Reviews

A Reevaluation of the Costs of Heart Failure and Its Implications for Allocation of Health Resources in the United States

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ABSTRACT

The annual cost of heart failure (HF) is estimated at $39.2 billion. This has been acknowledged to underestimate the true costs for care. The objective of this analysis is to more accurately assess these costs. Publicly available data sources were used. Cost calculations incorporated relevant factors such as Medicare hospital cost-to-charge ratios, reimbursement from both government and private insurance, and out-of-pocket expenditures. A recently published Atherosclerosis Risk in Communities (ARIC) HF scheme was used to adjust the HF classification scheme. Costs were calculated with HF as the primary diagnosis (HF in isolation, or HFI) or HF as one of the diagnoses/part of a disease milieu (HF syndrome, or HFS). Total direct costs for HF were calculated at $60.2 billion (HFI) and $115.4 billion (HFS). Indirect costs were $10.6 billion for both. Costs attributable to HF may represent a much larger burden to US health care than what is commonly referenced. These revised and increased costs have implications for policy makers.

Introduction

Heart failure (HF) is prevalent in 5.7 million people in the United States.[1] Annual costs for treating HF recently have been estimated at between $37.2 and $39.2 billion (direct and indirect).[2,3] This finding is commonly quoted.[4,5] Recently, a revised estimate of $34.4 billion ($24.7 billion direct plus $9.7 billion indirect) for HF has been proposed.[6] These cost estimates underestimate the true costs for this condition.[7] Reasons for this include a lack of consensus by policy makers on diagnostic criteria,[8] including missing cost data when HF is the primary diagnosis (eg, physician costs for inpatient care).[7] There are also discrepancies in the annual pharmaceutical cost estimation for treating HF—likely due to an inability by researchers to parse out drug costs for treating HF vs comorbidities.[9,10] Recently a new classification scheme was developed for identifying episodes of acute decompensated heart failure, the main driver for inpatient admission for HF.[8] This methodology is used in the current analysis.

This analysis uses publicly available data, examines and updates a conservative cost estimate (HF in isolation, or HFI), and examines the disease in the context of comorbid illness (HF syndrome, or HFS). HF syndrome allows examination of patient encounters that have HF as one of the diagnoses reported. Deriving costs of HF in isolation may be appropriate for providing a lower boundary to the cost range of HF. Examining HF costs as part of a syndrome provides an upper boundary to this range.

Methods

Data Sources

The data sources were as follows:

- Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project Web site. For the analysis reported here, the Healthcare Cost and Utilization Project (HCUP)[11] Nationwide Inpatient Sample and State Inpatient Databases were used. For 2009, these states comprised 96% of the US population (HCUPnet Tables 1 and 3, 2011). The State Inpatient Databases comprise 90% of all nonfederal, short-term, general, and other specialty hospitals. Thus, HCUPnet is considered a US population-based analysis.
- AHRQ Medical Expenditure Panel Survey (MEPS). The MEPS is a set of large-scale surveys of families and individuals, their medical providers (eg,

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doctors, hospitals, pharmacies), and employers across the United States.[12] The MEPS results included either congestive heart failure (CHF) alone or all expenditures for persons who reported CHF as a diagnosis (Clinical Classifications Software single-level diagnosis category 108) for 2009 (see Supporting Appendix 1 for diagnosis code definitions).
- National Association for Home Care & Hospice (NAHC), which provides home-care and hospice data to the public.
- National Ambulatory Medical Care Survey (NAMCS) and the National Hospital Ambulatory Medical Care Survey (NHAMCS).
- For prescription-drug costs, several sources were used, including randomized controlled trials on HF that evaluated the annual costs of cardiovascular drugs; longitudinal studies in large series of HF patients that captured cardiovascular drug costs; and specific research reports that evaluated the annual cost/dispensed HF prescriptions.[13]
- Centers for Medicare & Medicaid Services (CMS) Data Compendium[14] and BCC Research.[15]

When cost data on a particular service were unavailable, the clinical guidelines for that service were used as a proxy and were estimated using the present Current Procedural Terminology (CPT) code reimbursement levels from Medicare.

The costs obtained from each of these data sources were from the 2007 to 2012 timeframe and were inflated to 2012 using the medical Consumer Price Index (Supporting Appendix 2).

Direct Cost Calculation

Direct costs were calculated for the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) HF diagnosis codes (identified in Supporting Appendix 1). These diagnosis codes have been used by experts in assessing the incidence of HF (correspondence, June 23, 2012) Veronique Roger, MD, MPH, Medical Director, Center for the Science of Health Care Delivery, Mayo Clinic, Rochester, MN.

