HHS Public Access

Author manuscript

Am Heart J. Author manuscript; available in PMC 2017 February 27.

Published in final edited form as:

Am Heart J. 2015 December ; 170(6): 1211–1219. doi:10.1016/j.ahj.2015.09.009.

Trends in Acute Myocardial Infarction Hospitalizations: Are We Seeing the Whole Picture?

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Abstract

Background—Payers and policy makers rely on studies of trends in Acute Myocardial Infarction (AMI) hospitalizations and spending that count only hospitalizations where the AMI is the principal discharge diagnosis. Hospitalizations with AMI coded as a secondary diagnosis are ignored. The effects of excluding these hospitalizations on estimates of trends are unknown.

Methods—Observational study of all AMI hospitalizations in Fee-for-Service Medicare beneficiaries ages 65 and over, from 2002 through 2011.

Results—We studied 3,663,137 hospitalizations with any AMI discharge diagnosis over 288,873,509 beneficiary-years. Of these, 66% had AMI coded as principal (versus secondary). From 2002 to 2011, AMI hospitalization rates declined 24.5% (from 1,485 per 100,000 beneficiary-years in 2002 to 1,122 in 2011). Meanwhile, the proportion of these hospitalizations with a secondary AMI diagnosis increased from 28% to 40%; by 2011 these secondary AMI hospitalizations accounted for 43% of all expenditures for hospitalizations with AMI, or $2.8 billion. Major changes in comorbidities, principal diagnoses and mean costs for hospitalizations with a non-principal AMI diagnosis occurred in the 2006-2008 timeframe.

Conclusions—Current estimates of the burden of AMI ignore an increasingly large proportion of overall AMI hospitalizations and spending. Changes in the characteristics of hospitalizations that coincided with major payment and policy changes suggest that non-clinical factors affect AMI coding. Failing to consider all AMIs could inflate estimates of population health improvements, underestimate current and future AMI burden and expenditures, and overestimate the value of AMI prevention and treatment.

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Conflicts of Interest: The authors report no conflicts of interest.

INTRODUCTION

Accounting for as much as 17% of all national healthcare expenditures, cardiovascular disease (CVD) remains a leading cause of morbidity, mortality and cost in the United States.[1] Acute Myocardial Infarction (AMI), a common manifestation of CVD in the elderly, carries increased risks of morbidity, mortality, and excess costs.[234] Policy makers use estimates of AMI burden to assess population health, to identify opportunities to improve health, and to set healthcare budgets. In turn, national data agencies, such as the Centers for Disease Control and Prevention (CDC), use these estimates to guide surveillance activities that monitor and evaluate health system performance,[5-7] and funding agencies, like the National Institutes of Health (NIH), use them to set research priorities. Because nearly all AMI patients are hospitalized, hospitalization data are used to estimate morbidity, mortality and expenditures attributable to AMI,[8910111213] making accurate tracking of AMI hospitalizations important for national health accounting.

Several recent studies reporting steep declines in AMI hospitalization rates [911121415] have been interpreted as evidence of dramatic improvements in cardiovascular health. However, these studies count only a subset of AMIs – those that appear as the *principal diagnosis* on a hospital discharge abstract; they do not count hospitalizations when the AMI is coded in other positions. Most hospitalized patients receive care for multiple problems, and the principal diagnosis should reflect “the condition established after study to be chiefly responsible for the (patient’s) admission” while conditions that coexisted when the patient was admitted to the hospital – or developed during the hospitalization – should be coded as secondary diagnoses.[16] *The* single, chief reason for a hospitalization, however, may be clinically ambiguous, particularly in patients with multiple, serious conditions, in which case non-clinical considerations can influence which diagnosis gets coded first. One important non-clinical consideration is that the principal diagnosis largely determines the Diagnosis Related Group (DRG) used by the Centers for Medicare and Medicaid Services (CMS) to calculate hospital payment. For example, in 2008, coding septicemia as principal and AMI second would lead to 3.3 times more reimbursement than if the codes were reversed, whereas in the 2006 Medicare reimbursement schema, reversing the order of these two diagnoses had minimal effect on payment.[17,18] To the extent that reimbursement rules or other non-clinical factors affect hospital decisions to code AMI as the principal discharge diagnosis, national reports of AMI trends based only on principal diagnoses may overestimate the success of national AMI prevention efforts, underestimate the current burden of AMI, and understate opportunities to save both money and lives.

To describe the full burden of AMI hospitalizations, including those that usually go uncounted, we examined all hospitalizations with any discharge diagnosis for AMI from 2002 to 2011. Specifically, we calculated age-sex adjusted AMI hospitalization rates in total, and separately, for when the AMI is coded as principal versus secondary, that is, in any position other than the first-listed discharge diagnosis; we refer to these hospitalizations as principal and secondary AMI, respectively. To explore differences between the two kinds of admissions, we compared rates of cardiac- and non-cardiac-related comorbidities, and longitudinal changes in these rates, in patients with first- versus second-listed AMIs. Further, since CMS payments for hospitalizations are based primarily on the principal diagnosis, we

examined changes in the distributions of principal diagnoses in patients with second-listed AMIs. We were especially interested in coding changes over the 2006-2008 timeframe, since CMS made major changes to its DRG methodology with the Medicare Severity (MS) DRGs, introduced in October, 2007.[19]

METHODS

Data

This investigation used the CMS 100% sample Medicare Provider Analysis and Review (MedPAR) files linked to Medicare Denominator files for the years 2002-2011. The MedPAR files contain hospital discharge abstracts for the acute-care hospitalizations of all Medicare beneficiaries with Part A coverage, including admission and discharge dates, admission source, International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis and procedure codes, discharge disposition, total charges, covered charges, and Medicare reimbursement. The Medicare denominator files include information on beneficiaries' dates of birth, sex, race (categorized as black, white, or other), enrollment status, region of residence, and vital status (including date of death). To limit the potential effects of a change in the definition of AMI made by the American College of Cardiology and the European Society of Cardiology in 2000, we began our study with 2002 data.[20]

Study Population

We studied residents of U.S. states, the District of Columbia and Puerto Rico enrolled in Medicare fee-for-service (FFS) coverage between January 1, 2002 and December 31, 2011. We excluded beneficiaries during months in which they lacked Medicare Part A coverage or were enrolled in a Medicare HMO, since their hospitalization claims were only sporadically submitted for reimbursement. Because individuals can move in and out of FFS coverage, and because they become age-eligible for Medicare on the first day of the month in which they turn 65, we used a study denominator of eligible beneficiary months aggregated into beneficiary-years.

Outcomes

Our key outcomes were annual AMI hospitalization rates in each calendar year, 2002-2011, and expenditures for these hospitalizations, calculated separately for when AMI was coded as the principal or a secondary diagnosis. Expenditures, reported in nominal dollars, included Medicare reimbursements to hospitals and the required patient co-payments for hospitalizations. Our analysis counted each AMI hospitalization, including multiple admissions for the same patient in a year. We identified AMI hospitalizations as those with a discharge diagnosis of AMI (410.xx, excluding 410.x2) coded in any position. Hospital transfers within this set of AMI hospitalizations (i.e., admissions occurring within one day of discharge from another hospital) were linked and treated as a single episode of AMI hospitalization. When the episode included hospitalizations with AMI discharge diagnoses in both principal and secondary positions, we classified it using the diagnosis position of the AMI from the first hospitalization with a length of stay greater than one day. If each hospitalization contributing to an episode lasted just one day, we used the diagnosis position

from the first hospitalization, unless the patient died, in which case, we used its position in the final hospitalization.

Following common practice, we excluded non-transfer hospitalizations with length of stay less than two days if the patient was discharged alive and not against medical advice, as these hospitalizations were unlikely to have been for an AMI.[21] We attributed hospitalizations spanning more than one calendar year to the admission year.

