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Effect of cardiologist care on 6-month outcomes in patients discharged with heart failure: results from an observational study based on administrative data

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ABSTRACT

Objectives To evaluate the effect of cardiologist care on adherence to evidence-based secondary prevention medications, mortality and readmission within 6 months of discharge in patients with heart failure (HF).

Design Retrospective observational study based on administrative data.

Setting Local Healthcare Authority (LHA) of Bologna, one of the largest LHAs of Italy with ~870 000 inhabitants.

Participants All patients residing in the LHA of Bologna discharged from hospital with a diagnosis of HF between 1 January 2015 and 31 December 2015.

Primary and secondary outcome measures Multivariable regression analysis was used to assess the association of inpatient and outpatient cardiologist care with adherence to evidence-based medications, all-cause mortality and hospital readmission (including emergency room visits) within 6 months of discharge.

Results The study population included 2650 patients (mean age 82.3 years). 340 (12.8%) patients were discharged from cardiology wards, while 635 (24.0%) were seen by a cardiologist during follow-up. Inpatient and outpatient cardiologist care was associated with an increased likelihood of adherence to ACE inhibitors/angiotensin receptor blockers (ACEIs/ARBs), β-blockers and aldosterone antagonists after discharge. The risk of mortality was significantly lower among patients adherent to ACEIs/ARBs and/or β-blockers (–53% and –28%, respectively); the risk of hospital readmission was significantly lower among patients adherent to ACEIs/ARBs (–28%).

Conclusions Compared with non-specialist care, cardiologist care improves patient adherence to evidence-based medications and might thus favourably affect mortality and readmission following HF.

Strengths and limitations of this study

- This is one of the first studies in Italy to investigate the effect of inpatient and outpatient cardiologist care on process (medication adherence) and outcome measures (mortality and readmission) in patients with heart failure.
- Healthcare use of each individual patient was mapped through the linkage of different administrative data sources using the patient's unique identifier.
- Administrative databases do not include lifestyle behaviours and some relevant clinical information that may affect the study outcomes.

INTRODUCTION

Heart failure (HF) is a complex clinical syndrome with a prevalence ranging from 1% to 3% in the adult population of high-income countries and whose prevalence increases up to 30% among people older than 85 years of age.[1 2] HF is a major public health issue due to population ageing, the complex management of elderly patients and the recurrent hospital admissions, which account for most of HF-related costs.[3]

Evidence about the role of cardiologists in the management of HF is controversial. Research studies have, to date, compared cardiologist care with care provided by generalists or other physicians in relation to mortality and readmissions.[4–18] Most of them suggested that patients with HF have improved outcomes when seen by a cardiologist[4–11]; on the other hand, other authors did not find outcome differences between cardiologist and non-cardiologist care,[12–14] while Lowe *et al*[15] reported that patients managed by cardiologists have a higher mortality rate. Interestingly, a few other studies have highlighted the beneficial effect of the collaboration between generalists and cardiologists in improving processes and outcomes for these patients.[16–18] Also, some authors found

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that patients treated by cardiologists, compared with those treated by generalists or other physicians, are more frequently male, younger,[4 6 8 10 13] and receive more evidence-based drug prescriptions and invasive procedures.[6–8 10 11] In light of this consideration, it has been suggested that cardiologist care could be associated with higher costs and resource use.[4]

Still, given the small number of studies on this topic and the high heterogeneity between them in terms of design and setting, with less studies evaluating outpatient cardiologist care, comparison groups and outcomes time frame, there is still no consistent evidence that cardiologist care should be preferred in the management of HF. To date, patients with HF are predominantly treated by non-cardiologists to respond to organisational rather than clinical demands; nevertheless, it is essential to ascertain the benefits of specialty care to improve HF management, both in terms of effectiveness and efficiency. This entails the implementation of a structured model of care that involves cardiologists, beyond generalists and other physicians.

