 5-FTE increments <sup>†</sup>	0.99	0.98-1.01	1.00	1.00-1.00
Hospital located in rural area	0.90	0.61-1.34	<b>1.12</b>	<b>1.01-1.25</b>
Number of cardiologists on staff, 5-FTE increments <sup>†</sup>	0.97	0.90-1.05	1.00	0.98-1.01
C-statistic	0.71		0.78	
Number of observations	856		26,720	

NOTE: Source: CCP Baseline data. Sample inclusive from February 1994 to July 1995. Bold text indicates statistically significant ORs.

**Abbreviations:** APACHE III, Acute Physiology, Age, Chronic Health Evaluation assessment (3rd revision); BMI, body mass index; CCP, Cooperative Cardiovascular Project; CI, confidence interval; FTE, full-time equivalents employed by the treating hospital; LAT/DNR, limitation of aggressive treatment/do-not-resuscitate; OR, odds ratio; PAC/LTC, post-acute/long-term care; PTCA, percutaneous intervention.

\* CIs were adjusted to reflect robust standard errors.

<sup>†</sup> ORs are presented as the mean value of continuous variables.

1.0) for all eligible patients. For the eligible samples, we did not find the anticipated relationship between reperfusion and 30-day survival. The ORs and CIs for community admissions were significantly greater than 1.0. However, we noted lower ORs of mortality for the subgroups of ideally eligible patients, with 95% CIs under 1.0 for both PAC/LTC and community admissions, indicating better survival among those who were ideally eligible for reperfusion treatment. The unadjusted data indicated that PAC/LTC patients were much more likely than their community counterparts to die within 30 days of AMI (Table 1). The multiple logistic regression results indicates PAC/LTC patients had similar ORs for mortality compared to community patients when aspirin was given to eligible patients and when reperfusion was given to ideally eligible patients (Tables 4 and 5). Based on the logistic regression results, we calculated that the adjusted probability of 30-day mortality among eligible PAC/LTC patients who received aspirin was 0.14 compared to 0.32 for those who did not, which is a difference in probability of 0.18. For eligible community admissions, the adjusted probability of mortality with aspirin was 0.09 with aspirin treatment compared to 0.26 without. For reperfusion, the adjusted probability of 30-day mortality for ideally eligible PAC/LTC admissions falls from 0.27 to 0.15 if treatment is given, representing a difference in probability of 0.12. Similarly, the adjusted probability difference for community admissions who were ideally eligible and received reperfusion was approximately 0.08 ( $P = 0.16$  without treatment and  $P = 0.08$  with treatment).

## Discussion

This investigation has important implications. The results suggest systematic differences in care for PAC/LTC compared to community-based patients hospitalized with AMI. It is possible that short-term mortality was impacted by guideline adherence differences according to admission source. The analytic methods accounted for clinical eligibility, tested for residual confounding and used econometric methods (SUR bivariate probit) to correct it where found, and excluded patients who refused treatments. Therefore, poor eligibility and treatment refusal are inadequate explanations for the observed differences in treatment according to admission source from a PAC/LTC facility.

Providers may not follow AMI treatment guidelines because the perceived risks for patients transferred from PAC/LTC were too great or due to a limited clinical evidence base. Even though PAC/LTC patients were not included in clinical trials for AMI care, studies that carefully use observational data may help guide applicability of clinical recommendations for acute care to subgroups of clinically complex patients. This study offers observational evidence and information to guide additional studies regarding of the clinical benefit of treating a particularly vulnerable subgroup of patients.

Other research has noted that adherence to clinical practice guidelines in PAC/LTC facilities is low.<sup>36,37</sup> LTC practitioners have been reluctant to apply clinical practice guidelines to residents with chronic illnesses because these regimens often do not take into consideration individuals

with the multiple chronic diseases prevalent among PAC/LTC patients<sup>9</sup> and the complexity of the PAC/LTC environment.<sup>38,39</sup> Rather than dismiss the utility of clinical practice guidelines in the PAC/LTC population, this study is one of the first to demonstrate that use of *acute* care clinical practice guidelines, particularly aspirin, was associated with improved acute care outcomes among PAC/LTC patients transferred to acute care hospitals with AMI. Thus, guidelines for acute inpatient care may be more readily applied to the PAC/LTC population than studies aimed at treating chronic illnesses.<sup>9,38,40</sup> Our results indicate that reperfusion might not be indicated for the preponderance of PAC/LTC patients, but many would agree that treatments such as aspirin would be a low-burden intervention for most PAC/LTC patients. This investigation supports considering AMI treatment guidelines even for frail subpopulations such as those transferred from PAC/LTC. Further, the findings suggest there may be important information obtained by including PAC/LTC patients in future clinical trials.

This study has several limitations. First, the data were collected during 1995, and may not adequately reflect the current state of the art for AMI treatment or other changes in the organization, financing, and delivery of care for AMI. Nevertheless, care guidelines for AMI have not changed in ways that we anticipate altering the patterns of care examined in this study. For example, in the 2004 National Healthcare Disparities Report,<sup>41</sup> receipt of aspirin among elderly individuals ranged from 79.6% to 86%, which closely resembles our results. Despite overall care improvements from 1990 to 2006, women, minorities, and patients ages 75 years and older remain significantly less likely to receive revascularization or discharge lipid-lowering therapy relative to their counterparts indicating that differences in care persist today.<sup>42</sup> While the data used in these analyses existed before recommendations included specific guidance regarding the care of older adults, other researchers examined data collected from January 1, 2005 to June 30, 2006 and demonstrated that elderly individuals remained less likely to receive indicated therapies.<sup>43</sup> Further, this is the only dataset we identified that included an adequate presence of both PAC/LTC and community admission sources and sufficient data to assess guideline adherence and other covariates for our models. Second, The SUR bivariate probit models that account for correlation of error terms in models predicting both admission source and treatment were included to minimize issues related to residual confounding, but may not completely eliminate all systematic variation related to the underlying health status of community vs. PAC/LTC residents. Third, limitation of aggressive treatments was not recorded as to specific type of directives but research has shown that orders to forego treatments other than CPR are written for fewer than 8 % of nursing home residents.<sup>44,45</sup> Furthermore, all of these patients were transferred to a hospital; these transfers almost certainly occurred with an expectation that acute treatment would be offered. Fourth, we were unable to distinguish PAC vs. LTC

based on admission source categories provided in the original data source. Finally, PTCA and thrombolysis were considered as a single variable because separating the 2 procedures would result in inadequate sample size to detect statistical differences between the 2 groups.

## Conclusions

Patients admitted from PAC/LTC settings were less likely to receive early guideline-recommended treatment for AMI compared to community-dwelling patients. Our study finds evidence that following the aspirin guideline may improve survival for most patients, but that reperfusion improved survival only for a clinically-select subgroup of patients. As such, a possible recommendation for further clinical study is that low-burden treatments such as aspirin should be offered to most patients with AMI, including those from PAC/LTC. Higher-burden treatments with have greater associated risks, such as reperfusion, also require more study to inform situations applicable to PAC/LTC patients. Clinical trials data would be indicated to strengthen evidence regarding which AMI treatment guidelines should be followed in frail populations from PAC/LTC settings; we identified no randomized trials that specifically demonstrate efficacy of AMI guidelines for this subgroup of vulnerable patients.

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