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In-Hospital Mortality and Coronary Procedure Use for Individuals with Dementia with Acute Myocardial Infarction in the United States

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Abstract

OBJECTIVES: To determine in-hospital mortality differences in individuals with dementia and acute myocardial infarction (AMI) when using invasive coronary procedures.

DESIGN: Retrospective cohort study.

SETTING: 2009 Nationwide Inpatient Sample.

PARTICIPANTS: Individuals admitted with a primary diagnosis of AMI (N = 631,734) to 1,045 hospitals in 44 states during 2009.

MEASUREMENTS: Dementia status and procedural use of diagnostic catheterization, percutaneous intervention (PCI), and coronary artery bypass grafts (CABG) as indicated by *International Classification of Diseases, Ninth Revision*, codes. The primary outcome was in-hospital mortality. Using multivariable analysis adjusted for covariates, associations were made between coronary procedural use in individuals with dementia and in-hospital mortality. Additional multivariable analysis identified the association between utilization of coronary procedures and in-hospital mortality in AMI patients with dementia.

RESULTS: Dementia diagnosis (n = 15,335) was associated with greater likelihood of in-hospital mortality (odds ratio (OR) = 1.22, 95% confidence interval (CI) = 1.15–1.29, $P < .001$) and less use of diagnostic catheterization (OR = 0.37, 95% CI = 0.35–0.40, $P < .001$), PCI (OR = 0.37, 95% CI = 0.35–0.40, $P < .001$), and CABG (OR = 0.19, 95% CI = 0.16–0.22, $P < .001$). There was less likelihood of in-hospital mortality in participants with dementia who received diagnostic catheterization (OR = 0.36, 95% CI = 0.16–0.78, $P < .001$), PCI (OR = 0.57, 95% CI = 0.47–0.70, $P < .001$), or CABG (OR = 0.22, 95% CI = 0.08–0.56, $P < .001$) than in those not receiving respective interventions.

CONCLUSION: Dementia is a significant predictor of in-hospital mortality for hospitalized individuals with AMI and is associated with less use of invasive coronary procedures. Beyond differing care patterns for individuals with AMI and dementia, these results indicate that

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individuals with dementia are at substantially greater risk for inhospital mortality when they do not receive procedural interventions.

Keywords

dementia; in-hospital mortality; acute myocardial infarction

Coronary heart disease, specifically acute myocardial infarction (AMI), is the leading cause of death in the older U.S. population.[1] The number of individuals aged 65 and older in the United States is expected to increase to 72.1 million by 2030, more than twice the number in 2000.[2] This population simultaneously has the highest burden of dementia. In 2000, more than 4.5 million Americans were estimated to have dementia caused by Alzheimer's disease alone.[3] Prevalence of dementia in the U.S. population will substantially increase as older age groups increase in size, with estimates suggesting a near tripling, to 13.2 million, for Alzheimer's disease by 2050.[3] This underestimates the true prevalence of dementia of all causes. Understanding the possible effect of dementia on AMI outcomes could vastly improve effective diagnosis and appropriate care for these individuals.

Little is known about the effect of a dementia diagnosis on treatment patterns for individuals with cardiovascular complications. Past studies have shown that, of individuals hospitalized for acute coronary syndrome, those with dementia had a 27% lower likelihood of receiving interventional therapies and a 22% lower likelihood of receiving guideline-recommended medications.[4] A retrospective chart review of 1994–95 Medicare beneficiaries similarly showed that those with dementia were less likely to receive coronary interventions and had a 16% greater risk of 30-day and 18% greater risk of 1-year all-cause mortality than those without dementia.[5] With recent data showing that 15.6% of deaths of individuals with dementia occur in the hospital,[6] more-recent appraisals of post-AMI treatment patterns and in-hospital mortality are needed on a national level, but no contemporary study of individuals diagnosed with dementia who experience AMI and receive coronary interventions and outcomes has been done. The current study used data from the 2009 Nationwide Inpatient Sample (NIS) to compare in-hospital mortality and use of invasive coronary procedures after AMI admission in individuals with and without dementia.