The aim of this study was to evaluate the effect of both inpatient and outpatient cardiologist care on adherence to evidence-based secondary prevention medications, all-cause mortality and readmission within 6 months of discharge after HF in the Local Healthcare Authority (LHA) of Bologna, one of the largest LHAs of Italy.

MATERIALS AND METHODS

Setting and study population

This retrospective observational study included all patients residing in the LHA of Bologna (866 000 inhabitants in 2015) who were discharged from hospital with a primary diagnosis of HF International Classification of Diseases, Clinical Modification (ICD-9-CM) diagnosis codes: 398.91, 402.x1, 404.x1, 404.x3, 428.xx) between 1 January 2015 and 31 December 2015. Data were retrieved from the Hospital Discharge Records (HDRs) Database (see online supplementary file 1 for a description of the data source).

Patients were excluded if any of the following criteria were met:

1. age >100 years, because very old patients may have distinctive clinical features at diagnosis and survival
2. a secondary diagnosis of non-cardiogenic acute pulmonary oedema (ICD-9-CM 518.4), that is, patients with symptoms probably related to causes other than HF
3. a major procedure on the cardiovascular system (ICD-9-CM 00.5x, 00.66, 35.xx, 36.xx, 37.3x–37.8x, 37.94–37.99), that is, patients with severe cardiac impairment
4. length of stay >90 days, that is, very complex or unstable cases
5. planned hospital admission, to focus analyses on acute/urgent episodes of care
6. transfer from another facility, to ascribe the study outcomes to the hospital of first admission
7. death during hospital stay or discharge against medical advice.

For patients with multiple eligible hospital admissions over the 1-year study period, we considered only the first one as the index admission.

Cardiologist care

The independent variables of interest were related to inpatient and outpatient cardiologist care. These included the following:

1. type of ward of discharge (cardiology, internal medicine, geriatrics, other)
2. outpatient cardiology visit during follow-up.

We also took into account in the analyses some care processes implemented in the LHA of Bologna for the elderly and patients with HF. In particular, we considered the following:

1. Continuing home care (not necessarily focused on HF) delivered by general practitioners (GPs) or nurses, before index hospitalisation or during follow-up.
2. Inclusion in a specific HF care pathway before index hospitalisation or during follow-up. Since 2008 the LHA of Bologna has implemented this care pathway for the integrated management of patients with HF. GPs meet to share evidence-based guidelines and to manage along with skilled nurses the patient's follow-up, and fast tracks are activated for diagnostic tests when needed. Patients can be referred by GPs or by hospital specialists when the diagnosis is made for the first time during hospitalisation. The HF care pathway promotes patient self-management through counselling by nurses to improve lifestyle and optimise therapy compliance, detection of early acute symptoms of HF, and an easier access to specialist and non-specialist care when needed.
3. Access to residential care facility for the elderly (RCFE) before index hospitalisation or during follow-up.

Information on outpatient care was collected from regional and LHA administrative databases, and linked to HDRs using the patient's unique identifier.

Study outcomes

The study had three outcomes of interest. Specifically:

1. Adherence to evidence-based secondary prevention medications, consisting of three drug categories: ACE inhibitors/angiotensin receptor blockers (ACEIs/ARBs), β-blockers and aldosterone antagonists. Adherence to each of the three drug classes was calculated using the medication possession ratio (MPR) on the basis of the minimum effective doses defined in clinical trials. Patients were classified a priori into two categories: adherent (MPR ≥75%) and non-adherent (MPR <75%) (see online supplementary file 2 for the list of drugs and doses, including references

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to clinical trials). Data on filled prescriptions were retrieved from the Outpatient Pharmaceutical Database (OPD) (see online supplementary file 1 for a description of the data sources).
2. All-cause mortality, retrieved from the Regional Mortality Register Database (see online supplementary file 1 for a description of the data sources).
3. All-cause unplanned readmissions occurred at any hospital and lasting >1 day, including emergency room (ER) visits not related to injuries and not resulting in inpatient admission. These data were retrieved from the HDRs and ER administrative databases.

