



Health care service usage and costs for high-needs elderly patients with heart failure

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Heart failure (HF) has been defined as global disease of pandemic proportions, since it affects around 26 million people worldwide.^[1] According to a recent study, age is the most important factor influencing the prevalence of HF, as it is for most other chronic conditions.^[2] This means that, with the predicted aging of the population (the proportion of the world’s population aged 60 years and over will nearly double from 2015 to 2050),^[3] there will be a growth in the total burden of HF, and a rise in the number of comorbidities in HF patients. According to a recent study, almost 86% of adults with HF have two or more comorbid conditions.^[4] Comorbidity, defined as the co-existence of one or more additional conditions in individuals with a specified index medical condition,^[5] adds to the complexity of treating elderly patients with HF.

The economic burden of HF is also considerable across the globe. In 2012, HF was responsible for an estimated health care expenditure of around 108 \$ billion a year.^[6] Projections are even more alarming, however, with total costs expected to increase by 195% between 2015 and 2030 in the USA.^[7] In Italy, HF absorbed 2.05% of government health care expenditure in 2012, which amounted to 3.924 million \$, making Italy the 7th country for total health care expenditure in the high-income world.^[6]

That said, few studies have analyzed the costs of health care services for managing comorbidity in patients with HF. The aim of our study was therefore to investigate the impact of comorbidities on health care service usage and costs for an elderly HF cohort with high health care needs (HHCN), based on real-world data.

The Italian National Health System is public and guaran-

tees access to treatment for all citizens, free of charge or against payment of a fee depending on their income. The system is administered by the Regional Authorities, with each region divided into several Local Health Units (LHUs). The data extrapolated for this study refer to the LHU “ex-ULSS4-Veneto”, which covered a catchment area with a population of about 190,000.

The ACG System is a population risk stratification method that is used internationally to characterize multimorbidity on the strength of routinely-collected administrative data pooled using record linkage.^[8] This tool has been adopted in the Veneto Region since 2012.^[9] Based on health care resource usage, the ACG system automatically collapses different ACG categories into 6 Resource Utilization Bands (RUBs), from 0 (“nonuser”) to 5 (“very high morbidity”). For the purposes of the present study, only people over 65 years old in 2012 with a diagnosis of HF failure, residing in the area served by the ex-ULSS4-Veneto LHU, and characterized as having HHCN (corresponding to RUBS 4 “high morbidity”, and 5 “very high morbidity”) with at least one comorbidity were included. The diagnosis of HF and other chronic diseases was established using Expanded Diagnosis Clusters (EDC), which coincided with clinical diagnoses that the ACG system assigns to single patients by combining different information flows. To improve the sensitivity of the model, patients with chronic conditions were also identified by means of the information available from the drug prescription records, the (RX)-based morbidity marker groups (Rx-MGs), and the clinical criteria used to assign medication to morbidity groups. The Rx-MGs provide further ways to describe the particular morbidity profile of a given population, and form the basis of predictive models reliant on pharmaceutical consumption.

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The selection and definition of comorbidities to include is inevitably subjective to some degree, and depends largely on available data. This study focused on a subset of conditions including: cancer, ischemic heart disease, atrial fibrillation, cerebrovascular disease, Alzheimer's disease, depression, asthma/bronchitis, diabetes, COPD, osteoporosis, hypothyroidism, and chronic renal disease. Cases of cancer, Alzheimer's disease, atrial fibrillation, and cerebrovascular disease were only discernible from EDC codes.

Patients were then assigned to one of six comorbidity classes based on the number of their chronic conditions in addition to HF, which ranged from one to six or more. Costs were assessed from the perspective of the Veneto Region's NHS using the ACG system. Each patient was linked to all administrative data regarding their hospital admissions, day hospital visits, drug usage, outpatient visits and diagnostic procedures, and access to the emergency department (ED) in order to compute the direct costs incurred over one year.

For each health care service (e.g., access to emergency care; number of outpatient visits; number of hospital admissions) only the direct cost incurred by the regional public health service on the basis of the Veneto Region tariff was considered.

A descriptive analysis was also conducted, estimating the means, medians and standard deviations for continuous variables, and absolute and relative frequencies for categorical variables.