METHODS

This was a retrospective cohort study conducted using the 2009 Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project NIS database to identify the fraction of individuals hospitalized with an AMI who were also diagnosed with dementia. NIS is the largest publicly available all-payer inpatient care database and includes discharge codes from 1,045 hospitals in 44 states (2009). NIS was designed as a stratified, 20% representative sample of all nonfederal U.S. hospitals,[7] and is regularly used to identify national trends in healthcare use, charges, quality, and outcomes. Each record in the NIS includes *International Classification of Disease, Ninth Revision* (ICD-9) procedure and diagnosis codes recorded on each individual's hospital discharge abstract. NIS also includes admission and discharge status; demographic information; length of stay; and hospital region, teaching status, ownership type, and bed size. The NIS sample has been validated using Medicare inpatient claims for count estimates of percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) claims.[8] The University of California Regents institutional review board approved this study.

This study identified AMI admissions from NIS according to principal ICD-9 codes of 410.0 to 410.92. Individuals with an AMI secondary to an in-hospital complication were excluded from the cohort. Of individuals hospitalized with AMI, secondary diagnoses were used to

evaluate those who were also diagnosed with presenile dementia (ICD-9 codes 290.10–290.13), senile dementia (ICD-9 codes 290.0–290.3), vascular dementia (ICD-9 codes 290.41–290.43), and Alzheimer's disease (ICD-9 code 331.0). All post-AMI admissions were examined for principal procedures or secondary procedures that included cardiac diagnostic catheterization (ICD-9 codes 37.22, 37.23, 88.53–88.55), PCI (ICD-9 codes 00.66, 36.04, 36.06, 36.07), and CABG (ICD-9 codes 36.10–36.17, 36.19) performed during the same admission. A coronary procedural intervention was defined as cardiac catheterization, PCI, or CABG during the hospital admission for AMI. Individuals who had more than one of the coronary procedural interventions during the same hospital stay were categorized as having the most invasive of the three procedures. The primary outcome of the study was in-hospital mortality, ascertained from the individual's discharge vital status.

The AHRQ Elixhauser adjustment scheme was used for all participants to determine the presence of up to 29 chronic comorbidities likely to have been present on admission.[9] Neurological disorders were excluded from the adjustment scheme to evaluate procedural and mortality outcomes in individuals with dementia. Comorbidities in the risk adjustment algorithm included heart failure, valvular disease, peripheral vascular disease, paralysis, chronic pulmonary disease, pulmonary circulation disorders, diabetes mellitus with chronic complications, hypothyroidism, renal failure, liver disease, peptic ulcer disease, acquired immunodeficiency syndrome, lymphoma, metastatic cancer, solid tumor without metastasis, rheumatoid arthritis, coagulopathy, psychoses, obesity, weight loss, fluid and electrolyte disorders, chronic blood loss anemia, deficiency anemia, alcohol abuse, depression, drug abuse, and hypertension.

Statistical Analysis

Demographic characteristics and selected comorbidities of participants with and without dementia and of participants with dementia who did and did not undergo coronary procedures were compared using the chi-square test for categorical variables and the Student *t*-test for continuous variables. The proportion of participants with and without dementia who received diagnostic catheterization, PCI, CABG, or experienced in-hospital mortality was evaluated. The incidence of in-hospital mortality in individuals with dementia with and without coronary procedures was also evaluated. Multivariable logistic regression analyses were used to calculate odds ratios (ORs) for outcomes of diagnostic catheterization, PCI, CABG, and in-hospital mortality of individuals with AMI and dementia. These models were adjusted for age, sex, race, hospital location, hospital volume, insurance type, MI type, and 29 Elixhauser comorbidity variables. Similarly adjusted multivariable logistic regression analysis was used to examine mortality in those individuals with AMI and dementia who received each of the coronary procedural interventions. All statistical analyses were performed using SAS 9.3 (SAS Institute, Inc., Cary, NC).