Analyses

We calculated annual overall AMI hospitalization rates per 100,000 beneficiary-years for each year from 2002 to 2011 and, separately, rates for principal versus secondary AMIs. All rates were adjusted to the age-sex-race distribution of the 2007 Medicare population using direct standardization. To appraise trends in AMI hospitalization coding, we examined changes in the proportion of all AMI hospitalizations coded as secondary. To explore differences over time in patients with principal and secondary AMI, we compared rates of common cardiac- and non-cardiac-related comorbid conditions for admissions in which the AMI was either the first-listed (that is, principal) or second-listed discharge diagnosis. To identify these comorbidities, we first examined the top 10 ICD-9 diagnoses coded in any position in each year for hospitalizations with a principal AMI diagnosis, and, separately, for hospitalizations with a second position AMI diagnosis; we then grouped diagnoses for the same comorbidity, identified occurrences of additional ICD-9 diagnoses for that comorbidity, and used these ICD-9 codes to estimate the prevalence of each comorbidity in each year. We also examined changes in the most common first-listed diagnoses for AMI hospitalizations where the AMI was coded second, paying special attention to changes occurring between 2006, the last full year that the older DRG version was in place, and 2008, the first full year for the new version. We were concerned that AMIs coded in secondary positions might be consequent to non-cardiac surgical procedures. Although the discharge claim contains no information about timing, we explored this by examining the prevalence of admissions with cardiac and non-cardiac-related procedures (Appendix D includes the ICD-9 procedure codes), separately for AMIs coded as principal versus secondary diagnoses. Due to major changes in hospital procedure coding in 2005, we examined these data starting in 2006. Finally, we calculated expenditures for all hospitalizations with AMI, and the proportion of these expenditures when the AMI was coded as secondary.

All analyses used Stata version 13 (StataCorp. 2013. *Stata Statistical Software: Release 13*. College Station, TX: StataCorp LP).

This study was supported by P01AG031098 from the National Institute of Aging (NIA) and 5UL1TR000161 from the National Center for Research Resources (NCRR) and by National Institutes of Health (NIH) grants U01HL05268-04 and UL1TR000161. The authors are solely responsible for the design and conduct of this study, all study analyses and drafting and editing of the paper and its final content.

RESULTS

Baseline Characteristics

Over the 10 year study timeframe, 3,663,137 hospitalizations had an AMI discharge diagnosis (1.27 per 100 beneficiary-years); of these, 2,425,179 (66%) were hospitalizations with AMI coded as principal, with the remaining having an AMI coded in a secondary position. Table 1 shows the characteristics of beneficiaries hospitalized for AMI in 2002 and 2011 (the first and last years studied), stratified by whether the AMI was principal or secondary. Principal AMI patients were younger than secondary (mean age of 78.3 years vs. 79.5 in 2002; 78.5 years vs. 80.1 in 2011), less likely to be female (50.7% vs. 53.7% in 2002; 48.2% vs. 53.0% in 2011) and more likely to be white (88.6% vs. 86.6% in 2002; 86.7% vs. 84.6% in 2011). These differences were not year-to-year fluctuations, but reflected consistent trends over the 10 year study period (see Appendix A).

AMI Hospitalizations

Overall, hospitalization rates declined 24.5% (from 1,485 per 100,000 beneficiary-years in 2002 to 1,122 in 2011). However, the decline in rates of principal AMI hospitalizations was much larger (36.4%, from 1,063 to 677), while the rate of secondary AMI hospitalizations *actually increased* (5.5%, from 422 to 445). (Figure 1) Consequently, the proportion of all AMI hospitalizations with a principal AMI diagnosis decreased from 72% in 2002 to 60% in 2011,and from 2002 to 2011 secondary AMI hospitalizations grew from 28% to 40% of all AMI hospitalization. The underlying data are in Appendix B.

Distribution of Principal, Second and Other Secondary Position AMI Hospitalizations

As shown in Table 2, much of the shift in the proportion of AMIs coded as principal vs. secondary reflected an increase in AMIs coded in the second position. In 2002, when AMI was present in any position, it was coded first 72% of the time and second 13% of the time; by 2011, it was coded first only 60% of the time and second 22% of the time. Thus, even though the distribution of first- versus second-position AMIs shifted, the percent of all AMIs coded either first or second remained fairly constant between 2002 and 2011, falling only slightly from 84% to 82% over the decade. Over the same period, very few AMIs in any year were coded in any single position other than first or second, and the proportion appearing in all other positions held steady at approximately 17%.

Comparing Hospitalizations with AMI as Principal versus Second Position Diagnosis

Table 3 shows common comorbid conditions for principal and second-listed AMI hospitalizations in each year 2002, 2006, 2008, and 2011, organized as cardiac- and non-cardiac related conditions. The ICD-9 codes used to identify these comorbidities are also listed. Rates of cardiac-related comorbidities were relatively stable for principal AMI patients across these years but differed in the later versus earlier years for second-listed patients. Notable shifts often occurred for hospitalizations with second-listed AMI between 2006 and 2008; congestive heart failure (CHF), for example, affected more than half of these patients in 2002 (51%) and 2006 (54%), but less than 1/3 in 2008 (28%) and 2011 (31%). Rates of coronary atherosclerosis and atrial fibrillation were also lower for these

hospitalizations in the second half of the study period (2011 vs. 2002: coronary atherosclerosis 26% vs. 36%; atrial fibrillation: 16% vs. 29%).

Among patients with a second position AMI diagnosis, sepsis and septicemia were increasingly common non-cardiac-related comorbidities, affecting 2% in 2002 and 20% in 2011; we did not observe sepsis or septicemia diagnoses for principal AMI patients, however. Rates of kidney disease (kidney failure and CKD) also increased dramatically over the 10-year study period in second-position AMI patients (from 9% in 2002 to 35% in 2011), although they increased in principal AMI patients as well (from 4% in 2002 to 26% in 2011). Rates of diabetes, acute respiratory failure and pneumonia were higher in patients with a second (versus principal) position AMI diagnosis throughout the study period, but otherwise showed no major changes in either group.

Principal Discharge Diagnoses for Second Position AMI Hospitalizations

Principal diagnoses for hospitalizations where the AMI was the second discharge diagnosis also differed in the earlier and later study years, with changes occurring especially in the 2006-2008 timeframe (Table 4). From 2002-2006, congestive heart failure (CHF, ICD-9 428.0) was the principal discharge diagnosis for more than 20% of these hospitalizations, followed by coronary atherosclerosis (5-6%) and pneumonia (3-5%). CHF, however, was rare after 2007, declining to 3.3% of all principal discharge diagnoses in 2008 and disappearing from the top 5 for the remainder of the study period. Septicemia (038.9), which was not in the top five in 2002-2005, increased from 3.5% of all principal discharge diagnoses in 2006 to 9.7% in 2011. Acute Respiratory Failure entered the top 5 comorbidities starting in 2005, albeit at a relatively stable rate through 2011. Notably, CHF was not replaced by another dominant principal discharge diagnosis. Consequently, the top 5 diagnosis codes accounted for 42-43% of all principal discharge diagnoses through 2006, but only 27% from 2008-2011.

Cardiac- and non-Cardiac Related Procedures

Over the 6 year period 2006-2011, admissions with only non-cardiac procedures were more common when the AMI was secondary (about 1/3 of such admissions) than when it was listed first (about 1 in 9). However, there were only modest changes from 2006 to 2011 in the prevalence of cardiac and non-cardiac procedures for each kind of AMI hospitalization (Table 5). The largest change was among hospitalizations with a principal discharge diagnosis of AMI, where the proportion with any cardiac procedure grew by 5 percentage points (from 61% to 66%), counterbalanced by a decline from 27% to 22% in the proportion of hospitalizations with no listed procedure. Among hospitalizations with a secondary diagnosis of AMI during the same 6 years, the percent with any cardiac procedure fluctuated within a narrow range (starting at 45% and ending at 43%), matched by modest fluctuations in the percentage with only non-cardiac procedures, starting at 32% and ending at 34%. See Appendix C for more detail.