Heart failure costs were analyzed in 2 different ways. In the HFI approach, costs were calculated when HF was the principal diagnosis: HF was the condition established, after patient evaluation, to be chiefly responsible for the resultant hospital admission or for other hospital (emergency department [ED], outpatient) or nonhospital treatment. As recently proposed by Rosamond et al,[8] the acute-care costs for hospital inpatient procedures were adjusted using confirmed acute decompensated heart failure and chronic stable HF episodes—the chief reasons for patient admissions. This classification scheme was employed in this analysis.

The population of patients from which the Rosamond analysis was derived represented 4 diverse US communities.[16] These communities are part of the Atherosclerosis Risk in Communities (ARIC) study protocol and selected based on location, availability of census data, study population size, population stability, cooperativeness of the study population, and cooperativeness of the medical facilities and agencies. Risk-factor profiles of the HF patients were similar to those reported on in other population-based US studies.[2] Further, because HCUPnet is a population-based analysis, the assumption is that the risk factors of HF patients in ARIC are similar to those found in HCUPnet.

Adjustments based upon the Rosamond et al protocol were incorporated due to a lack of clear diagnostic consensus for HF in the classification schemes used (eg, Framingham, Modified Boston, National Health and Nutrition Examination Survey [NHANES], Gothenburg, and ICD-9-CM). These classification schemes make it difficult to assess the prevalence, incidence, and costs of HF.[8] A 2×2 table for computing validity measures using the Rosamond approach was then calculated using the sensitivity, positive predictive value, and specificity of the ICD-9-CM classification codes for HF, reflecting this approach. As shown in Supporting Appendix 1, the Rosamond approach was applied to both primary discharge ICD-9-CM codes (for calculation of HFI costs) and any listed ICD-9-CM code (for HFS costs).

The Rosamond approach served to adjust HFI and HFS hospital discharge costs either up or down based on its clinical methods of determining whether patients presented with acute decompensated heart failure or chronic stable HF.

Using the Rosamond approach in the HFI scenario, a 2009 HCUPnet query was first run on the number of patients with a primary discharge diagnosis of HF (as defined in Supporting Appendix 1). Next, a HCUPnet query was run on the total number of all possible HF that might be defined as HF (ie, where HF was one of the diagnoses). Using these 2 queries and the sensitivity, specificity, and positive predictive values for HF as the primary diagnosis, a grand total of cases for the HF population was calculated (see results below for 2×2 tables). In the HFS approach, costs were included when HF was identified as any listed diagnosis per the 2009 HCUPnet query. A grand total of cases were then calculated in a similar manner.

In the HFS approach, results were further adjusted to exclude costs unrelated to HF (eg, thyroid diseases, cancer, and osteoarthritis). These unrelated comorbidities represented 10% of admissions and were excluded.

Costs were estimated based upon the following factors: Medicare hospital cost-to-charge ratio, reimbursement received for a procedure from Medicare, and Medicaid (estimate) and private insurance or the direct expenditures (including out-of-pocket costs) as tracked by MEPS. Direct costs were costs for care of a patient who had a diagnosis of HF, regardless of the care setting.

Costs were calculated for the following care settings for both the HFI and HFS approaches: (1) inpatient costs; (2) inpatient professional fees; (3) drug/prescription costs; (4) physician office visits; (5) emergency department (ED) and hospital outpatient visits; (6) nursing home, skilled nursing facility, home care; hospice care; (7) other equipment/supplies; (8) out-of-pocket expenditures.

Estimation of inpatient professional fees (the clinician professional services) for the HFI and HFS approaches were calculated as follows: The CPT codes were derived from a recent white paper outlining the HF protocol for the minimal appropriate professional services for a patient,[17]

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which included observation (CPT 99223 and 99233), discharge (CPT 99239), transthoracic echocardiography (CPT 93306), continuous pulse oximetry (CPT 94762), and electrocardiography (CPT 93000). The payment-by-CPT codes were derived from the 2012 CPT code payment rates for Medicare. The average length of stay (LOS), which was derived from diagnosis-related groups 291–293 (HF with shock) and weighted based upon procedures per diagnosis-related group, was 4.77 days for 2009. The number of discharges for the HFI and HFS approaches is shown in the tables and relies upon the ICD-9-CM diagnosis codes found in online Supporting Appendix 1.

In both HFI and HFS approaches, prescription-drug costs were estimated by multiplying the HF prevalence in the general population with yearly drug costs. As mentioned above, because these costs vary widely in the literature, a number of reports/studies on annual medication costs were reviewed to determine how these costs should best be calculated. Studies that evaluated costs for HF-related cardiovascular medications (ie, those directly attributable to the HF condition) were evaluated[18–22] to determine consistency of finding. A range of costs was then used.