RESULTS

From the sample of 7,810,762 hospital admissions in the 2009 NIS database, 631,734 admissions with a primary AMI diagnosis were identified, 15,335 (2.4%) of which had a secondary dementia diagnosis. Table 1 shows selected characteristics of participants with and without a diagnosis of dementia and of individuals with dementia who did and did not undergo a coronary procedural intervention. Participants with dementia were more likely to be female (39.1% vs 57.7%. $P < .001$) and older (67.0 vs 83.5, $P < .001$) than those without. Primary insurance type differed significantly between participants with and without dementia ($P < .001$), with 91.8% of participants with dementia having Medicare. Participants with dementia had a greater prevalence of hypertension (67.5% vs 69.4%, $P < .001$), iron-deficiency anemia (15.5% vs 24.5%, $P < .001$), hypothyroidism (9.6% vs 17.4%,

$P < .001$), and renal failure (17.4% vs 26.7%, $P < .001$). Of individuals with dementia, those undergoing coronary procedural interventions were less likely to be female and more likely to have comorbidities of diabetes mellitus hypertension, and peripheral vascular disease (all $P < .001$).

Of identified cases with a primary diagnosis of AMI 108,382 (17.2%) had only a diagnostic catheterization, 272,816 (43.2%) had a PCI (without a CABG), 57,211 (9.1%) had a CABG, and 35,186 (5.6%) died in the hospital. Participants with AMI without dementia had significantly higher proportions of diagnostic catheterization (17.4% vs 6.9%, $P < .001$), PCI (43.9% vs 12.7%, $P < .001$), and CABG (9.3% vs 1.4%, $P < .001$) than their counterparts with dementia. Furthermore, individuals with AMI and dementia had significantly greater in-hospital mortality (11.8%, 1,822/15,335) than those with AMI but no dementia (5.4%, 33,364/616,399) ($P < .001$).

Table 2 shows adjusted ORs for in-hospital mortality and coronary procedure for individuals with dementia and AMI. There was a significantly lower likelihood of individuals with dementia undergoing diagnostic catheterization (OR = 0.37, 95% confidence interval (CI) = 0.35–0.40, $P < .001$), PCI (OR = 0.37, 95% CI = 0.35–0.40, $P < .001$), and CABG (OR = 0.19, 95% CI = 0.16–0.22, $P < .001$) than of those without dementia. Ultimately, a greater OR of 1.22 (95% CI = 1.15–1.29, $P < .001$) was seen for in-hospital mortality in participants with AMI and dementia.

Of hospitalized participants with AMI and dementia, 21.1% (3,239/15,335) underwent at least one of the coronary procedural interventions. Figure 1 shows in-hospital mortality in individuals with dementia who did and did not receive interventions. In-hospital mortality was 13.4% (1,617/12,096) in individuals with dementia who did not receive any coronary procedures and 6.3% (205/3,239) in individuals with dementia who underwent at least one of the procedures ($P < .001$). A similar trend for in-hospital mortality in individuals with dementia was seen for each coronary procedure individually (all $P < .001$). In participants with dementia, after adjustments for age, sex, race, hospital location, hospital volume, insurance type, MI type, and comorbidities, a significant decrease in mortality was seen in those who underwent diagnostic catheterization (OR = 0.36, 95% CI = 0.16–0.78, $P < .001$), PCI (OR = 0.57, 95% CI = 0.47–0.70, $P < .001$), or CABG (OR = 0.22, 95% CI = 0.08–0.56, $P < .001$) after AMI (Table 2).

DISCUSSION

After robust adjustments, participants' dementia status persisted as a significant predictor of in-hospital mortality for individuals admitted to the hospital with AMI, which indicates a disparity in treatment between those with and without dementia after an AMI. Participants with AMI and dementia were significantly less likely to receive coronary diagnostic and revascularization procedures than those without dementia. Use of any of the defined coronary diagnostic procedures or interventions was likely in only one-quarter of individuals with dementia, and in the case of CABG, was 81% lower in individuals with dementia.

