

Costs of Heart Failure–Related Hospitalizations in Patients Aged 18 to 64 Years

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In the United States, rates of hospitalization for heart failure (HF) increased substantially in the past 3 decades, and HF has become an epidemic.¹⁻³ Although HF affects adults 65 years or older more than those below age 65 years, the younger group had a higher relative increase in hospitalization rates for HF, regardless of sex, than did the older group.¹ In addition, the percent increase was greater for hospitalizations with HF as a secondary diagnosis than it was for hospitalizations with HF as the primary diagnosis.¹ Nationally, approximately 70% of HF-related hospitalizations listed HF as a secondary diagnosis.¹ From a public health perspective, promoting prevention and improving medical management based on an understanding of the costs for HF-related hospitalizations in people aged 18 to 64 years could have a large payoff in terms of containing the ever-increasing healthcare costs.

For 2007, the medical cost of HF in the United States for those aged 65 years or older was estimated at \$30.2 billion.⁴ The hospitalization cost for this age group was estimated at \$20.1 billion in 2009.⁵ The average cost for an HF hospitalization more than doubled from about \$7000 in the 1990s to \$18,086 in recent years.⁶⁻⁸ On the national level, HF has an extraordinary impact, consuming 1% to 2% of the total healthcare resources in industrialized countries, including the United States, with this percentage likely to increase in the future.⁹⁻¹¹ Moreover, HF is the fastest-growing cardiac disease entity in the United States, affecting 2% of the population, with nearly 1 million hospitalizations for acute decompensated congestive HF occurring annually.¹¹

Although many researchers have investigated the medical costs related to HF, nearly all the cost studies have been for the population 65 years or older because of the high hospitalization rates for HF in this age group.^{4,6-9,12-18} Correspondingly, information is lacking on the costs of HF in adults under 65 years. Furthermore, although many previous studies had focused on hospitalization costs,^{8,18,19} the costs by detailed diagnosis codes and diagnosis status have not been well examined. Because the types of HF vary considerably and at least 70% of HF diagnoses are listed as a secondary diagnosis, it would be helpful to have cost analyses for this disease that consider these characteristics, especially as the information obtained could influence the cost-effectiveness

of HF management programs. Thus, we investigated HF-related hospitalization costs among patients aged 18 to 64 years by diagnosis status.

Objective: To examine the costs of hospitalizations related to heart failure (HF) among patients aged 18 to 64 years by diagnosis status.

Background: There are few reports on HF-related hospitalization costs in patients aged 18 to 64 years, although this group has had increased HF hospitalization rates in recent decades.

Methods: Using the 2005 MarketScan Commercial Claims and Encounters inpatient data set, we identified 23,216 hospitalizations for which HF was the primary or secondary diagnosis among patients aged 18 to 64 years who had a noncapitated health insurance plan. We used multivariate regression to analyze the association between patient characteristics and both hospitalization costs and length of stay (LOS).

Results: For the entire population, the mean cost of hospitalization was \$23,077; the cost was higher when HF was a secondary rather than the primary diagnosis (\$25,325 vs \$17,654; $P < .001$). After controlling for covariates, hospitalizations with HF as a secondary diagnosis resulted in \$3944 higher costs than those with HF as the primary diagnosis ($P < .001$). Among those with HF as a secondary diagnosis, the cost of hospitalization with the primary diagnosis of ischemic heart disease was \$14,989 higher than it was when the primary diagnosis was noncardiovascular disease and nonrespiratory conditions ($P < .001$). However, patients in the latter group had a longer LOS.

Conclusions: Information on the costs of HF-related hospitalizations can be used as inputs in economic evaluations such as cost-effectiveness analyses and as references for policy makers in making resource allocation decisions.

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Take-Away Points

The costs of 23,216 hospitalizations related to heart failure (HF) among patients aged 18 to 64 years were analyzed.

- The mean cost of HF-related hospitalizations was \$23,077 and was higher when HF was a secondary rather than the primary diagnosis.
- For those with a secondary diagnosis of HF and the primary diagnosis of ischemic heart disease, the costs of hospitalizations were \$14,989 higher than they were when the primary diagnosis was noncardiovascular disease and nonrespiratory conditions.
- Among all the categories of primary diagnoses, the primary diagnosis of noncardiovascular disease and nonrespiratory conditions resulted in the longest length of stay.