Expenditures for AMI Hospitalizations

Expenditures for AMI hospitalizations with secondary discharge diagnoses of AMI accounted for an increasing proportion of the expenditures for all AMI hospitalizations over

time (Figure 2). This increase reflected both the rising proportion of secondary AMIs and more rapid growth in mean costs for these hospitalizations. Notably, in 2002, the mean costs for principal versus secondary AMI hospitalizations were nearly identical (Principal: $15,581 vs. Secondary: $15,541), and remained similar for several years. However, starting in 2007, mean costs for secondary AMI hospitalizations surpassed principal AMI hospitalizations; by 2011, they were 16.4% higher (Principal: $18,981 vs. Secondary: $22,097). Thus, secondary AMI hospitalizations accounted for an increasing proportion of all AMI hospitalization expenditures, growing from 28% in 2002 to 43% in 2011 (Figure 2). Of the $6.5 billion spent on all AMI hospitalizations in 2011, $2.8 billion was spent on hospitalizations with secondary diagnoses of AMI.

DISCUSSION

Hospitalizations with AMI coded as a secondary discharge diagnosis are usually absent from national reporting, leading to underestimates of the full burden of AMI. We found that this group of AMIs is substantial, and represents an increasing proportion of all AMI hospitalizations over time. Concomitantly, expenditures for these hospitalizations have increased, accounting for over $2.8 billion (43%) of the $6.5 billion spent on AMI hospitalizations in 2011 (compared to 28% of the total a decade earlier). Thus, when provided with data based only on hospitalizations with principal diagnoses of AMI, policy makers will fail to see a large and growing portion of the full AMI burden.

Researchers have reported marked declines in AMI hospitalizations,[9,11,12,14,15] minimal increases in their average costs,[9] and pronounced improvements in AMI treatment quality.[22,23] However, these studies only count hospitalizations with a principal discharge diagnosis of AMI. We examine all hospitalizations in which an AMI occurred, finding that hospitalizations with AMI coded in secondary positions are a substantial and increasing proportion of all AMI hospitalizations. Consequently, estimates that ignore this growing subset of AMIs may overstate improvements in population health, underestimate current and future expenditures for AMI, and, in turn, overestimate the value of recent efforts in AMI prevention and treatment. As such, understanding and accounting for these AMIs will be increasingly important for health policy and research planning.

Increasingly sensitive troponin tests may be responsible for some of the increases in secondary AMIs. [24,25] Diagnostic code enhancements to distinguish AMI subtypes,[26,27] as Shroff et al. propose,[24,25] could help clarify the impact of these tests on trends in secondary AMIs. However, the sudden changes in comorbidities, principal discharge diagnoses and costs in the 2006-2008 timeframe are not consistent with marginal changes in test sensitivity, suggesting that changes in coding practice are also at play. It is also possible that the increase in the proportions of secondary AMI hospitalizations reflected an increase in AMIs occurring as a consequence of non-cardiac procedures. Yet, despite the dramatic shifts in various characteristics of principal and secondary AMI hospitalizations between 2006 and 2008, there was essentially no change in the fraction of hospitalizations with non-cardiac procedures (or cardiac procedures) listed from 2006-2011 for either type of AMI hospitalization.

Indeed, two major payment policy and quality reporting changes implemented during our study period could have affected how hospitals determine coding order on discharge abstracts. First, the October, 2007 introduction of the Medicare-Severity Diagnosis Related Groups (MS-DRGs) included major changes to the payment weights for AMI (and other hospitalizations).[1928] Second, public reporting of hospital-level post-AMI mortality began in the same year.[1329] Both the MS-DRGs and CMS' Hospital Compare quality measure reporting for AMI consider only hospitalizations where the AMI is coded as principal. Thus, for patients admitted with AMI and at least one other serious condition, listing that other condition first removes the hospitalization from AMI quality reporting and could – depending upon what diagnosis replaces it – result in a higher MS-DRG payment. For example, although increases in hospitalizations with principal discharge diagnoses of sepsis (so AMI becomes secondary) could reflect increased troponin test sensitivity, coding sepsis or septicemia first will also lead to higher MS-DRG-based reimbursements and remove the sickest AMI patients from performance and other measures. [17] Thus, incentives for the order in which to code diagnoses of AMI and other serious conditions (such as CHF) on discharge abstracts changed in 2007; by 2008, abrupt changes appear in the frequencies of hospitalizations of AMIs coded first or second in combination with conditions such as CHF. Recent studies of Heart Failure (HF) and pneumonia, which, like AMI, are the target of CMS quality improvement and cost containment initiatives, suggest that code shifting has contributed to secular trends in diagnostic coding, and that including secondary discharge diagnoses can generate very different estimates of trends in these high profile conditions.[3031] The MS-DRG payment weights have also provided new incentives for hospitals to record more diagnoses on the discharge abstract, however, fueling secular growth in the coding of all secondary diagnoses.[323334] Identifying the extent to which increases in troponin test sensitivity, code shifting and coding intensity are driving the marked growth in the numbers and proportion of hospitalizations with secondary AMIs is important for epidemiologic research and has significant implications for population health and national accounting of AMI burden.

Limitations

Our study of hospitalizations with AMI in the Medicare over-65 population has only accounted for reimbursements to the hospital from Medicare and patients; we did not include payments for physicians and other services occurring during the hospitalization but billed separately. However, these services typically account for a small proportion of total hospitalization costs.[3] We also studied only the Fee-for-Service population, as Medicare managed care plans were not required to submit claims to Medicare.

Further, we used administrative data, which provide minimal to no information on the severity of the AMI, other clinical risk factors, or troponin test findings, each of which would help interpret the clinical meaning of a secondary AMI. Although we observed changes in coding patterns coincident with the introduction of a new MS-DRG payment system version and public reporting of hospital quality in 2007, we do not know that the increasing proportions of secondary AMI hospitalizations are due to these payment and policy changes, and while plausible, we cannot definitively attribute the observed AMI trends to financial incentives or other non-clinical factors. Finally, although unlikely to be

the sole driver of these trends, it is possible that the increase in secondary AMIs may simply reflect clinical reality.

CONCLUSION

Secondary AMI hospitalizations are a large and growing proportion of all AMI hospitalizations, and an even larger proportion of their expenditures. These hospitalizations increased over a decade surrounding 2007, during which time hospitalizations with AMI coded as the principal discharge diagnosis fell. Thus, estimates of trends in AMI hospitalization rates and expenditures that rely on principal discharge diagnosis alone fail to account for secular trends in coding, and thereby overstate national success in reducing the burden of heart attacks. Efforts to understand and improve cardiovascular health should start with a full accounting of the complete burden of AMI.