Nursing-home and skilled nursing facility (SNF) costs, for both HFI and HFS, were estimated by multiplying the census for patients with HF[14,23,24] by the median LOS for SNF.[14,23,24] This result was then multiplied by the average Medicaid payment rate ($190/day).[24] The Medicaid rate was used based on the assumption that most HF patients in nursing homes and SNFs were age >65 years and likely had exhausted their savings. Accordingly, they would qualify for Medicaid.

The HFI costs for home care were derived using CMS Data Compendium information.[25–27] HFS home-care costs were derived by multiplying total home visits by the percent of those home-visit patients with HF. This result was then multiplied by the total number of home visits per HF patient as well as the Medicare per-visit reimbursement rate.

Out-of-pocket costs and coinsurance payments were estimated based on the number of Medicare inpatient discharges, using either the HFI or HFS approach, and this was multiplied by the inpatient deductible for part A Medicare (at ~$1000 in 2009). Part B Medicare services were calculated at 20% of physician inpatient charges (using a 3× mark-up of physician-reimbursement-to-estimate charges).

Indirect costs were estimated using the yearly lost future earnings of a person who would die from HF in 2010 discounted at 3%, net present value.[3] This analysis of yearly lost future earnings was based on the US population for 2010, the life expectancy per age of patient,[28] mortality rates from HF by age group,[29] and mean per-person income expected, as a function of age, for the year 2010 (mean income).

Results

The costs were distributed across 8 direct cost categories.

Cost Type 1: Inpatient Costs

HFI Approach: Table 1 identifies the ICD-9-CM primary diagnoses, the number of hospital discharges, cost per discharge, and total cost for treating each of these diagnoses, for cases where CHF was listed as the principal diagnosis only. Table 2 shows the 2 × 2 table for computing the validity measures.

HFS Approach: Table 3 provides results for ICD-9-CM diagnoses where HF was any listed ICD-9-CM HF code (See Supporting Appendix 1). Table 4 shows the 2 × 2 table for computing the validity measures.

Estimated costs of Tables 1 and 3 are per discharge. All costs were adjusted to reflect HF admissions and HFS costs were adjusted for unrelated comorbidities, as described earlier. Further, a weighted average cost was used (as shown in Tables 1 and 3) in determining the total costs for all inpatient discharges. The tables show that the aggregate costs for treating HFI and HFS patients were $32.05 billion and $65.2 billion, respectively.

Cost Type 2: Clinician Inpatient Costs (Hospitalist Services Only)

HFI Approach: Table 1 shows the number of discharges at 1.1 million. This was adjusted upward using Rosamond's approach to 3 million. Average length of stay (ALOS) of 4.77 days per HF stay resulted in professional services of $2.54 billion (see Supporting Table 1).

HFS Approach: The number of discharges with HFS was 5.27 million (after adjustments using Rosamond). Using the same ALOS of 4.77 days per HF stay resulted in professional services costs of $4.46 billion (see Supporting Table 2 for the calculation).

Cost Type 3: Drug/Prescription Costs

Cost estimates drawn from the literature and other databases were used to calculate the pharmaceutical costs for treating HF (both for HFI and HFS). This estimate included a large sample of patients, a range of payers, and a representative range of New York Heart Association HF (I–IV).[30,31] The prescription costs for treating HF using these estimates resulted in a range of $750 to $1626/person/year.[22,32]

HFI and HFS Approach: When the average medication costs listed above are multiplied by the 5.7 million prevalence of HF, the yearly cost range for HF medications totals $6.13 billion to $9.43 billion.

Cost Type 4: Physician Office Visits

HFI and HFS Approach: There were 1.037 billion office visits, according to 2009 NAMCS data. Of these office visits, 23.7% were for 1 chronic condition, and HF was present in 2.1% of these, leading to 5.16 million visits for HF. Because the Medicare rate for a clinical assessment of a patient presenting with HF in the physician office setting (2009 Writing Group) is $505 (see Supporting Table 3), the yearly cost is $2.61 billion (5.16 million visits × $505/visit).

Cost Type 5.1: Emergency Department (Patient Not Admitted to Hospital)

HFI Approach: The total 2009 costs for ED visits for persons diagnosed with HF were $0.5 billion (MEPS, $1272 per event × 398 272 visits).[33]

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Table 1. HFI Diagnostic Codes