Outcome Measures and Other Control Variables

The main outcome for this analysis, hospitalization costs (total payments to providers, not charges), represented the total costs per hospitalization, which included the costs for physician services, all diagnostic tests, therapeutics, supplies, and room fees during the stay. We excluded the hospitalizations with a cost below \$1060 (cutoff point of the 1st percentile) and above \$208,507 (cutoff point of the 99th percentile).

Length of stay (LOS) was a second outcome measure. Because LOS is a major factor influencing the cost, reducing it might have important implications for managing HF and for cost containment.^{19,25,26} The LOS was categorized as 1 for hospital stays of fewer than 7 days and as 2 for hospital stays of 7 or more days. We used 7 days as the cutoff point because the average number of days for an HF-related hospitalization in the United States is about 6 to 8 days.^{11,19} In our data, the average was 6.3 days.

We included age, sex, urbanization, and the Charlson Comorbidity Index as control variables. We used the Charlson Comorbidity Index, which measures the likelihood of death or serious disability in the subsequent year by diagnosis codes for up to 18 different diseases,²⁷ to control for the effects of disease severity and comorbidities on the costs.¹⁶

Statistical Analysis

Statistical analyses were performed using SAS version 9.2 (SAS Institute Inc, Cary, NC). Significance was assumed when the 2-tailed probability value was less than .001. For cost comparisons between hospitalizations with the primary diagnosis of HF and those with a secondary diagnosis of HF, the Wilcoxon 2-sample test was used. We used regression models to conduct multivariate analysis of the costs and LOS. Medical cost data were usually skewed and not normally distributed; thus, many researchers have used log-transformation in cost analyses. Many other studies, however, did not use the transformation because of the difficulties in interpreting the results.²⁸⁻³⁰ We excluded hospitalizations with total costs below the 1st or above the 99th percentile to avoid the effects of outliers, and our large sample sizes also made the analysis relatively robust to the violations of normality. Therefore, we did not transform the costs in our analysis. Because the study samples consisted of hospitalizations rather than patients, some patients might have had multiple hospitalizations during the year. To account for the possibility of the repeated measures in the analysis, we used the PROC MIXED procedure to estimate the impact of patient character-

METHODS

Study Population

We identified HF-related hospitalizations from the 2005 MarketScan Commercial Claims and Encounters inpatient data set, which in that year had data on more than 1 million inpatient hospitalizations for privately insured patients 64 years or younger. The data contain comprehensive, high-quality coding of medical services.²⁰ Researchers have previously used this database for medical cost analyses of cardiovascular diseases (CVDs).²¹⁻²⁴

We used the primary diagnosis and 14 secondary diagnoses to identify hospitalizations for patients aged 18 to 64 years with a diagnosis of HF; our analysis was restricted to the *International Classification of Diseases, Ninth Revision (ICD-9)* codes listed in the American College of Cardiology/American Heart Association HF performance measures (Table 1). We identified 23,216 HF-related hospitalizations for patients with a noncapitated health insurance plan and with hospitalization costs between the 1st and 99th percentiles. We excluded the hospitalizations of patients with a capitated health insurance plan because their costs did not reflect the medical services they received; excluding hospitalizations with a cost below the 1st or above the 99th percentile reduced the influences of extreme values on the cost estimates. We further created 2 subsamples for the cost analyses: (1) HF as the primary diagnosis and (2) HF as a secondary diagnosis. Hospitalizations with both the primary diagnosis and a secondary diagnosis of HF were included in the first subsample.

For hospitalizations with a secondary diagnosis of HF, we identified the primary diagnoses of (1) ischemic heart disease (IHD) (ICD-9 codes 410-414); (2) other diseases of the heart (ICD-9 codes 392-398, 402, 404, 415, 416, 420-427, and 429); (3) other CVDs (ICD-9 codes 390-459, excluding the codes for IHD and other diseases of the heart); (4) respiratory disease (ICD-9 codes 460-519), including pneumonia and chronic obstructive pulmonary disease; and (5) non-CVD and nonrespiratory conditions.