For the medication adherence analysis, we excluded patients with individual follow-up <90 days to give all individuals the chance to achieve clinical stability and to guarantee a minimum observation period of 3 months, and patients who spent more than 30% of their follow-up in the hospital, because drugs dispensed to inpatients cannot be retrieved from the OPD, possibly leading to immeasurable time bias.[19] In the mortality and readmission analyses, medication adherence was considered as a potential predictor of the study outcome.

Repeated admissions within 2 days of discharge were regarded as one single 'episode of care' and were not counted as readmissions. The beginning of the follow-up was set at the date of hospital discharge, and all patients were followed up to 6 months.

Statistical analysis

Continuous variables were summarised as mean±SD or as median and range; discrete and categorical variables were summarised as frequencies and percentages.

In order to minimise the potential confounding of individual risk factors on the association between predictors and outcomes, we retrieved some patient baseline characteristics from HDRs. These included age, gender, citizenship, district of residence, length of stay, hospital of discharge, provision of intensive care during hospital stay, 28 comorbidities chosen a priori and identified in the index hospitalisation and in all hospital admissions occurring 2 years prior to the index hospitalisation, and use of 10 drug therapies during the 3 months prior to the index admission (see online supplementary file 3 for the detailed list of comorbidities and drugs).

The crude association between each potential confounder and the study outcomes was first examined in univariable regression models. Predictors with prevalence >1% and significantly associated with the outcome at p<0.25 in univariable analyses were selected for inclusion in multivariable regression models. A bootstrap procedure was used to determine which of these factors were significantly associated with the outcome in multivariable models. Using this approach, 200 replicated bootstrap samples were selected from the original cohort. In each replicated sample, a backward elimination of potential confounders was applied with a significance level of removal equal to 0.01. Only risk factors selected in at least 50% of the replicates were included as covariates in the final regression models. The confounders included in the final models are reported in table footnotes.

The effect of healthcare factors (cardiologist care and other outpatient care services) on medication adherence was analysed using multivariable logistic regression. The effect of healthcare factors and medication adherence on the risk of mortality and readmission was analysed using multivariable conditional logistic regression (see online supplementary file 4 for methodological details).

The significance level was set at 0.01. All analyses were carried out using Stata V.13 software.

Sensitive data management

In Italy, anonymous administrative data-gathering is subject to the law *Protection of individuals and other subjects with regard to the processing of personal data, ACT no. 675 of 31.12.1996* (amended by Legislative Decree no. 123 of 09.05.1997, no. 255 of 28.07.1997, no. 135 of 08.05.1998, no. 171 of 13.05.1998, no. 389 of 6.11.1998, no. 51 of 26.02.1999, no. 135 of 11.05.1999, no. 281 of 30.07.1999, no. 282 of 30.07.1999 and no. 467 of 28.12.2001) (http://www.privacy.it/legge675encoord.html).

Data were anonymised prior to the analysis at the regional statistical office, and each patient was assigned a unique identifier that eliminates the ability to trace the patient's identity or other sensitive data. As anonymised administrative data are used routinely for healthcare management, no specific written informed consent was needed to use the patient information.

All procedures performed in this study were in accordance with the 1964 Helsinki Declaration and its later amendments.

RESULTS

Of the 3320 patients discharged after HF, 2650 (79.8%) met the inclusion criteria. The mean age was 82.3±10.1 years, 56.3% were women and the median length of stay was 7 days. The distribution of patient baseline characteristics is reported in table 1.