Differences in median values for continuous variables were tested with the Kruskal-Wallis test. Associations between comorbidity classes and categorical variables were tested with Pearson's chi-squared. Correlations between annual health care usage and cost variables, and comorbidity classes were tested with Spearman's test.

A Poisson model was used to study the associations between the health care usage outcomes and the number of comorbidities, adjusting for age and sex. The association between health care costs and number of comorbidities was investigated using a Tobit regression model for censored dependent variables, adjusting for age and sex.

The data analysis was performed on anonymized aggregate data with no chance of individuals being identifiable. The study complied with the Declaration of Helsinki and with resolution n. 9/2016 of the Italian Guarantor for the Protection of Personal Data, which also confirmed the allowability of processing personal data for medical, biomedical and epidemiological research, and that personal health status data can be used in aggregate form in scientific studies.

Permission to use unidentifiable individual data extracted from administrative databases was granted by the ex-ULSS4-

Veneto administration. To ensure confidentiality and anonymity, the Veneto Regional Authority removes all direct identifiers (e.g., health code numbers), replacing them with an identifier code number in all data sets that still enables the linkage of data drawn from different administrative databases.

As result of our analysis, there were 1690 elderly patients with HF and HHCN served by the ex-ULSS4-Veneto LHU in 2012. The sample's characteristics are shown in Table 1. The patients' average age was 81.3 years. More than 90% of them had hypertension, and almost 41% had atrial fibrillation or neoplastic diseases. The related average annual health care costs amounted to 8585 euros.

Table 2 shows the distribution of these patients' health care resource usage and costs by comorbidity class. The costs of drugs, emergency (A&E) services, and outpatient visits differed significantly between comorbidity classes.

Our analyses also indicated that measures of patients' usage of health care resources, in terms of A&E services, and outpatient visits, correlated significantly with comorbidity classes ($\rho = 0.05$ [$P = 0.05$] for A&E care; $\rho = 0.11$ [$P < 0.001$] for outpatient visits) (data not shown). A

Table 1. Characteristics of the study sample.

Sex	Female	882 (52.19%)
	Male	808 (47.81%)
Age		81.3 ± 7.58
RUB	4	1365 (80.77%)
	5	325 (19.23%)
Hypertension		1545 (91.42%)
Chronic Renal Failure		212 (12.54%)
Diabetes		579 (34.26%)
Alzheimer's		292 (17.28%)
Depression		458 (27.1%)
Parkinson's		94 (5.56%)
Arthritis		30 (1.78%)
Osteoporosis		323 (19.11%)
Hypothyroidism		152 (8.99%)
Neoplasia		703 (41.6%)
Hyperlipidemia		453 (26.8%)
COPD		465 (27.51%)
Cerebrovascular disease		557 (32.96%)
Atrial fibrillation		695 (41.12%)
Total cost		8585.99 ± 8284.93
Drug-related costs		883.12 ± 1413.61
Access to the emergency department		0.77 ± 1.19
Outpatient visits		15.37 ± 11.64
Hospitalizations		1.22 ± 1.14

Data are presented as mean ± SD or *n* (%). COPD: chronic obstructive pulmonary disease; RUB: resource utilization bands.

Table 2. Distribution of health care resource use and costs by comorbidity class.