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Table 1. Heart Failure Diagnosis Codes and Number and Mean Costs of Hospitalizations for Patients Aged 18 to 64 Years^a

Heart Failure Group	ICD-9 Code ^b	Hospitalizations, No. (%)	Mean ± SD Cost, \$
Hypertensive heart failure	40201, 40211, 40291, 40401, 40403, 40411, 40413, 40491, 40493	495 (2.1)	18,286 ± 26,117
Unspecified heart failure	4280, 4289	19,610 (84.5)	23,096 ± 29,633
Left heart failure	4281	1034 (4.5)	23,903 ± 31,420
Systolic heart failure	42820-42823	1152 (5.0)	25,210 ± 30,874
Diastolic heart failure	42830-42833	665 (2.9)	21,369 ± 29,413
Combined systolic and diastolic heart failure	42840-42843	260 (1.1)	22,396 ± 23,821
Total		23,216 (100)	23,077 ± 29,654

ICD-9 indicates *International Classification of Diseases, Ninth Revision*; SD, standard deviation.

^aData are from the 2005 MarketScan Commercial Claims and Encounters inpatient data set.

^bTaken from the American College of Cardiology/American Heart Association heart failure performance measures.

istics and other covariates on hospitalization costs, and we used the PROC GENMOD procedure to estimate the impact of these variables on LOS.

RESULTS

For all 23,216 HF-related hospitalizations, the mean cost was \$23,077; for the 6806 hospitalizations (29%) with HF listed as the primary diagnosis, the mean cost was \$17,654, and for the 16,410 hospitalizations (71%) with HF listed as a secondary diagnosis, the mean cost was \$25,325 (Table 2). Hospitalized men incurred higher costs than hospitalized women, and among the 6 groups formed by combining sex and diagnosis status, men with HF as a secondary diagnosis had the highest cost (\$27,277), whereas women with HF as a primary diagnosis had the lowest cost (\$16,058). The costs across age groups varied slightly regardless of diagnosis status.

The regression results indicated that sex significantly influenced costs, but age did not (Table 3). In the entire sample, hospitalized men incurred costs that were \$4317 ($P < .001$) higher than those of hospitalized women. Regional variations in the hospitalization costs were significant, with the highest cost in the West. Hospitalized patients with a LOS of 7 days or more incurred significantly higher costs than those with a LOS of less than 7 days. Hospitalized patients with a secondary diagnosis of HF incurred costs that were \$3944 ($P < .001$) higher than hospitalized patients with the primary diagnosis of HF.

Among patients with a secondary diagnosis of HF, 17% had a primary diagnosis of IHD; 14%, other diseases of the heart; 7%, other CVDs; 18%, respiratory diseases; and 44%, non-CVD and nonrespiratory conditions. Among these groups, hospitalized patients with IHD had the highest costs per hos-

pitalization (\$36,442). After controlling for other covariates and using hospitalizations with the primary diagnosis of non-CVD and nonrespiratory conditions as the reference, hospitalized patients with IHD incurred costs that were \$14,989 higher ($P < .001$); those with other diseases of the heart had costs that were \$9480 higher ($P < .001$) (Table 3).

For both the entire sample and hospitalizations with a secondary diagnosis of HF, age 40 to 54 years, urbanization of hospitals, and the Charlson Comorbidity Index were significant predictors of LOS status (≥ 7 days vs < 7 days) (Table 4). For example, patients aged 40 to 54 years were less likely to have a stay of 7 days or more than the reference population (those aged 55-64 years). Hospitalized male patients had a lower probability of having a LOS of 7 days or more than hospitalized female patients. For the entire sample only, having a secondary diagnosis of HF increased the probability of a longer stay. For the group of hospitalizations with a secondary diagnosis of HF, the primary diagnosis of other CVDs decreased the probability of having a longer LOS when compared with the primary diagnosis of non-CVD and nonrespiratory conditions. Hospitalized patients with the primary diagnosis of IHD, other diseases of the heart, or respiratory diseases might have a shorter LOS than the reference group.