As shown in table 1, 340 (12.8%) patients were discharged from cardiology wards, while 1813 (68.4%), 372 (14.0%) and 125 (4.7%) patients were discharged from internal medicine, geriatrics and other-discipline wards, respectively. There were 635 (24.0%) patients seen by a cardiologist during follow-up, with a median wait time between referral and specialist appointment of 7 days. In addition, we found 1279 (48.3%) patients with home care; of these, 836 (65.4%) were already receiving this service before index admission. The most common reason for home care, as reported in the home-based service records, was administration of anticoagulants (24.9%), followed by management of HF, coronary artery disease or dementia (18.7%). A total of 232 patients (8.8%) had been included in the HF care pathway; of these, 156 were included during the 6-month follow-up period. One hundred and ninety-one patients (7.2%) were in residential care

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Table 1 Distribution of patient characteristics and organisational factors

Patient characteristics	n=2650	%
Female	1491	56.3
Age in years, mean±SD	82.3±10.1	–
Foreigners	40	1.5
Length of stay in days, median (range)	7 (1–69)	–
Provision of intensive care during hospital stay	103	3.9
Discipline of the ward of discharge		
Internal medicine	1813	68.4
Cardiology	340	12.8
Geriatrics	372	14.0
Other	125	4.7
Comorbidities		
Malignant tumours	151	5.7
Diabetes	336	12.7
Disorders of lipid metabolism	89	3.4
Obesity	68	2.6
Haematological diseases	396	14.9
Arterial hypertension	652	24.6
Previous myocardial infarction	331	12.5
Other forms of ischaemic heart disease	706	26.6
Ill-defined descriptions and complications of ischaemic heart disease	38	1.4
Rheumatic heart disease	166	6.3
Cardiomyopathies	198	7.5
Endocarditis and acute myocarditis	1	0.04
Other cardiac diseases	218	8.2
Conduction disorders and cardiac dysrhythmias	1366	51.5
Cerebrovascular diseases	291	11.0
Vascular diseases	150	5.7
HIV/AIDS	0	0.0
COPD	339	12.8
Pneumoconiosis and other alveolar or parietoalveolar lung diseases	17	0.6
Chronic nephropathies	524	19.8
Chronic diseases of liver, pancreas and intestine	47	1.8
Alcohol abuse	0	0.0
Previous bypass surgery	51	1.9
Previous PCI	152	5.7
Cerebrovascular revascularisation	20	0.8
Other surgery of the heart	106	4.0
Other surgery of great vessels	72	2.7
Previous HF	736	27.8
Number of comorbidities		
0	366	13.8
1	623	23.5
≥2	1661	62.7
Previous medication use		
Antidiabetic drugs	596	22.5
Drugs for cardiac therapy	588	22.2
Drugs for obstructive air way diseases	602	22.7
Diuretics	1597	60.3
β-blockers	1426	53.8
ACEIs/ARBs	1438	54.3
Calcium channel blockers and other antihypertensives	710	26.8
Statins	760	28.7
Antiplatelet drugs	1024	38.6
Vitamin K antagonists	660	24.9
Number of previous medications		
0	264	10.0
1	205	7.7
2	318	12.0
3	471	17.8
4	519	19.6
5	418	15.8
6	275	10.4
≥7	180	6.8
Patients with cardiology visit during follow-up	635	24.0
Patients with home care	1279	48.3
Patients included in the HF care pathway	232	8.8
Patients in RCFE	191	7.2

ACEIs/ARBs, ACE inhibitors/angiotensin receptor blockers; COPD, chronic obstructive pulmonary disease; HF, heart failure; PCI, percutaneous coronary intervention; RCFE, residential care facility for the elderly.

facilities during the follow-up period—of these, 60.2% had accessed RCFE prior to the index hospitalisation.

As a whole, 887 (33.5%) patients received none of the outpatient care services described above, while 93 (3.5%) patients were enrolled in the HF care pathway and seen by a cardiologist during follow-up.

Adherence to medication

Adherence to evidence-based medications after discharge was calculated for patients with an observation period of at least 3 months and with less than 30% of follow-up spent in the hospital (n=2243). The percentages of adherence to ACEIs/ARBs, β-blockers and aldosterone antagonists were 46.5%, 59.4% and 35.6%, respectively.