Appendix A

Medicare Beneficiary and AMI Patient Characteristics: 2002-2011

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Denominator (Beneficiary-Years)	28.8 mn	29.3 mn	29.6 mn	29.7 mn	29.1 mn	28.6 mn	28.3 mn	28.2 mn	28.5 mn	28.9 mn	288.9 mn
Mean Age *	75.4	75.4	75.4	75.4	75.4	75.4	75.3	75.3	75.3	75.2	75.4
Age 65-74, %	46.7	46.7	46.9	46.9	46.9	47.2	48.0	48.6	49.1	49.8	47.7
Age 75-84, %	37.2	37.0	36.8	36.5	36.0	35.3	34.3	33.4	32.7	32.1	35.1
Age ≥ 85, %	16.2	16.3	16.3	16.6	17.1	17.5	17.7	18.0	18.2	18.2	17.2
Male, %	41.8	42.0	42.2	42.4	42.7	42.9	43.3	43.5	43.7	44.0	42.8
Female, %	58.2	58.0	57.8	57.6	57.3	57.1	56.7	56.5	56.3	56.0	57.2
White, %	87.5	87.3	87.1	86.9	87.0	86.9	86.8	86.5	86.2	85.9	86.8
Black, %	8.0	8.0	8.1	8.0	7.9	7.8	7.8	7.8	7.9	8.0	7.9
Other, %	4.6	4.7	4.8	5.1	5.1	5.3	5.5	5.7	5.9	6.2	5.3
AMI Hospitalizations (Principal Discharge Diagnosis)											
# Hospitalizations	302,829	295,030	277,389	260,792	243,040	225,744	220,026	204,213	202,114	194,002	2,425,179
% of All Hospitalizations w/AMI	72%	72%	70%	68%	66%	65%	63%	62%	61%	60%	66%
Mean Age *	78.3	78.5	78.5	78.6	78.7	79.7	78.8	78.6	78.6	78.5	78.6
Age 65-74, %	35.2	34.6	34.6	34.3	34.4	34.4	34.5	35.8	36.3	37.1	35.0
Age 75-84, %	41.2	41.0	41.0	40.4	39.5	38.9	38.1	36.9	36.5	36.0	39.2
Age ≥ 85, %	23.7	24.5	24.5	25.3	26.1	26.8	27.4	27.4	27.3	27.0	25.8
Female, %	50.7	50.6	50.5	50.1	50.1	49.7	49.9	49.1	48.9	48.2	49.9
White, %	88.7	88.3	88.0	88.0	87.9	87.9	87.6	87.3	87.0	86.7	87.7
Black, %	7.4	7.6	7.6	7.7	7.9	7.8	7.8	8.1	8.2	8.4	7.8

AMI Hospitalizations (Secondary Discharge Diagnosis)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
# Hospitalizations	119,943	116,493	116,991	121,396	126,526	122,310	131,313	125,721	129,787	127,478	1,237,958
% of All Hospitalizations w/AMI	28%	28%	30%	32%	34%	35%	37%	38%	39%	40%	34%
Mean Age (SD, y) *	79.6	79.7	79.8	79.9	79.9	79.8	80.0	80.0	80.1	80.2	79.9
Age 65-74, %	28.8	29.5	28.4	28.2	27.9	28.5	28.4	28.9	28.8	29.1	28.7
Age 75-84, %	43.3	44.3	42.9	42.5	41.8	40.8	39.8	39.1	38.2	37.4	40.9

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AMI Hospitalizations (Secondary Discharge Diagnosis)	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Total**
Age ≥ 85, %	27.9	26.2	28.7	29.3	30.3	30.7	31.8	32.1	33.0	33.5	30.4
Female, %	53.7	52.2	54.1	54.0	54.2	53.4	53.5	53.3	53.2	53.0	53.5
White, %	86.7	86.2	86.2	85.9	86.0	85.7	85.6	85.4	84.9	84.6	85.7
Black, %	8.8	9.1	9.0	9.2	9.2	9.4	9.4	9.5	9.7	10.0	9.3
AMI Hospitalizations (Any Discharge Diagnosis)											
# Hospitalizations	422,772	411,523	394,380	382,188	369,566	348,054	351,339	329,934	331,901	321,480	3,663,137
Mean Age (SD, y)*	78.7	78.8	78.9	79.0	79.1	79.8	79.2	79.2	79.2	79.1	79.1
Age 65-74, %	33.4	33.1	32.8	32.4	32.2	32.3	32.2	33.1	33.4	33.9	32.9
Age 75-84, %	41.8	41.9	41.5	41.1	40.3	39.6	38.8	37.7	37.2	36.5	39.8
Age ≥ 85, %	24.9	25.0	25.8	26.6	27.5	28.1	29.1	29.2	29.5	29.6	27.4
Female, %	51.6	51.0	51.6	51.3	51.5	51.0	51.2	50.7	50.6	50.1	51.1
White, %	88.1	87.7	87.5	87.3	87.3	87.1	86.9	86.6	86.2	85.8	87.1
Black, %	7.8	8.0	8.0	8.2	8.3	8.4	8.4	8.6	8.8	9.0	8.3

* Mean age per hospitalization

Appendix B

AMI Hospitalization Rates by Diagnosis Position, 2002-2011.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change 2002-2011
Any AMI Hospitalization											
Total	1,485	1,432	1,344	1,294	1,273	1,218	1,244	1,175	1,169	1,122	−24.5%
Age 65-74	960	910	850	812	795	762	761	730	725	696	−27.5%
Age 75-84	1,730	1,663	1,567	1,507	1,476	1,415	1,452	1,366	1,360	1,302	−24.7%
Age ≥ 85	2,812	2,772	2,600	2,538	2,518	2,400	2,500	2,328	2,313	2,224	−20.9%
Female	1,309	1,267	1,197	1,151	1,142	1,089	1,124	1,056	1,052	1,007	−23.1%
Male	1,720	1,651	1,539	1,484	1,446	1,390	1,404	1,333	1,324	1,274	−25.9%
White	1,500	1,443	1,352	1,302	1,278	1,221	1,245	1,174	1,167	1,119	−25.4%
Black	1,423	1,396	1,329	1,307	1,330	1,301	1,349	1,299	1,297	1,268	−10.9%
Principal Diagnosis AMI Hospitalizations											
Total	1,063	1,017	945	883	837	790	779	727	711	677	−36.4%
Age 65-74	725	681	632	588	559	526	510	487	480	459	−36.7%
Age 75-84	1,221	1,166	1,087	1,012	952	903	894	827	814	774	−36.6%
Age ≥ 85	1,918	1,880	1,742	1,649	1,571	1,481	1,478	1,353	1,303	1,226	−36.1%
Female	922	884	824	766	730	688	685	633	619	585	−36.5%
Male	1,252	1,194	1,106	1,039	979	926	904	852	834	798	−36.2%
White	1,081	1,030	956	895	847	799	786	732	717	681	−37.0%
Black	966	948	886	838	827	787	788	754	738	711	−26.4%
Secondary Diagnosis AMI Hospiatlizations											
Total	422	415	399	411	436	428	465	448	457	445	5.5%
Age 65-74	235	229	219	224	236	236	251	243	245	237	0.8%
Age 75-84	509	497	480	495	524	513	558	539	547	528	3.8%
Age ≥ 85	894	892	858	889	947	920	1,022	975	1,010	998	11.7%
Female	457	449	443	469	502	514	561	545	559	556	21.8%
Male	387	383	373	385	412	401	439	423	433	422	9.1%
White	468	457	433	445	467	464	500	481	490	476	1.6%
Black	420	413	396	407	431	422	459	442	450	438	4.4%