DISCUSSION

Our cost analysis provided new information in that it was based on all possible ICD-9 diagnoses of HF as well as diagnosis status. The detailed information we obtained could be useful in developing or evaluating the cost-effectiveness of HF management programs as well as related policies, such as evaluating the impact on hospitalization costs of the classification of HF by the Agency for Healthcare Research and Quality

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Table 2. Mean Hospitalization Costs by Diagnosis Status for Heart Failure for Patients Aged 18 to 64 Years^a

Characteristic	Primary or Secondary Diagnosis		Primary Diagnosis		Secondary Diagnosis	
	No.	Mean ± SD Cost, \$	No.	Mean ± SD Cost, \$	No.	Mean ± SD Cost, \$ ^b
Total hospitalizations	23,216	23,077 ± 29,654	6806	17,654 ± 24,081	16,410	25,325 ± 31,406
Men	12,850	24,657 ± 30,986	3969	18,795 ± 25,339	8881	27,277 ± 32,866
Women	10,366	21,117 ± 27,790	2837	16,058 ± 22,109	7529	23,024 ± 29,427
Age, y						
18-39	1162	22,417 ± 32,435	323	16,986 ± 24,231	839	24,508 ± 34,873
40-54	7015	23,217 ± 29,992	2064	18,211 ± 25,312	4951	25,304 ± 31,508
55-64	15,039	23,062 ± 29,269	4419	17,443 ± 23,475	10,620	25,400 ± 31,069
Urban	17,567	23,543 ± 30,459	5094	17,895 ± 24,593	12,473	25,849 ± 32,270
Rural	5694	21,628 ± 26,949	1712	16,937 ± 22,484	3937	23,667 ± 28,436
Region						
Northeast	1278	25,716 ± 30,946	339	20,380 ± 28,355	939	27,642 ± 31,623
North Central	7569	20,214 ± 26,826	2192	15,332 ± 21,202	5377	22,204 ± 28,569
South	12,366	23,500 ± 29,614	3788	17,987 ± 23,985	8578	25,934 ± 31,479
West	2003	29,595 ± 37,011	487	23,614 ± 31,396	1516	31,517 ± 38,454
Length of hospital stay, d						
1-6	16,098	14,829 ± 18,193	5381	13,646 ± 18,375	10,717	15,423 ± 18,072
≥7	7118	41,730 ± 40,223	1425	32,791 ± 34,724	5693	43,967 ± 41,186
Primary diagnosis						
Ischemic heart disease					2861	36,442 ± 34,090
Other diseases of the heart					2300	28,889 ± 34,552
Other cardiovascular diseases					1090	22,857 ± 28,953
Respiratory diseases					2965	20,097 ± 27,512
Noncardiovascular disease and nonrespiratory conditions					7194	22,294 ± 29,881

SD indicates standard deviation.

^aData are from the 2005 MarketScan Commercial Claims and Encounters inpatient data set.

^b*P* < .001 for the cost comparisons between heart failure as the secondary diagnosis versus heart failure as the primary diagnosis for the total population and each of the subgroups.

as an ambulatory care-sensitive condition.³¹ This classification indicates that HF is a condition for which good outpatient care might prevent the need for hospitalization or for which early intervention might prevent the need for hospitalization or prevent complications or more severe diseases. Effective ambulatory care for HF will reduce hospitalization of patients with HF as the primary diagnosis, but will increase hospitalization of patients with HF as a secondary diagnosis. Moreover, improving survival of patients living with acute myocardial infarction (AMI) and the aging of the US population will increase the number of patients living with HF.³² Therefore, despite an overall decline in age-adjusted mortality from IHD in the United States, HF incidence and hospitalization rates have increased.^{1,33,34}

According to Dr J. Fang, MD, an epidemiologist at the Centers for Disease Control and Prevention, as mortality from AMI and other IHDs continues to decline and the population continues to age, it is expected that the incidence and prevalence of HF will continue to increase. Management of HF in order to reduce hospitalizations with HF as the primary diagnosis was one of the Healthy People 2010 objectives. It also will be an objective in Healthy People 2020 (E-mail communication, July 2010).