These results support past findings of decreased use of invasive coronary intervention in participants with AMI and dementia than in those with AMI alone.[4,5] Nonetheless, these studies were conducted when diagnostic and interventional procedures were not yet rapidly diffused in hospitals or in healthcare systems outside the United States. Because the NIS sample was designed as a recent representation of a wide spectrum of hospitals across the United States, these results suggest that lower rates of invasive coronary procedures are more closely linked to differing treatment patterns in individuals with dementia than access to advanced care.

One possible explanation for the low rates of use of invasive treatments and diagnostic tests for participants with AMI and dementia has been vulnerability to side effects, but the current study shows that, even within the subset of individuals with dementia and AMI, those who underwent a PCI or CABG had approximately 43% and 78% lower odds of in-hospital mortality, respectively, than individuals who did not undergo these interventions. Furthermore, a comprehensive list of clinical factors was used for adjustment when identifying the odds of mortality in the overall sample of participants with AMI and within the subset with dementia.

Alternatively, lower rates of intervention for individuals with dementia could be attributed to physicians who are reluctant to recommend invasive procedures or to individuals and their families who refuse aggressive treatment because of uncertain benefits. Past studies have established that older adults experiencing AMI are less likely than younger adults to have invasive interventions and admissions to intensive care units.[10-12] These results are consistent with more-recent studies showing that older adults with AMI are not receiving empirically based therapies.[13] Although age is an imprecise indicator for physical and cognitive status, it is possible that individuals with dementia are also receiving less-aggressive medical care because of the perception of the marginal benefit of additional treatments. Although the results indicate that use of coronary diagnostics and interventions in individuals with dementia decrease in-hospital mortality, further research is needed to establish postdischarge mortality and quality-of-life indicators.

These results are inconsistent with similar recent studies that found that dementia had a minimal effect on mortality in participants with AMI. The study of 1,837 Japanese individuals with AMI (62 with dementia) showed that, after adjustment for age, sex, daily activity, and selected cardiovascular comorbidities, no significant association was found between in-hospital or postdischarge mortality and dementia.[14] A separate study in 1,052 individuals with AMI (22 with dementia) showed that those with dementia aged 65 and older were unlikely to be undertreated or have greater in-hospital mortality than their counterparts without dementia.[15] Although it is possible that differences in national healthcare systems may account for these disparities, the current study used a larger sample with a wider range of adjustments than previous studies to demonstrate significantly greater in-hospital mortality and less use of interventions in individuals with AMI and dementia than in those without dementia.

This study had several limitations. The results apply only to individuals admitted to the hospital with a primary diagnosis of AMI. Because older adults commonly delay hospital arrival despite symptoms of an AMI, individuals with a greater likelihood of prehospital mortality were not captured.[16,17] Additionally, because of the nature of the database, it is possible that the severity and the criteria for dementia diagnosis varied between physicians. Similarly, it was not possible to control for severity of cardiac illness (e.g., shock on arrival, cardiac arrest, mean arterial pressure). These factors could lead to selection bias, because individuals with more-severe disease (dementia or AMI) may not have been referred for cardiac catheterization and subsequent revascularization. Last, the outcome of mortality was defined as any-cause mortality and was limited to in-hospital or short-term mortality.

In conclusion, individuals with dementia hospitalized for AMI are more likely to have in-hospital mortality and fewer invasive treatments of cardiac catheterization, PCI, and CABG than individuals with AMI without dementia. Additionally, individuals with dementia who experience AMI and do not receive invasive coronary procedures are more likely to die in the hospital than their counterparts who receive intervention.