Code	Definition	No. of Discharges	Per-Case Cost, $	% of All Discharges	Weighted Cost per Case Contribution, $
398.91	Rheumatic HF	14 112	13 592	1.27	171.96
402.01	Malignant hypertensive disease with HF	3329	8456	0.30	25.24
402.11	Benign hypertensive disease with HF	515	9878	0.05	4.56
402.91	Unspecified hypertensive disease with HF	30 329	8785	2.72	238.87
404.01	HHCKD with HF	3848	10 789	0.34	37.22
404.03	HHCKD, malignant, with HF and with CKD stage 5 or ESRD	0	0	0.00	0.00
404.11	HHCKD, benign, with HF and with CKD stage 1–4, or unspecified	378	9916	0.03	3.36
404.13	HHCKD, benign, with HF and CKD stage 5 or ESRD	0	0	0.00	0.00
404.91	HHCKD, unspecified, with HF and with CKD stage 1–4, or unspecified	28 484	12 026	2.55	307.10
404.93	HHCKD, unspecified, with HF and CKD stage 5 or ESRD	0	0	0.00	0.00
416.9	Chronic pulmonary heart disease, unspecified	1777	9761	0.16	15.55
425.4	Other primary cardiomyopathies	19 139	25 573	1.72	438.79
428	CHF, unspecified: congestive heart disease, right-heart failure (secondary to left-heart failure). Excludes fluid overload NOS (276.6).	448 211	9910	40.18	3982.13
428.1	Left-heart failure: acute edema of lung with heart disease NOS or HF, acute pulmonary edema with heart disease NOS or HF, cardiac asthma, LV failure	2383	10 397	0.21	22.21
428.2	Systolic HF (unspecified)	18 333	11 565	1.64	190.08
428.21	Systolic HF (acute)	63 308	10 434	5.68	592.20
428.22	Systolic HF (chronic)	18 797	18 386	1.69	309.84
428.23	Systolic HF (acute on chronic)	183 452	11 185	16.45	1839.57
428.3	Diastolic HF (unspecified)	33 556	9342	3.01	281.04
428.31	Diastolic HF (acute)	47 310	9152	4.24	388.18
428.32	Diastolic HF (chronic)	9219	9181	0.83	75.88
428.33	Diastolic HF (acute on chronic)	113 428	9459	10.17	961.89
428.4	Combined systolic and diastolic HF (unspecified)	4492	11 214	0.40	45.16
428.41	Combined systolic and diastolic HF (acute)	11 471	11 635	1.03	119.65
428.42	Combined systolic and diastolic HF (chronic)	3342	14 794	0.30	44.33
428.43	Combined systolic and diastolic HF (acute on chronic)	51 020	11 562	4.57	528.85
428.9	HF, unspecified: cardiac failure NOS, HF NOS, myocardial failure NOS, weak heart	737	10 889	0.07	7.19
518.4	Acute edema of lung, unspecified	4457	8502	0.40	33.97
786	Dyspnea and respiratory abnormalities	0	0	0.00	0.00
Total		1 115 426		1.00	10 665
Adjustment of primary HF (Rosamond methodology)		3 005 453			32 052 625 243

Abbreviations: CHF, congestive heart failure; CKD, chronic kidney disease; ESRD, end-stage renal disease; HF, heart failure; HFI, heart failure in isolation; HHCKD, hypertensive heart and chronic kidney disease; LV, left ventricular; NOS, not otherwise specified.

Table 2. HFI analysis

	Positive, Definite Probable	Suspected, Not Present	Sum	PPV	NPV
A: HF (primary diagnosis)	1 081 963 (TP)	33 463 (FP)	1 115 426	0.97	
B: HF (secondary diagnosis)	1 923 490 (FN)	2 384 633 (TN)	4 308 123		0.55
Sum (A + B)	3 005 453	2 418 096			
Sensitivity	0.36 (TP/sum)				
Specificity		0.99 (TN/sum)			

Abbreviations: ADHF, acute decompensated heart failure; ARIC, Atherosclerosis Risk in Communities study; FN, false negative; FP, false positive; HCUP, Healthcare Cost and Utilization Project; HF, heart failure; NPV, negative predictive value; PPV, positive predictive value; TN, true negative; TP, true positive.

HF includes ADHF and stable chronic HF as primary diagnosis (using ARIC classification criteria). Positive, definite probable are all positives cases that should be positive. Suspected, not present are all negative cases that should be negative. Reported sum values are from 2009 HCUPnet data queries using the following diagnosis codes: 398.91, 402.01, 402.11, 402.91, 404.01–404.93, 416.9, 425.4, 428.0–428.9, 518.4, and 786. HF diagnoses includes comparability ratio of 0.371.

HFS Approach: During this same period, the total cost for ED visits was $2.9 billion ($708 per event × 4.093 million visits).[33,34]

Cost Type 5.2: Hospital Outpatient Visits (Patient Not Admitted to Hospital)

HFI Approach: The total costs for hospital outpatient visits in treating HF were $0.6 billion ($1209 × 0.515 million visits).[33,34]

HFS Approach: The total 2009 costs for hospital outpatient visits for persons with HF were $2.3 billion ($1209 × 1.93 million visits).[33,34]

Cost Type 6.1: Nursing Home/Skilled Nursing Facility

HFI and HFS Approach: According to statistics from the Centers for Disease Control and Prevention 2009 National Nursing Home Survey, the US census for HF patients was 70 000 patients.[35] The median LOS for HF patients was 1 year.[23] Because the 70 000 patients were counted at a Medicaid rate of $190/day,[24] the estimated portion of nursing-home care cost for HF was $4.86 billion (70 000 × 365 days/year × $190/day).