As we expected, we found that HF was more likely to be listed as a secondary diagnosis than as the primary diagnosis. We also found that the costs of hospitalizations were much higher with HF as a secondary diagnosis than as the primary diagnosis (the difference was \$7671). After controlling for co-

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Table 3. Estimates for Coefficients of Hospitalization Costs for Patients Aged 18 to 64 Years by Diagnosis Status for Heart Failure^a

Characteristic	Coefficient (P)		
	Primary or Secondary Diagnosis	Primary Diagnosis	Secondary Diagnosis
Age, y			
18-39	387.8 (.689)	-155.4 (.924)	2585.0 (.093)
40-54	961.7 (.038)	771.7 (.301)	1193.1 (.105)
55-64	Reference	Reference	Reference
Men	4316.7 (<.001)	2635.4 (<.001)	3314.4 (<.001)
Urban	534.3 (.275)	202.6 (.796)	969.7 (.214)
Region			
Northeast	-4965.1 (<.001)	-4097.9 (.037)	-6412.6 (<.001)
North Central	-8680.3 (<.001)	-8014.5 (<.001)	-8962.4 (<.001)
South	-5641.1 (<.001)	-5065.7 (<.001)	-5796.3 (<.001)
West	Reference	Reference	Reference
Length of hospital stay, d			
1-6	-26,277.0 (<.001)	-19,298.0 (<.001)	-28,825.0 (<.001)
≥7	Reference	Reference	Reference
Charlson Comorbidity Index	229.5 (.047)	-381.8 (.079)	587.1 (.001)
Secondary vs primary diagnosis of heart failure	3944.3 (<.001)		
Primary diagnosis			
Ischemic heart disease			14,989.0 (<.001)
Other diseases of the heart			9480.0 (<.001)
Other cardiovascular diseases			1719.5 (.209)
Respiratory diseases			-1867.5 (.043)
Noncardiovascular disease and nonrespiratory conditions			Reference

^aData are from the 2005 MarketScan Commercial Claims and Encounters inpatient data set.

variates, the difference still was substantial (\$3944). Further study is needed to investigate how much of the hospitalization costs were for the medical management of HF, so the economic burden of HF can be quantified correctly.

Earlier research found that hospitalization costs for HF management averaged \$7000 in the early 1990s in patients 65 years or older and increased to an average of \$18,086 in that group recently.^{6-8,17} However, it is unclear whether the HF in those studies was based on a primary or secondary diagnosis. If the most recent average was based on HF as the primary diagnosis, our results of \$17,654 in 2005 for patients aged 18 to 64 years with HF as the primary diagnosis are quite comparable with the costs for patients 65 years or older.

Among hospitalized adults with a secondary diagnosis of HF, we found that patients with IHD or with other diseases of the heart as the primary diagnosis incurred higher costs than those who had non-CVD and nonrespiratory conditions as the primary diagnosis. However, the hospitalized adults with IHD and other diseases of the heart were not more likely to have a LOS of 7 days or more than were those with non-CVD

and nonrespiratory conditions. That may be because patients with IHD have a greater chance of getting percutaneous transluminal coronary angioplasty and coronary artery bypass grafting, which are very expensive, whereas treatment for acute myocardial infarction with revascularization reduced the total hospital LOS.^{35,36} The literature has shown that among HF-related hospitalizations in the United States, the percentage for patients with IHD, other diseases of the heart, and other CVDs as the primary diagnosis declined, while the proportion with a primary diagnosis of non-CVD increased.¹ Because IHD causes reduced pump efficiency that may lead to HF, IHD is a major risk factor for HF. Primary prevention and appropriate management of IHD are critical steps in the reduction of HF admissions.¹¹

We found that hospitalizations of men were more costly than those of women; when this finding was combined with the fact that men had higher hospitalization rates for HF than women,¹ it suggests that improving HF management might be more cost-effective in men than in women. However, among hospitalizations of adults with HF as a secondary diagnosis, the

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Table 4. Estimates for Coefficients of Length of Stay Status (≥ 7 Days vs < 7 Days) for Patients Aged 18 to 64 Years by Diagnosis Status for Heart Failure^a

Characteristic	Coefficient (P)		
	Primary or Secondary Diagnosis	Primary Diagnosis	Secondary Diagnosis
Age, y			
18-39	-0.102 (.154)	-0.123 (.448)	-0.108 (.182)
40-54	-0.144 (<.001)	-0.075 (.288)	-0.160 (<.001)
55-64	Reference	Reference	Reference
Men	-0.098 (.002)	0.013 (.841)	-0.107 (.003)
Urban	0.199 (<.001)	0.190 (.012)	0.199 (<.001)
Region			
Northeast	0.259 (.001)	0.335 (.048)	0.247 (.006)
North Central	-0.034 (.565)	0.015 (.906)	-0.046 (.483)
South	0.0004 (.964)	-0.088 (.474)	0.028 (.651)
West	Reference	Reference	Reference
Charlson Comorbidity Index	0.229 (<.001)	0.302 (<.001)	0.209 (<.001)
Secondary vs primary diagnosis of heart failure	0.579 (<.001)		
Primary diagnosis			
Ischemic heart disease			-0.104 (.031)
Other diseases of the heart			-0.181 (.001)
Other cardiovascular diseases			-0.300 (<.001)
Respiratory diseases			-0.104 (.029)
Noncardiovascular disease and nonrespiratory conditions			Reference