Appendix C

Cardiac- and Non-Cardiac Related Procedures by Year and AMI Diagnosis Position

ANY CARDIAC PROCEDURES						CARDIAC PROCEDURES ONLY						NON-CARDIAC PROCEDURES ONLY					
TYPE	**YEAR**	**NO**	**YES**	**TOTAL**	**% ANY CARDIAC**	**TYPE**	**YEAR**	**NO**	**YES**	**TOTAL**	**% CARDIAC ONLY**	**TYPE**	**YEAR**	**NO**	**YES**	**TOTAL**	**% NON-CARDIAC ONLY**
DX1	2006	94,741	148,299	243,040	61%	DX1	2006	204,448	38,592	243,040	16%	DX1	2006	214,010	29,030	243,040	12%
	2007	85,211	140,533	225,744	62%		2007	188,186	37,558	225,744	17%		2007	197,866	27,878	225,744	12%
	2008	83,492	136,534	220,026	62%		2008	183,856	36,170	220,026	16%		2008	193,000	27,026	220,026	12%
	2009	73,341	130,872	204,213	64%		2009	170,592	33,621	204,213	16%		2009	180,153	24,060	204,213	12%
	2010	69,339	132,775	202,114	66%		2010	168,335	33,779	202,114	17%		2010	179,180	22,934	202,114	11%
	2011	65,292	128,710	194,002	66%		2011	163,987	30,015	194,002	15%		2011	172,309	21,693	194,002	11%
TYPE	**YEAR**	**NO**	**YES**	**TOTAL**	**% ANY CARDIAC**	**TYPE**	**YEAR**	**NO**	**YES**	**TOTAL**	**% CARDIAC ONLY**	TYPE	**YEAR**	**NO**	**YES**	**TOTAL**	**% NON-CARDIAC ONLY**
DX2+	2006	69,755	56,682	126,437	45%	DX2+	2006	117,259	9,178	126,437	7%	DX2+	2006	85,735	40,702	126,437	32%
	2007	65,184	57,026	122,210	47%		2007	113,416	8,794	122,210	7%		2007	83,007	39,203	122,210	32%
	2008	69,120	62,112	131,232	47%		2008	121,352	9,880	131,232	8%		2008	89,601	41,631	131,232	32%
	2009	66,567	59,069	125,636	47%		2009	116,375	9,261	125,636	7%		2009	86,232	39,404	125,636	31%
	2010	69,789	59,896	129,685	46%		2010	120,186	9,499	129,685	7%		2010	88,116	41,569	129,685	32%
	2011	72,170	55,172	127,342	43%		2011	119,053	8,289	127,342	7%		2011	83,920	43,422	127,342	34%

BOTH						NONE				
TYPE	**YEAR**	**NO**	**YES**	**TOTAL**	**% BOTH**	**YEAR**	**NO**	**YES**	**TOTAL**	**% NONE**
DX1	2006	133,333	109,707	243,040	45%	2006	177,329	65,711	243,040	27%
	2007	122,769	102,975	225,744	46%	2007	168,411	57,333	225,744	25%
	2008	119,662	100,364	220,026	46%	2008	163,560	56,466	220,026	26%
	2009	106,962	97,251	204,213	48%	2009	154,932	49,281	204,213	24%
	2010	103,118	98,996	202,114	49%	2010	155,709	46,405	202,114	23%
	2011	95,307	98,695	194,002	51%	2011	150,403	43,599	194,002	22%
TYPE	**YEAR**	**NO**	**YES**	**TOTAL**	**% BOTH**	**YEAR**	**NO**	**YES**	**TOTAL**	**% NONE**
DX2+	2006	78,933	47,504	126,437	38%	2006	97,384	29,053	126,437	23%
	2007	73,978	48,232	122,210	39%	2007	96,229	25,981	122,210	21%
	2008	79,000	52,232	131,232	40%	2008	103,743	27,489	131,232	21%

BOTH					NONE				
	2009	75,828	49,808	125,636	40%	2009	98,473	27,163	125,636	22%
	2010	79,288	50,397	129,685	39%	2010	101,465	28,220	129,685	22%
	2011	80,459	46,883	127,342	37%	2011	98,594	28,748	127,342	23%

Appendix D

Cardiac-Related ICD9 Procedure Codes

Cardiac Procedures (ICD9 Code/Description)		
0002 THER ULTRASOUND OF HEART	3752 IMPLANT TOT REP HRT SYS	3869 LEG VEIN EXCISION
0024 IVUS CORONARY VESSELS	3753 REPL/REP THORAC UNIT HRT	387 INTERRUPTION VENA CAVA
0066 PTCA OR CORONARY ATHER	3754 REPL/REP OTH TOT HRT SYS	3880 SURG VESSEL OCCLUS NEC
3500 CLOSED VALVOTOMY NOS	3761 PULSATION BALLOON IMPLAN	3881 OCCLUS INTRACRAN VES NEC
3501 CLOSED AORTIC VALVOTOMY	3762 INS NON-IMPL HRT ASSIST	3882 OCCLUS HEAD/NECK VES NEC
3502 CLOSED MITRAL VALVOTOMY	3763 REPAIR HEART ASSIST SYS	3883 OCCLUDE ARM VESSEL NEC
3503 CLOSED PULMON VALVOTOMY	3764 REMOVE HEART ASSIST SYS	3884 OCCLUDE AORTA NEC
3504 CLOSED TRICUSP VALVOTOMY	3765 IMP EXT HRT ASSIST SYST	3885 OCCLUDE THORACIC VES NEC
3510 OPEN VALVULOPLASTY NOS	3766 IMPLANTABLE HRT ASSIST	3886 OCCLUDE ABD ARTERY NEC
3511 OPN AORTIC VALVULOPLASTY	3767 IMP CARDIOMYOSTIMUL SYS	3887 OCCLUDE ABD VEIN NEC
3512 OPN MITRAL VALVULOPLASTY	3768 PERCUTAN HRT ASSIST SYST	3888 OCCLUDE LEG ARTERY NEC
3513 OPN PULMON VALVULOPLASTY	3770 INT INSERT PACEMAK LEAD	3889 OCCLUDE LEG VEIN NEC
3514 OPN TRICUS VALVULOPLASTY	3771 INT INSERT LEAD IN VENT	3891 ARTERIAL CATHETERIZATION
3520 REPLACE HEART VALVE NOS	3772 INT INSER LEAD ATRI-VENT	3892 UMBILICAL VEIN CATH
3521 REPLACE AORT VALV-TISSUE	3773 INT INSER LEAD IN ATRIUM	3893 VENOUS CATH NEC
3522 REPLACE AORTIC VALVE NEC	3774 INT OR REPL LEAD EPICAR	3894 VENOUS CUTDOWN
3523 REPLACE MITR VALV-TISSUE	3775 REVISION OF LEAD	3895 VEN CATH RENAL DIALYSIS
3524 REPLACE MITRAL VALVE NEC	3776 REPL TV ATRI-VENT LEAD	3898 ARTERIAL PUNCTURE NEC
3525 REPLACE PULM VALV-TISSUE	3777 REMOVAL OF LEAD W/O REPL	3899 VENOUS PUNCTURE NEC
3526 REPLACE PULMON VALVE NEC	3778 INSER TEMP PACEMAKER SYS	390 SYSTEMIC-PULM ART SHUNT
3527 REPLACE TRIC VALV-TISSUE	3779 REV/RELOC CARD DEV POCKT	391 INTRA-ABD VENOUS SHUNT
3528 REPLACE TRICUSP VALV NEC	3780 INT OR REPL PERM PACEMKR	3921 CAVAL-PULMON ART ANASTOM
3531 PAPILLARY MUSCLE OPS	3781 INT INSERT 1-CHAM, NON	3922 AORTA-SUBCLV-CAROT BYPAS
3532 CHORDAE TENDINEAE OPS	3782 INT INSERT 1-CHAM, RATE	3923 INTRATHORACIC SHUNT NEC
3533 ANNULOPLASTY	3783 INT INSERT DUAL-CHAM DEV	3924 AORTA-RENAL BYPASS
3534 INFUNDIBULECTOMY	3785 REPL PACEM W 1-CHAM, NON	3925 AORTA-ILIAC-FEMOR BYPASS
3535 TRABECUL CARNEAE CORD OP	3786 REPL PACEM 1-CHAM, RATE	3926 INTRA-ABDOMIN SHUNT NEC
3539 TISS ADJ TO VALV OPS NEC	3787 REPL PACEM W DUAL-CHAM	3927 DIALYSIS ARTERIOVENOSTOM