Cost Type 6.2: Home Care

HFI and HFS Approach: In 2009, there were 3.3 million home-care Medicare-eligible patients,[14] with 14.3% of these patients diagnosed with HF (or 469 000 Medicare-eligible HF patients).[25] Further, 2009 data state that each HF patient had an average of 23 visits,[26] with the average Medicare reimbursement payment per visit at $146.[23] Accordingly, the total 2009 expenditures for these visits were $1.6 billion ($1.7 billion, calculated as 3.3 million × 0.143 × 23 × $146, and inflated to 2012.

Cost Type 6.3: Hospice Care

HFI and HFS Approach: For the year 2007, the number of patients admitted for hospice care with a primary diagnosis of HF was 66 400,[25] with an average associated Medicare payment outlay of $10 385.[27] This yielded a total hospice-care cost of $0.69 billion (66 400 × $10 385). Because Medicare makes up 83.6% of all patients, the total estimated cost for all HF patients in hospice care in 2007 was $0.825 billion ($0.69 billion/0.836).

Cost Type 7: Other Equipment/Supplies

HFI Approach: In 2009, the total costs for other equipment/supplies were not reported in MEPS and thus could not be estimated.

HFS Approach: The total cost for other equipment/supplies for persons who reported HF, in 2009, was $4.6 billion.[36]

Cost Type 8: Out-of-Pocket/Coinsurance Payments

HFI Approach: In 2009, Medicare beneficiaries with CHF were responsible for a copay of approximately $1000 for an inpatient admission (deductible for Medicare Part A). Further, patients were also responsible for a 20% copay on part B services (inpatient clinician services). There were 1.1 million Medicare patients discharged from the hospital with the diagnoses listed in Table 1 who had HF identified as the primary diagnosis. The total costs for deductibles were $3.0 billion (3 million discharges × $1000/discharge in 2009 dollars). Further, because there is a 20% copay for physician services and reimbursement is approximately one-third of what the actual charges are for physician services (2011 Medicare cost-to-charge ratio for urban hospitals),[37] the out-of-pocket/copay expenses for inpatient physician services totaled $1.52 billion (2012 dollars). This can be calculated as using the HFI dollar amount from Cost Type 2 above for inpatient professional services ($2.54 billion) × 300% markup of reimbursement to account for charges × 20%. Accordingly, out of pocket/copay expenses were calculated as deductibles of $3.0 billion and copays of $1.52 billion.

HFS Approach: In 2009 there were 5.27 million Medicare patients discharged with the diagnoses listed in Table 3 and having HF as one of the diagnoses. At $1000 in out-of-pocket expenditures, the total cost for deductibles was $5.27 billion (2009 dollars). The out-of-pocket/coinsurance payments for inpatient physician services totaled $4.46 billion (2012 dollars, as calculated above). This results in out-of-pocket/copay expenses with deductibles of $5.27 billion and copays of $4.46 billion.

Total Direct and Indirect Costs

Direct Costs: Table 5 and Supporting Table 6 provide a rollup of the total direct costs for the main service categories in HFI and HFS, respectively, inflated to 2012 amounts in

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Table 3. HFS Inpatient Costs