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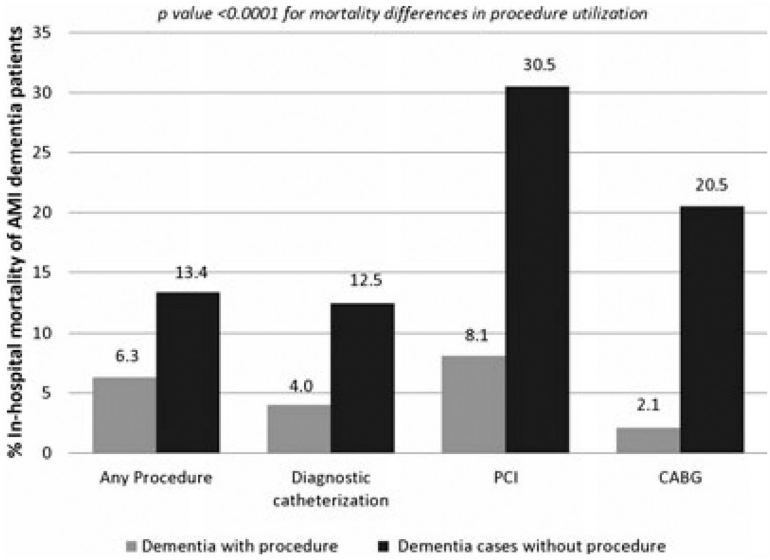

Figure 1.

Association between invasive coronary procedure and in-hospital mortality in individuals with dementia and acute myocardial infarction (AMI). PCI = percutaneous coronary intervention; CABG = coronary artery bypass graft.

Table 1

Demographic and Clinical Characteristics of Individuals with Acute Myocardial Infarction with and without Dementia

Characteristic	Overall, N = 631,734	Dementia, n = 15,335	Without Dementia, n = 616,399	*P*-Value	Dementia with Any Coronary Procedure, n = 3,239	Dementia with No Coronary Procedure, n = 12,096	*P*-Value
Age, mean ± standard deviation	67.4 ± 14.5	83.5 ± 7.7	67.0 ± 14.4	<.001	79.3 ± 7.7	84.7 ± 7.3	<.001
Female,%	39.5	57.7	39.1	<.001	46.9	60.6	<.001
Ethnicity,%							
White	76.6	67.4	63.7	<.001	66.8	67.6	<.001
Black	9.2	7.8	7.6		6.0	8.3	
Hispanic	7.2	6.7	6.0		6.7	6.7	
Asian	2.2	1.9	1.8		1.9	1.9	
Other or missing	20.8	16.2	20.9		18.6	15.6	
Insurance,%							
Medicare	56.0	91.8	55.1	<.001	89.8	92.4	<.001
Medicaid	6.0	1.2	6.1		2.2	0.9	
Private insurance	28.2	5.6	28.8		5.8	5.5	
Other	9.9	1.4	10.1		2.3	1.2	
Comorbidities,%							
Diabetes mellitus	33.9	33.3	33.9	.08	37.3	32.2	<.001
Hypertension	67.6	69.4	67.5	<.001	73.5	68.3	<.001
Iron-deficiency anemia	15.8	24.5	15.5	<.001	23.5	24.7	.16
Hypothyroidism	9.8	17.4	9.6	<.001	15.2	17.9	<.001
Peripheral vascular disease	11.4	10.4	11.4	<.001	11.9	10.0	.002
Renal failure	17.6	26.7	17.4	<.001	22.3	27.8	<.001

Coronary procedure was defined as any diagnostic catheterization, percutaneous coronary intervention, or coronary artery bypass graft.

Table 2

Multivariable Logistic Regression Analyses: Odds of Dementia Diagnosis and Coronary Procedures in Participants with Acute Myocardial Infarction (AMI)

Dependent Variable	Odds Ratio (95% Confidence Interval)	*P*-Value
Association between dementia diagnosis and healthcare outcomes in individuals with AMI		
In-hospital mortality	1.22 (1.15–1.29)	<.001
Diagnostic catheterization	0.37 (0.35–0.40)	<.001
PCI	0.37 (0.35–0.40)	<.001
CABG	0.19 (0.16–0.22)	<.001
Association between procedure and in-hospital mortality in AMI individuals with dementia		
Diagnostic catheterization	0.36 (0.16–0.78)	.001
PCI	0.57 (0.47–0.70)	<.001
CABG	0.22 (0.08–0.56)	.002

All models adjusted for age, sex, race, hospital location, insurance type, ST-elevation vs non-ST elevation myocardial infarction, and 29 Elixhauser comorbidities (excludes neurological disorders).

PCI = percutaneous coronary intervention; CABG = coronary artery bypass graft.