3541 ENLARGE EXISTING SEP DEF	3789 REVISE OR REMOVE PACEMAK	3928 EXTRACRAN-INTRACR BYPASS
3542 CREATE SEPTAL DEFECT	3790 INS LEFT ATR APPEND DEV	3929 VASC SHUNT & BYPASS NEC
3550 PROSTH REP HRT SEPTA NOS	3791 OPN CHEST CARDIAC MASSAG	3930 SUTURE OF VESSEL NOS
3551 PROS REP ATRIAL DEF-OPN	3792 INJECTION INTO HEART	3931 SUTURE OF ARTERY
3552 PROS REPAIR ATRIA DEF-CL	3793 INJECTION INTO PERICARD	3932 SUTURE OF VEIN
3553 PROST REPAIR VENTRIC DEF	3794 IMPLT/REPL CARDDEFIB TOT	3941 POSTOP VASC OP HEM CONTR
3554 PROS REP ENDOCAR CUSHION	3795 IMPLT CARDIODEFIB LEADS	3942 REVIS REN DIALYSIS SHUNT
3560 GRFT REPAIR HRT SEPT NOS	3796 IMPLT CARDIODEFIB GENATR	3943 REMOV REN DIALYSIS SHUNT
3561 GRAFT REPAIR ATRIAL DEF	3797 REPL CARDIODEFIB LEADS	3949 VASC PROC REVISION NEC
3562 GRAFT REPAIR VENTRIC DEF	3798 REPL CARDIODEFIB GENRATR	3950 ANGIO OTH NON-CORONARY
3563 GRFT REP ENDOCAR CUSHION	3799 OTHER HEART/PERICARD OPS	3951 CLIPPING OF ANEURYSM
3570 HEART SEPTA REPAIR NOS	3800 INCISION OF VESSEL NOS	3952 ANEURYSM REPAIR NEC
3571 ATRIA SEPTA DEF REP NEC	3801 INTRACRAN VESSEL INCIS	3953 ARTERIOVEN FISTULA REP
3572 VENTR SEPTA DEF REP NEC	3802 HEAD/NECK VES INCIS NEC	3954 RE-ENTRY OPERATION
3573 ENDOCAR CUSHION REP NEC	3803 UPPER LIMB VESSEL INCIS	3955 REIMPLAN ABERR RENAL VES
3581 TOT REPAIR TETRAL FALLOT	3804 INCISION OF AORTA	3956 REPAIR VESS W TIS PATCH
3582 TOTAL REPAIR OF TAPVC	3805 THORACIC VESSEL INC NEC	3957 REP VESS W SYNTH PATCH
3583 TOT REP TRUNCUS ARTERIOS	3806 ABDOMEN ARTERY INCISION	3958 REPAIR VESS W PATCH NOS
3584 TOT COR TRANSPOS GRT VES	3807 ABDOMINAL VEIN INCISION	3959 REPAIR OF VESSEL NEC
3591 INTERAT VEN RETRN TRANSP	3808 LOWER LIMB ARTERY INCIS	3961 EXTRACORPOREAL CIRCULAT
3592 CONDUIT RT VENT-PUL ART	3809 LOWER LIMB VEIN INCISION	3962 HYPOTHERMIA W OPEN HEART
3593 CONDUIT LEFT VENTR-AORTA	3810 ENDARTERECTOMY NOS	3963 CARDIOPLEGIA
3594 CONDUIT ARTIUM-PULM ART	3811 INTRACRAN ENDARTERECTOMY	3964 INTRAOP CARDIAC PACEMAK
3595 HEART REPAIR REVISION	3812 HEAD & NECK ENDARTER NEC	3965 EXTRACORPOREAL MEMB OXY
3596 PERC HEART VALVULOPLASTY	3813 UPPER LIMB ENDARTERECTOM	3966 PER CARDIOPULMON BYPASS
3598 OTHER HEART SEPTA OPS	3814 ENDARTERECTOMY OF AORTA	3971 ENDO IMPL GRFT ABD AORTA
3599 OTHER HEART VALVE OPS	3815 THORACIC ENDARTERECTOMY	3972 ENDOVASC REPAIR HEAD VES
3603 OPEN CORONRY ANGIOPLASTY	3816 ABDOMINAL ENDARTERECTOMY	3973 ENDO IMP GRFT THOR AORTA
3604 INTRCORONRY THROMB INFUS	3818 LOWER LIMB ENDARTERECT	3979 ENDO REPAIR OTHER VESSEL
3606 INS NONDRUG ELUT COR ST	3821 BLOOD VESSEL BIOPSY	398 VASCULAR BODY OPERATIONS

3607 INS DRUG-ELUT CORONRY ST	3822 PERCUTANEOUS ANGIOSCOPY	3990 INS NON-D-E PERPHRL STEN
3609 REM OF COR ART OBSTR NEC	3829 BLOOD VESSEL DX PROC NEC	3991 FREEING OF VESSEL
3610 AORTOCORONARY BYPASS NOS	3830 VESSEL RESECT/ANAST NOS	3992 VEIN INJECT-SCLEROS AGNT
3611 AORTOCOR BYPAS-1 COR ART	3831 INTRACRAN VES RESEC-ANAS	3993 INSERT VES-TO-VES CANNUL
3612 AORTOCOR BYPAS-2 COR ART	3832 HEAD/NECK VES RESEC-ANAS	3994 REPLAC VES-TO-VES CANNUL
3613 AORTOCOR BYPAS-3 COR ART	3833 ARM VESSEL RESECT/ANAST	8850 ANGIOCARDIOGRAPHY NOS
3614 AORTCOR BYPAS-4+ COR ART	3834 AORTA RESECTION & ANAST	8851 VENA CAV ANGIOCARDIOGRAM
3615 1 INT MAM-COR ART BYPASS	3835 THOR VESSEL RESECT/ANAST	8852 RT HEART ANGIOCARDIOGRAM
3616 2 INT MAM-COR ART BYPASS	3836 ABD VESSEL RESECT/ANAST	8853 LT HEART ANGIOCARDIOGRAM
3617 ABD-CORON ARTERY BYPASS	3837 ABD VEIN RESECT & ANAST	8854 RT & LT HEART ANGIOCARD
3619 HRT REVAS BYPS ANAS NEC	3838 LEG ARTERY RESECT/ANAST	8855 CORONAR ARTERIOGR-1 CATH
362 ARTERIAL IMPLANT REVASC	3839 LEG VEIN RESECT/ANASTOM	8856 CORONAR ARTERIOGR-2 CATH
3631 OPEN CHEST TRANS REVASC	3840 VESSEL RESECT/REPLAC NOS	8857 CORONARY ARTERIOGRAM NEC
3632 OTH TRANSMYO REVASCULAR	3841 INTRACRAN VES RESEC-REPL	8858 NEGATVE-CONTR CARDIOGRAM
3639 OTH HEART REVASCULAR	3842 HEAD/NECK VES RESEC-REPL	8944 CARDIAC STRESS TEST NEC
3691 CORON VESS ANEURYSM REP	3843 ARM VES RESECT W REPLACE	8945 PACEMAKER RATE CHECK
3699 HEART VESSEL OP NEC	3844 RESECT ABDM AORTA W REPL	8946 PACEMAKER WAVE FORM CHCK
370 PERICARDIOCENTESIS	3845 RESECT THORAC VES W REPL	8947 PACEMAKER IMPEDANCE CHCK
3710 INCISION OF HEART NOS	3846 ABD ARTERY RESEC W REPLA	8948 PACEMAKER VOLT THRESHOLD
3711 CARDIOTOMY	3847 ABD VEIN RESECT W REPLAC	8949 AICD CHECK
3712 PERICARDIOTOMY	3848 LEG ARTERY RESEC W REPLA	8950 AMBU CARDIAC MONITORING
3721 RT HEART CARDIAC CATH	3849 LEG VEIN RESECT W REPLAC	8951 RHYTHM ELECTROCARDIOGRAM
3722 LEFT HEART CARDIAC CATH	3850 VARICOSE V LIG-STRIP NOS	8952 ELECTROCARDIOGRAM
3723 RT/LEFT HEART CARD CATH	3851 INTCRAN VAR V LIG-STRIP	8953 VECTORCARDIOGRAM
3724 PERICARDIAL BIOPSY	3852 HEAD/NECK VAR V LIG-STR	8954 ELECTROCARDIOGRAPH MONIT
3725 CARDIAC BIOPSY	3853 ARM VARICOSE V LIG-STRIP	8955 PHONOCARDIOGRAM
3726 CARDIAC ELECTROPHY STIM	3855 THORAC VAR V LIG-STRIP	8956 CAROTID PULSE TRACING
3727 CARDIAC MAPPING	3857 ABD VARICOS V LIGA-STRIP	8957 APEXCARDIOGRAM
3728 INTRACARDIAC ECHOCARDIO	3859 LEG VARICOS V LIGA-STRIP	8958 PLETHYSMOGRAM
3729 HRT/PERICAR DX PROC NEC	3860 EXCISION OF VESSEL NOS	8959 NONOP CARDIAC/VASC EXAM