Diagnostic Code	Definition	No. of Discharges	Per-Case Cost, $	% of All Discharges	Weighted Cost per Case Contribution, $
398.91	Rheumatic HF	45 369	13 592	0.63	85.30
402.01	Malignant hypertensive disease with HF	5851	8456	0.08	6.84
402.11	Benign hypertensive disease with HF	2022	9878	0.03	2.76
402.91	Unspecified hypertensive disease with HF	101 806	8785	1.41	123.71
404.01	HHCKD with HF	6526	10 789	0.09	9.74
404.11	HHCKD, benign	1486	9.92	0.02	0.00
404.91	HHCKD unspecified with HF	83 178	12 026	1.15	138.36
416.9	Chronic pulmonary heart disease, unspecified	88 486	12 026	1.22	147.19
425.4	Other primary cardiomyopathies	936 432	25 573	12.95	3312.48
428	CHF, unspecified: congestive heart disease; right-heart failure (secondary to left-heart failure). Excludes fluid overload NOS (276.6).	4 022 433	9910	55.64	5513.88
428.1	Left-heart failure: acute edema of lung with heart disease NOS or HF; acute pulmonary edema with heart disease NOS or HF; cardiac asthma; LV failure	12 034	10 397	0.17	17.31
428.2	Systolic HF (unspecified)	108 431	11 565	1.50	173.46
428.21	Systolic HF (acute)	152 378	10 434	2.11	219.92
428.22	Systolic HF (chronic)	238 450	18 386	3.30	606.43
428.23	Systolic HF (acute on chronic)	336 645	11 185	4.66	520.84
428.3	Diastolic HF (unspecified)	244 754	9342	3.39	316.27
428.31	Diastolic HF (acute)	123 165	9152	1.70	155.92
428.32	Diastolic HF (chronic)	233 551	9181	3.23	296.60
428.33	Diastolic HF (acute on chronic)	239 731	9459	3.32	313.66
428.4	Combined systolic and diastolic HF (unspecified)	23 288	11 214	0.32	36.12
428.41	Combined systolic and diastolic HF (acute)	28 658	11 635	0.40	46.12
428.42	Combined systolic and diastolic HF (chronic)	47 033	14 794	0.65	96.25
428.43	Combined systolic and diastolic HF (acute on chronic)	103 161	11 562	1.43	164.98
428.9	HF, unspecified: cardiac failure NOS, HF NOS, myocardial failure NOS, weak heart	13 963	10 889	0.19	21.03
518.4	Acute edema of lung, unspecified	30 132	8502	0.42	35.44
786	Dyspnea and respiratory abnormalities	483	4106	0.01	0.27
Total		7 229 446		1.00	12 360.90
Adjustment	Less 10% patients for unrelated conditions	6 506 501			
Adjustment for any listed HF using Rosamond methodology		5 273 690			65 187 553 306

Abbreviations: CHF, congestive heart failure; HF, heart failure; HFS, heart failure syndrome; HHCKD, hypertensive heart and chronic kidney disease; LV, left ventricular; NOS, not otherwise specified.

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Table 4. HFS analysis

	Positive, Definite Probable	Suspected, Not Present	Sum	PPV	NPV
A: HF, primary diagnosis	5 010 006 (TP)	1 496 495 (FP)	6 506 501	0.77	
B: HF, secondary diagnosis	263 685 (FN)	447 005 (TN)	710 690		0.63
Sum (A + B)	5 273 690	1 943 500			
Sensitivity	0.95 (TP/sum)				
Specificity		0.23 (TN/sum)			

Abbreviations: ADHF, acute decompensated heart failure; ARIC, Atherosclerosis Risk in Communities study; FN, false negative; FP, false positive; HCUP, Healthcare Cost and Utilization Project; HF, heart failure; NPV, negative predictive value; PPV, positive predictive value; TN, true negative; TP, true positive.

HF includes ADHF and stable chronic HF as primary diagnosis (using ARIC classification criteria). Positive, definite probable are all positives cases that should be positive. Suspected, not present are all negative cases that should be negative. Other discharge codes are calculations based on sensitivities, PPV, and specificities as listed in Rosamond article. HF diagnosis includes comparability ratio of 1.2338.

the tables. These direct costs roll up to $60.2 billion (HFI) and $115.4 billion (HFS).

Indirect Costs: Using the same methodology employed in Table 20–1 of the American Heart Association Heart Disease and Stroke Statistics—2010 Update[2] for lost productivity (defined as the lost future earnings of person who will die from HF) results in an additional $10.6 billion cost (data not shown; 2012 dollars; future earnings discounted at 3%) for the HFI and HFS analyses. This amount of $10.6 billion is used for both HFI and HFS because it reflects lost income due to HF-related lost years of life, which is the same for both HFI and HFS.

Thus, the total direct plus indirect costs for treating HF are $70.8 billion (HFI) and $127 billion (HFS).

Discussion

Our analysis shows a range of direct costs from $60.2 billion to $115.4 billion, when HF was considered either in isolation or as part of a syndrome. This resulted in a range of costs from $70.8 billion (HFI) to $127 billion (HFS) (direct plus indirect). In the often-cited study by Lloyd-Jones et al,[2] the authors explicitly note that their estimate of $39.2 billion "is likely greatly understated because it is based on data for HF as the primary diagnosis or underlying cause of death." This proviso is widely cited. It is suggested in this analysis that the direct costs for treating HF should be understood to exist within a range.

It is difficult for clinicians to identify many comorbid conditions as separate from HF because many conditions manifest similar symptoms. Likewise, when surveying for the MEPS, patients likely have difficulty disentangling the costs of comorbidities. Accordingly, many HF patients may not have HF listed as the primary diagnosis when treated. As a result, it is likely that HF costs estimates reported in the literature, such as those using the analysis of Heidenreich et al,[6] may also underestimate direct costs for HF care.