Chronic conditions in addition to heart failure		1	2	3	4	5	6+	Total	P-value
No. of patients in class		54	212	418	463	310	222	1679	
Sex	Female	23 (42.59%)	106 (50%)	218 (52.15%)	251 (54.21%)	156 (50.32%)	55.86% (124)	878 (52.29%)	*0.443
	Male	31 (57.41%)	106 (50%)	200 (47.85%)	212 (45.79%)	154 (49.68%)	98 (44.14%)	801 (47.71%)	
Age	Mean;	81.43;	82.11;	81.84;	81.33;	80.54;	80.56;	81.31;	**0.066
	Median	81.5	82	83	82	81	81	82	
	(IQR)	(74.25–88.75)	(76–88)	(76–88)	(76–87)	(75–86)	(76–85)	(76–87)	
Total cost	Mean;	8601.44;	8781.35;	7947.12;	8568.92;	8757.27;	9087.97;	8545.39;	**0.146
	Median	5914.93	6084.61	5388.02	5682.92	6119.41	7066.02	5893.75	
Drug-related costs	(IQR)	(4062.2–11377.6)	(4138.3–11092.8)	(3236.7–10298.4)	(2784–1563.09)	(3158.0–10982.1)	(3773.7–12222.8)	(3344.5–11205.9)	**< 0.001
	Mean;	372.2;	593.6;	701.0;	869.9;	1078.7;	1411.3;	887.1;	
	Median	209	428.96	519.79	659.14	779.1	994.3	631.5	
Access to the emergency department	(IQR)	(64.1–422.2)	(178.6–776.5)	(247.9–952.4)	(367.5–1121.5)	(454.4–1303.9)	(618.0–1599.5)	(320.9–1126.5)	**0.018
	Mean;	0.56;	0.86; 0 (0–1)	0.68; 0 (0–1)	0.78; 0 (0–1)	0.79; 0 (0–1)	0.91; 0 (0–1)	0.78; 0 (0–1)	
Outpatient visits	Median	10.8; 10	15.0; 14 (6–19)	14.7; 12 (7–20)	14.8; 12 (7–20)	16.0; 15 (9–21)	18.5; 16	15.4; 13 (7–20)	**0.001
	(IQR)	(7–14)					(9.25–25)		
Hospitalizations	Mean;	1.31; 1	1.22; 1 (1–2)	1.13; 1 (0–2)	1.19; 1 (0–2)	1.28; 1 (0–2)	1.33; 1 (0–2)	1.22; 1 (0–2)	**0.260
	Median	(1–2)							
	(IQR)								

* Chi-squared test; ** Kruskal-Wallis test. IQR: interquartile range.

significant correlation was also detected between the drug-related cost variable and comorbidity class ($\rho = 0.33$ $P < 0.001$). No significant correlation emerged, on the other hand, between total cost and number of hospital admissions, and comorbidity class.

The regression analyses (Table 3) showed that female patients incurred lower costs for drugs, outpatient visits, and hospital admissions. No differences emerged in the usage of hospitalization by comorbidity class. On the other hand, the number of outpatient visits rose significantly with the number of comorbidities (starting from patients with two or more comorbidities as opposed to only one), as did the drug-related costs (starting from patients with more than two comorbidities), and the number of trips to the A&E (but only for patients with two or 6+ comorbidities).

This study identified a correlation between number of comorbidities and health care resource usage in a cohort of elderly HHCN patients with HF. The association particularly concerned outpatient visits and expenditure on medication, whereas a higher comorbidity class did not seem to be associated with more hospital admissions or higher overall health care costs.

As it is easy to imagine, higher numbers of comorbidities mean a greater expenditure on medication, and this trend

was more evident than the correlation between number of comorbidities and total costs. This finding is consistent with a study conducted in Spain on a similar population (also including RUB 3 patients), which found a clear increase in pharmaceutical consumption with more comorbidities.^[10] Our study findings are also consistent with a previous report that an increasing burden of morbidity is associated with an increasing number of outpatient visits.^[11] Specialists were found to play a major part in the management of many common conditions, particularly when the burden of morbidity was high.^[11]

As concerns hospital admissions, several studies conducted in the United States on the elderly and on the population as a whole found multimorbidity a key driver of the risk of hospitalization for patients with HF, rather than HF itself.^[12–14] Another study found that the risk of hospitalization for HF patients rose by 26% for every additional physical morbidity (adjusted HR 1.26; 95% CI: 1.20–1.32), and by 18% for every additional mental condition (adjusted HR 1.18; 95% CI: 1.07–1.29).^[15] Our study found no sign of such an association in a multivariate analysis of total health care cost by comorbidity class.

The unbalance emerging in our data between a greater use of outpatient (specialist) visits but not of hospitalization

Table 3. Regression analyses between dependents variables (health care resource usage and cost variables) and comorbidity class, adjusted for sex and age.