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3731 PERICARDIECTOMY	3861 INTRACRAN VESSEL EXCIS	8969 CORONARY BLD FLOW MONIT
3732 HEART ANEURYSM EXCISION	3862 HEAD/NECK VESSEL EXCIS	9336 CARDIAC RETRAINING
3733 EXC/DEST HRT LESION OPEN	3863 ARM VESSEL EXCISION	9960 CARDIOPULM RESUSCITA NOS
3734 EXC/DEST HRT LES OTHER	3864 EXCISION OF AORTA	9961 ATRIAL CARDIOVERSION
3735 PARTIAL VENTRICULECTOMY	3865 THORACIC VESSEL EXCISION	9962 HEART COUNTERSHOCK NEC
3741 IMPL CARDIAC SUPPORT DEV	3866 ABDOMINAL ARTERY EXCIS	9963 CLOSED CHEST CARD MASSAG
3749 HEART/PERICARD REPR NEC	3867 ABDOMINAL VEIN EXCISION	9964 CAROTID SINUS STIUMLAT
3751 HEART TRANSPLANTATION	3868 LEG ARTERY EXCISION	9969 CARDIAC RHYTHM CONV NEC

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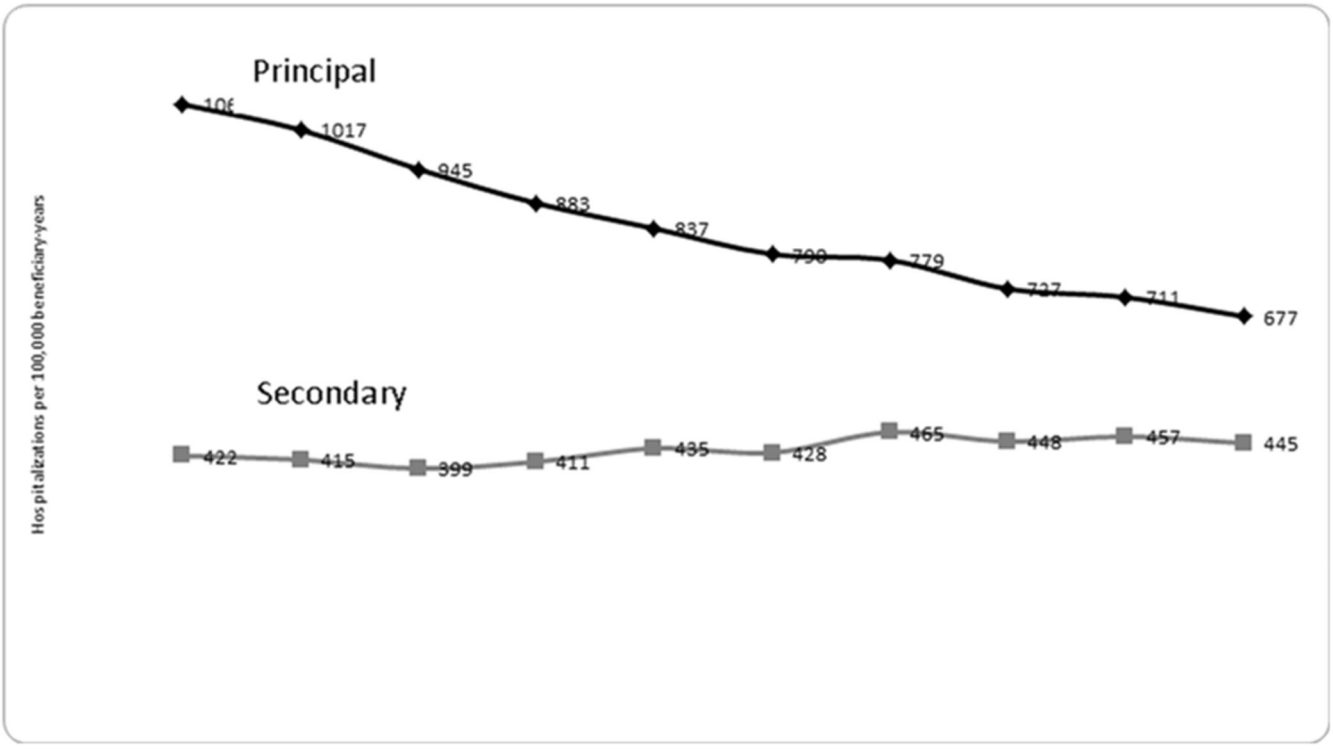

Figure 1.

Hospitalization Rates with Principal vs. Secondary Diagnoses: Declines in principal AMI hospitalizations are partially offset by increases in those with secondary AMIs