^aData are from the 2005 MarketScan Commercial Claims and Encounters inpatient data set.

rates increased faster for women than for men.¹ How this fact affects costs needs further investigation. Notably, in the present study, even though men incurred higher costs, they were less likely than women to have a LOS of 7 days or more. That might suggest that men underwent more procedures and made greater use of intensive care than did women. The regional differences in the hospitalization costs might be due to a higher cost of living in the western part of the United States compared with other regions. For example, the differences in the average cost of hospital rooms between western and eastern states have increased steadily since 1980, with the highest cost for hospital rooms in California and the lowest in Mississippi.³⁷

Several limitations should be understood when interpreting and applying the results of this study. First, we analyzed hospitalization costs only, although HF is a chronic disorder. Thus, a successful disease management program also should include effective outpatient care. Accordingly, outpatient visits and medications would account for a significant proportion of the financial resources needed for comprehensive treatment; these resources also would need to be analyzed by

HF diagnosis status. In addition, the hospitalization costs were direct medical costs; indirect costs related to HF might be very high. Unfortunately, estimates for indirect costs due to productivity loss because of morbidity from HF are still unavailable in the literature for any age group. Because individuals aged 18 to 64 years constitute most of the working population, investigating HF-related indirect costs for this subgroup could yield data with important policy implications.

A second concern is that because the data were for hospitalizations of patients aged 18 to 64 years only, we were unable to analyze and compare the costs of the patients 65 years and older. Because in the United States, more than 80% of HF-related hospitalizations are among those aged 65 years and older,¹ the costs for this population also should be analyzed by detailed diagnosis status. A third concern is that we could not separate the costs for treating HF from the costs of treating the comorbidities or complications of HF. Correspondingly, we could not analyze the costs of treating HF versus the costs of treating listed comorbidities or complications because we had no information on causations that would indicate which of these comorbidities

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or complications would have been tied to HF. Finally, it is possible that HF was overly recorded because of a desire to increase insurance reimbursement, especially for HF as a secondary diagnosis.³⁸ If this was the case, the cost of hospitalizations with a secondary diagnosis of HF might be overestimated.

Despite the limitations listed above, our study has considerable strengths. Most important, to our knowledge it is the first investigation to focus on the costs of HF-related hospitalizations for patients aged 18 to 64 years. Most of these adults will probably require continued medical management of this problem. Thus, strategies for managing HF among younger and middle-aged adults should be aimed at establishing control of this disorder and preventing complications later on. A second important strength is that this study also was the first to provide a detailed analysis of HF-related hospitalization costs by diagnosis status, including all possible ICD-9 codes for HF. This information should be useful in better understanding the health and economic burden of HF. Because previous studies did not present a complete list of ICD-9 codes or diagnosis status in their cost analyses, it was unclear whether some cases of HF were missing, especially cases in which HF was listed as a secondary diagnosis. A third strength is that we analyzed the costs for hospitalizations with HF listed as a secondary diagnosis and identified the primary diagnosis groups. This new information could be used to develop or evaluate HF management programs.

CONCLUSION

In the United States, the costs of hospitalizations related to HF are high, especially when HF is a secondary diagnosis. When this disease is a secondary diagnosis and the primary diagnosis is either IHD or other diseases of the heart, the costs can be expected to be particularly high. When the primary diagnosis is non-CVD or nonrespiratory conditions, the LOS could be expected to be longer than the LOS with other primary diagnoses.

Because HF is highly prevalent among people 65 years or older and because the prevalence in this age group will rise markedly in the future due to growth of that population and advanced treatments of CVD, the economic burdens of HF will increase as well.^{1,26,27,39} To contain the future health and economic burdens of HF in an aging society, interventions for managing HF among patients aged 18 to 64 years are important and might be cost-effective strategies.

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