Although cost estimates limited to "data for HF as the primary diagnosis or underlying cause of death" are likely to be "understated," costs identified as HFS as one of the diagnoses likely overestimate costs. Accordingly, we have adjusted for both using a reasonable and validated approach that adjusts according to empirically measured prevalence.[8] Taken together, it is likely for many cases, the true direct costs for treating HF fall within the proposed $60.2 billion to $115.4 billion range. The higher-end estimate of $115.4 billion is consistent with recent findings.[38]

On a HFS per-patient basis, we have calculated the yearly direct costs to be $20 245 ($115.4 billion/5.7 million). This amount is in line with recent analyses on the annual costs for treating HF as a primary diagnosis. For example, Dunlay et al[39] reported the average annual cost of HF (with HF as one of the diagnoses) at $20 618 (2008 dollars). Additional studies report annual HF costs for more severe cases approaching, and even exceeding, $40 000 per person, when including comorbid conditions such as coronary artery disease and chronic obstructive pulmonary disease.[21]

This study is different from prior studies in several important respects. First, there is significantly more detail of cost reconstruction. For example, some studies have noted very specific direct costs for hospital care,[3] rather than having fully delineated all hospital costs, as in the current analysis. Additionally, this approach examined care settings, such as hospice care, that have not been examined previously,[3] and accounted for all direct costs to the system, including those borne by the patients for their condition.

Also, this study examines HF as both the primary diagnosis and as one of multiple diagnoses. These 2 results were then used to provide a lower and upper boundary for HF care costs, which provides a context for moving along this range. The lower boundary is likely to reflect patients with no comorbid conditions (less severe or early-stage HF). The upper boundary is likely reflective of HF when there are significant comorbidities and may be more reflective of later-stage HF. The cost analysis presented here can serve to provide a more up-to-date, comprehensive, and appropriate estimate of HF costs for the US health care system.

If both direct and indirect costs for HF are included, the estimate of 2012 HFI total costs is $70.8 billion (direct costs of $60.2 billion and indirect costs of $10.6 billion), or $12 420 per person, annually. For HFS, these annual costs add up to $127 billion (direct, $115.4 billion; indirect, $10.6 billion), or $22 280 per person.

Congestive heart failure has been estimated to account for approximately 1% to 2% of the annual total costs to a health care system.[40,41] The current analysis suggests that HF may account for annual costs closer to 3.2% ($70.8 billion/$2.2 trillion) to 5.8% ($127 billion/$2.2 trillion).

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Table 5. Total Costs by Major Category (HFI Approach)

Category	Cost/Year, $, Billions	Costs Inflated to 2012, $, Billions	% of Total Cost
Inpatient, hospital	32.05/2009	37.03	62
Inpatient, clinician services	2.54/2012	2.54	4.2
Drug/prescription costs	4.0–9.4/2009	4.25–10.2	7.0
Physician office visits	2.61/2012	2.61	4.3
Ambulatory, ED	0.5/2009	0.56	1.0
Ambulatory, hospital outpatient	0.6/2009	0.67	1.0
Nursing home/SNF	4.86/2009	5.2	8.6
Home care	1.7/2012	1.7	2.8
Hospice care	0.825/2007	0.94	1.6
DME	NA	NA	NA
Out-of-pocket costs/coinsurance	3.0/2009 + 1.5/2012	4.7	7.8
Total	NA	60.2–66.15	100

Abbreviations: DME, durable medical equipment; ED, emergency department; HFI, heart failure in isolation; NA, not applicable; SNF, skilled nursing facility.

Based on these findings, it is important that policy makers and providers identify ways in which to provide cost-effective care. As an example, remote monitoring in its current configurations, which is believed to be cost effective, may not be.[42] Recently, the use of home telemonitoring (transmission of physiologic parameters and symptoms from patients at home to their health care provider) of signs and symptoms for the management of HF did not meet the California Technology Assessment Forum's criteria for safety, effectiveness, and improvement in health outcomes.[43]

Remote care likely needs to be reconfigured. Medicare demonstration projects have found that face-to-face interaction between patients and caregivers had a positive effect in lowering expenditures over time.[44] Further use of face-to-face with "automated hovering" may provide for a more cost-efficient means of "contact."[45]

Presymptom identification may also be an avenue for cost savings. Implantable products such as CardioMEMS (Atlanta, GA) can alert caregivers to early symptoms of HF (eg, fluid buildup in the lungs) that often lead to hospital admission. CardioMEMS in particular has demonstrated a 30% reduction in the endpoint of HF hospitalization for patients with advanced HF symptoms.[46]