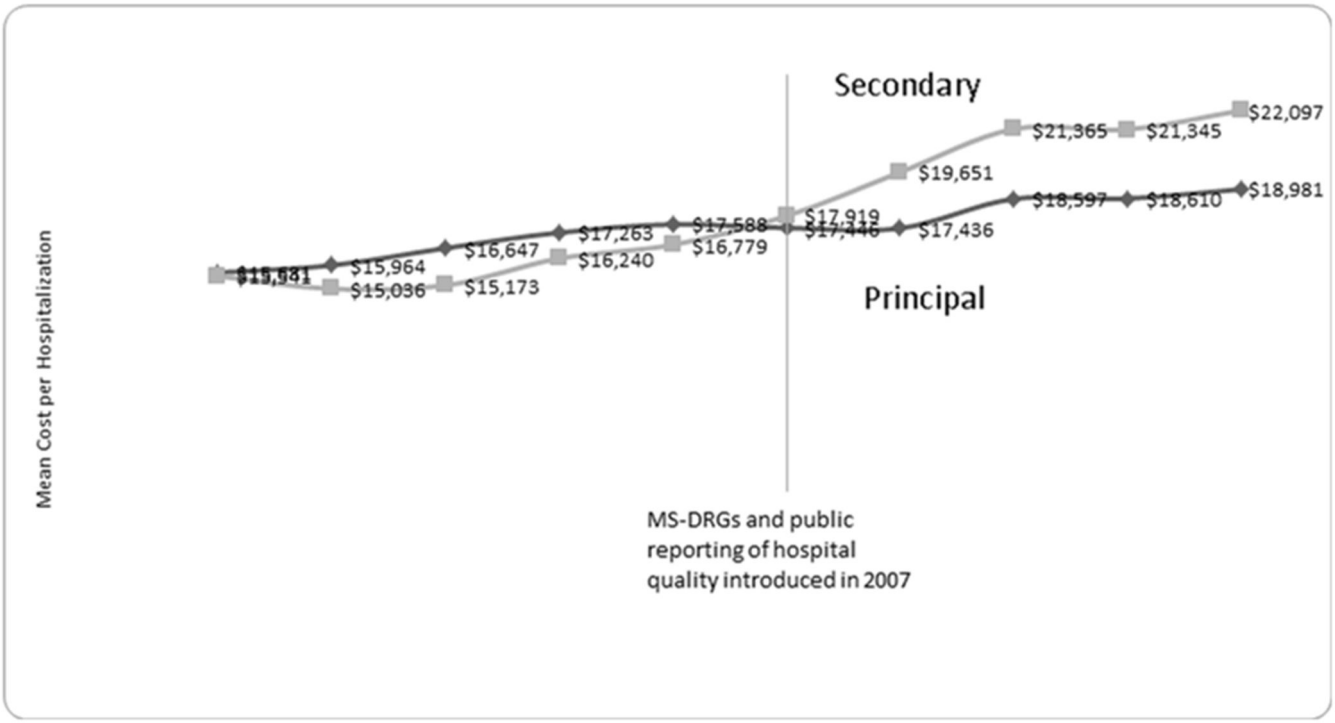

Figure 2.

Mean Cost per AMI Hospitalization:* Principal vs. Secondary Discharge Diagnoses: Beginning in 2007, hospitalizations with secondary AMIs became more expensive than those with AMIs coded as principal

TABLE 1

AMI Patient Characteristics in 2002 and 2011 by AMI Discharge Diagnosis Position: Patients with secondary AMI hospitalizations are increasingly older, more likely to be female and less likely to be white

	2002		2011	
	Principal	**Secondary**	**Principal**	**Secondary**
Beneficiary-years (#)	28.8 million		28.9 million	
AMI Hospitalizations (#)	302,829	119,943	194,002	127,478
% of All by Dx Position	72%	28%	60%	40%
Mean Age in years (SD)*	78.3 (7.9)	79.5 (7.9)	78.5 (8.5)	80.1 (8.5)
Age 65-74, %	35.2	28.8	37.0	29.1
Age 75-84, %	41.1	43.3	35.9	37.4
Age ≥ 85, %	23.7	27.9	27.0	33.5
Female, %	50.7	53.7	48.2	53.0
White, %	88.6	86.7	86.6	84.6
Black, %	7.4	8.8	8.4	10.0

TABLE 2

AMI Hospitalizations by Discharge Diagnosis Position: Second position AMI discharge diagnoses increased from 2002 – 2011

	2002	2006	2008	2011
AMI Hospitalization Discharge Diagnosis Position				
ANY Position	1,485	1,273	1,244	1,122
PRINCIPAL Position	1,063	837	779	677
SECOND Position	190	199	237	245
THIRD or SUBSEQUENT Position	232	237	228	200
Percent of AMI Hospitalizations				
PRINCIPAL Position	72%	66%	63%	60%
SECOND Position	13%	16%	19%	22%
PRINCIPAL *or* SECOND Position	84%	81%	82%	82%

TABLE 3

Cardiac and non-Cardiac-related Comorbidities* for Principal and Second Position AMI: Few big changes for Dx1 AMI hospitalizations between 2006 and 2008; many for Dx2**

	Comorbid Condition	Dx1 AMIs: Percent with Diagnoses for Comorbidity				Second Position AMIs: Percent with Diagnoses for Comorbidity			
Diagnosis (ICD-9) Codes	**Description**	**2002**	**2006**	**2008**	**2011**	**2002**	**2006**	**2008**	**2011**
CARDIAC-RELATED									
414.0×; 414.2×, 414.3×,414.8×,414.9×	Coronary atherosclerosis	63%	64%	73%	71%	36%	38%	29%	26%
401.×, 402.×, 404.×	Hypertension	45%	43%	41%	39%	33%	30%	31%	34%
428.×	Congestive Heart Failure, unspecified	39%	41%	38%	41%	51%	54%	28%	31%
427.31	Atrial fibrillation	22%	23%	18%	19%	29%	31%	19%	16%
NON-CARDIAC RELATED									
249.×, 250.×	Diabetes (Type 2)	19%	19%	20%	20%	15%	15%	15%	13%
584.×, 585.×	Kidney disease (Kidney failure/CKD)	4%	15%	23%	26%	9%	29%	23%	35%
038.*, 995.91, 995.92	Sepsis/septicemia	-	-	-	-	2%	4%	10%	20%
486	Pneumonia	6%	7%	9%	8%	13%	15%	13%	15%
518.81	Acute respiratory failure	6%	6%	8%	10%	15%	18%	16%	18%
496	Chronic airway obstruction, not elsewhere classified	13%	14%	9%	9%	15%	16%	7%	6%

"-" *indicates that no ICD-9 diagnosis codes for that comorbidity were not in the top 10 diagnosis codes in that year.*

* *Based on top 10 ICD-9 diagnoses in the non-principal or the non-second position for hospitalizations in that year with AMI coded as principal or second position discharge diagnosis, respectively.*

** *2007 was the transition year for the new DRG payment system.*

TABLE 4

Top 5 Principal Discharge Diagnoses When AMI Is Listed Second, By Year: *No principal diagnosis dominates after 2007*

Dx Code	Description	2002	2003	2004	2005	2006	2007*	2008	2009	2010	2011
4280	Congestive heart failure, unspecified	24.8	25.9	26.4	23.6	20.5	14.5	3.3	-	-	-
41401	Coronary atherosclerosis of native coronary artery	6.4	6.0	5.2	5.1	6.4	6.3	5.8	4.6	3.3	-
486	Pneumonia	4.7	4.7	4.0	4.0	-	3.6	5.3	5.4	5.0	5.0
42731	Atrial fibrillation	3.8	3.9	4.1	4.0	4.1	-	-	-	-	-
5070	Pneumonitis due to solids and liquids	2.9	2.4	-	-	-	-	-	3.5	3.3	3.7
51881	Acute respiratory failure	-	-	-	5.6	7.8	7.8	7.5	7.4	6.1	5.6
389	Septicemia	-	-	-	-	3.5	4.3	5.4	6.0	9.6	9.7
43491	Cerebral artery occlusion, w/infarc	-	-	2.3	-	-	-	-	-	-	-
5849	Acute kidney failure	-	-	-	-	-	-	-	-	-	2.9
Percent accounted for by:											
Top Dx Code:		24.8	25.9	26.4	23.6	20.5	14.5	7.5	7.4	9.6	9.7
Top 5 Dx Codes:		42.6	42.8	42.0	42.2	42.3	36.4	27.3	26.8	27.3	27.0

"-" *indicates that diagnosis was not in the top 5 principal discharge diagnoses for second-position AMI hospitalizations in that year.*

*2007 was the transition year for the new DRG payment system

TABLE 5

AMI Hospitalizations with Cardiac and Non-Cardiac Procedures Listed, by AMI Position and Year: *Changes in proportions are small*

AMI Position	Any Cardiac Procedure	Cardiac Procedures Only	Cardiac and Non-Cardiac Procedures	Non-Cardiac Procedures Only	None
Principal					
2006	61%	16%	45%	12%	27%
2007	62%	17%	46%	12%	25%
2008	62%	16%	46%	12%	26%
2009	64%	16%	48%	12%	24%
2010	66%	17%	49%	11%	23%
2011	66%	15%	51%	11%	22%
Secondary					
2006	45%	7%	38%	32%	23%
2007	47%	7%	39%	32%	21%
2008	47%	8%	40%	32%	21%
2009	47%	7%	40%	31%	22%
2010	46%	7%	39%	32%	22%
2011	43%	7%	37%	34%	23%