Total cost Tobit regression		Coefficient	95% CI	P-value
Sex (reference: male)	Female	-440.2	-1222.01-341.6	0.2698
Age		-287.91	-339.79--236.02	< 0.001
No. chronic pathologies in addition to heart failure (reference: 1)	2	412.53	-1954.41-2779.47	0.7327
	3	-489.58	-2735.45-1756.29	0.6692
	4	-16.04	-2250.17-2218.1	0.9888
	5	-62.97	-2353.51-2227.57	0.957
	6+	298.71	-2059.8-2657.23	0.804
Drug-related costs Tobit regression		Coefficient	95% CI	P-value
Sex (reference: male)	Female	-265.67	-404.29--127.05	< 0.001
Age		-36.61	-45.85--27.37	< 0.001
No. chronic conditions in addition to heart failure (reference: 1)	2	287.2	-136.69-711.09	0.1842
	3	407.08	4.88-809.28	0.0473
	4	582.84	182.86-982.83	0.0043
	5	776.78	367.08-1186.49	< 0.001
	6+	1123.97	702.38-1545.57	< 0.001
Trips to A&E Poisson regression		Exp (Coefficient) - RR	95% CI	P-value
Sex (reference: male)	Female	0.95	0.85-1.07	0.4059
Age		0.99	0.98-0.99	< 0.001
No. chronic conditions in addition to heart failure (reference: 1)	2	1.57	1.08-2.35	0.0224
	3	1.23	0.86-1.84	0.2736
	4	1.41	0.99-2.09	0.0694
	5	1.41	0.98-2.11	0.0744
	6+	1.63	1.13-2.44	0.0122
Outpatient visits Poisson regression		Exp (Coefficient) - RR	95% CI	p-value
Sex (reference: male)	Female	0.93	0.91-0.96	< 0.001
Age		0.97	0.97-0.97	< 0.001
No. chronic conditions in addition to heart failure (reference: 1)	2	1.44	1.32-1.57	< 0.001
	3	1.4	1.28-1.52	< 0.001
	4	1.39	1.28-1.52	< 0.001
	5	1.47	1.35-1.6	< 0.001
	6+	1.72	1.58-1.88	< 0.001
Hospitalizations Poisson regression		Exp (Coefficient) - RR	95% CI	P-value
Sex (reference: male)	Female	0.88	0.8-0.96	0.0047
Age		0.98	0.97-0.99	< 0.001
No. chronic conditions in addition to heart failure (reference: 1)	2	0.95	0.73-1.24	0.7013
	3	0.88	0.69-1.14	0.3311
	4	0.92	0.72-1.19	0.5033
	5	0.97	0.76-1.26	0.8143
	6+	1.02	0.79-1.33	0.877

might be due to the Veneto Regional Authority’s program to support a primary care approach based on an information-led model of population health risk assessment and service teams, and the proportion of an integrated care managed jointly by primary and specialist physicians.^[16]

In conclusion, in times of epidemiological transitions and changing population needs,^[17] these findings are important

for the purpose of developing more sustainable health systems to tackle multimorbidity.^[18] Our data show how an increasing burden of comorbidities leads to a greater use of primary care services rather than secondary-level health care. This means there is a pressing need to reinforce primary care and develop innovative financing and delivery systems that measure and reward quality and performance at

this health care level. It is also important to better integrate specialist visits with primary care delivery. Enhancing primary care, finding better ways to characterize and deliver specialty care, and devising mechanisms to make sure that primary and specialist care interactions pursue better health, and equity in health, will all be important challenges.^[19] The role of specialists and primary care providers differs, and so does their attitude. Specialists are more concerned with specific diseases, and adherence to the relevant guidelines for treating them. Primary care physicians tend more to target multiple aspects of their patients' condition, or their "generic" health.^[19] Sharing care between these two kinds of physician seems to be a good way to prevent unnecessary hospital admissions and an exponential increase in the costs of multimorbid patients. As Barbara Starfield suggested, specialists should have a role in solving severe or uncommon problems that cannot be managed by the general practitioner, who should then be responsible for a patient's routine follow-up.

By giving a picture of health care resource usage by HHCN patients with HF, our results have implications for strategies for managing such patients' health care needs. Our study shares the limitation of all cohort studies relying on linked administrative databases, but this shortcoming is outweighed by the strengths of this population-based approach, which minimizes selection bias by using independently collected administrative data.

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