Another issue regarding cost-effective care relates to hospital readmissions for HF patients based on care setting. An important initiative for Medicare is to reduce HF readmissions from SNFs. Patients discharged to SNFs represent a significant portion of HF hospitalizations each year; approximately 1 out of every 5 Medicare patients,[47] or 400 000 (2 000 000 × 0.20) Medicare patients (using the Rosamond methodology above) are discharged to a SNF with a primary diagnosis of HF.[48] Unfortunately, 25% of these patients are readmitted within 30 days of the initial hospitalization,[49] and this readmission rate is significantly higher than patients discharged to other care settings, such as the home.[47] Based on the above analysis, this represents >100 000 (400 000 × 0.25) readmissions from SNFs per year, with a significant number of these deemed avoidable.[50] Skilled-nursing facility patients are a unique population of patients with poor physical and cognitive health. Processes of care for these patients are different and may require different quality-of-care measures than are currently being used.[48] Hospital readmissions may also be influenced by nursing workforce issues in SNFs, such as higher turnover/burnout (creating a lack of continuity of care).[51] This also needs to be investigated. More recently it has been suggested that better care coordination upon discharge can reduce readmissions.[52] These care-coordination efforts include partnering with community physicians, hospitals, and SNFs; having processes in place to send all discharge information directly to the patient's caregiver; and having nurses responsible for medication reconciliation.[52] It has also been noted that <30% of hospitals have implemented these care-coordination steps.[52]

Last, it might be assumed that the admission and cost data used would be skewed (higher) based on the US economy during this time (ie, the deep recession of December 2007 to June 2009) and its effect on medical expenditures such as HF (with a resultant increase in hospitalization rates for HF). Medication nonadherence has been noted as the most common predicating factor for HF hospitalizations,[53] and not having enough money has been associated with medication nonadherence. In a separate analysis of HCUPnet data for the years 2006 to 2011 (data on file) using the 428.0–429.8 ICD-9-CM codes (which made up >95% of all hospital discharges) as the primary diagnosis at discharge, aggregate costs for discharge for all payers (Medicare [with Medicare constituting 70% to 73.5% of all costs in any one year], Medicaid, private insurance, uninsured) for the 2008 to 2011 timeframe remained fairly

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stable, varying −0.5% to 2.8% from year to year. In another analysis of HCUPnet data for the years 2006 to 2011 (data on file) using the 428.0–429.8 ICD-9-CM codes (which made up >95% of all hospital discharges) as any one of the diagnoses at discharge, discharges for all payers (Medicare [with Medicare constituting 76% to 78% of all discharge in any one year], Medicaid, private insurance, uninsured) increased year-over-year for the 2007 to 2009 time period (defined as the deep recession) by 15% (2007 to 2008) and 11% (2008 to 2009). This is in contrast to the year-over-year increase in discharges prior to 2008 and after 2009, which were essentially flat. Thus, there may have been an economic effect on medical expenditures, with these types of patients being less medication adherent, resulting in an increase in HF hospitalizations for comorbid patients. Additionally and as part of the 30-day readmission issue, the second most common comorbid condition associated with HF comorbid admissions has been identified as renal failure (data on file). Renal failure has been noted to be a significant predictor of readmission within 30 days of initial HF discharge.[54] Thus, the interplay of the 2007 to 2009 deep recession (causing medication nonadherence) and renal failure may have created a milieu for excessive readmissions. As noted, this analysis used 2009 discharge data and assumed essentially flat growth in its projections for 2012 estimates—which is what the data and analysis reflect.

Limitations

A portion of patients will see different clinicians over time. Documentation of patient care is fragmented, and different diagnosis can be assigned for the same condition. Lack of coordinated/complete data on all costs in any one database likely result in this continued underestimation of the costs for HF and required the examination over different years. Many Medicare-eligible patients carry supplemental insurance, which may mitigate out-of-pocket/coinsurance payment calculation (cost type 8). Out-of-pocket expenses for non-Medicare patients were also excluded in this analysis. The assumption used was that Medicare patients were fully responsible for the Part A deductible and a 20% copay for Part B services. Using a Medicare hospital cost-to-charge ratio is not an ideal method to calculate hospital costs for HF conditions in hospital-specific departments; however, it has been a widely used method for estimating costs when no other method exists. Using Medicare-only reimbursement rates for hospitalist services and for physician office payments may slightly underestimate the overall costs. Commercial capitated rates, per-diem fees, and other forms of fixed payment per patient were not taken into account and may account for a portion (although we believe a relatively small portion) of the costs. Using "standard of care" services and associated Medicare reimbursement for a patient workup in the hospital and in the physician office is not an ideal method. However, as no data appeared to exist on these specific services, we believe it was a reasonable method for estimating these costs. The data used in this analysis account for only cardiovascular-related HF; this may result in an underestimation of costs.

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