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Table 2 Effect of healthcare factors on adherence to secondary prevention medications in the 3-month to 6-month follow-up period

	ACEIs/ARBs		β-blockers		Aldosterone antagonists	
Organisational predictors	**OR***	**99% CI**	**OR†**	**99% CI**	**OR‡**	**99% CI**
Discipline of the ward of discharge						
Internal medicine	1.00		1.00		1.00	
Cardiology	1.53§	1.03 to 2.28	1.51	0.97 to 2.35	1.77§	1.24 to 2.51
Geriatrics	1.07	0.72 to 1.60	0.95	0.65 to 1.40	0.92	0.63 to 1.33
Other	0.86	0.45 to 1.62	1.11	0.61 to 2.01	0.77	0.42 to 1.41
Cardiology visit within 3 months of discharge	1.05	0.79 to 1.41	1.46§	1.09 to 1.97	1.43§	1.10 to 1.87
Home care within 3 months	0.63§	0.48 to 0.83	0.92	0.71 to 1.20	0.99	0.77 to 1.28
HF pathway within 3 months	1.20	0.76 to 1.91	0.82	0.52 to 1.30	1.36	0.89 to 2.09
RCFE within 3 months	0.28§	0.14 to 0.55	0.32§	0.18 to 0.56	0.38§	0.20 to 0.71

*Adjusted for age, length of stay, chronic nephropathies and previous use of ACEIs/ARBs.
†Adjusted for age, conduction disorders and cardiac dysrhythmias, previous percutaneous coronary intervention, other surgery of the heart, provision of intensive care during hospital stay and previous use of β-blockers.
‡Adjusted for length of stay, cardiomyopathies, chronic nephropathies and previous use of diuretics.
§OR significant at the 0.01 level.
ACEIs/ARBs, ACE inhibitors/angiotensin receptor blockers; HF, heart failure; RCFE, residential care facility for the elderly.

There were 705 (31.4%) patients who were adherent to both ACEIs/ARBs and β-blockers, while there were 310 (13.8%) patients with no filled prescriptions of ACEIs/ARBs and β-blockers during follow-up (MPR=0%).

The effect of healthcare factors on adherence to each drug therapy is shown in table 2. After adjusting for significant patient characteristics, we found that, compared with patients discharged from an internal medicine ward, those discharged from a cardiology ward had an increased likelihood of adherence to ACEIs/ARBs (OR 1.53, 99% CI 1.30 to 2.28); similarly, patients seen by a cardiologist within 3 months of hospital discharge were more likely to be adherent to β-blockers (OR 1.46, 99% CI 1.09 to 1.97). Adherence to aldosterone antagonists was favourably influenced by inpatient and outpatient cardiologist care (discharge from cardiology: OR 1.77, 99% CI 1.24 to 2.51; follow-up visit: OR 1.43, 99% CI 1.10 to 1.87). On the contrary, home care and RCFE were associated with a reduction in adherence. Lastly, no association was found between medication adherence and inclusion in the HF care pathway, although a secondary analysis revealed that patients enrolled in this pathway were more likely to be seen by a cardiologist during follow-up (OR 1.67, 99% CI 1.10 to 2.52).

Mortality and readmission

Mortality and readmission rates at 1, 3 and 6 months are shown in figure 1. At the end of follow-up, about one-half of patients (51.3%) experienced hospital readmission or visited the ER, while about one-fifth (21.1%) died from any cause. Of all readmissions, 39.8% were HF-related.

The effect of medication adherence and healthcare factors on mortality and readmission is presented in tables 3 and 4. After adjusting for potential confounders, the risk of 6-month mortality was 53% lower among patients adherent to ACEIs/ARBs and 28% lower among patients adherent to β-blockers; a significant mortality reduction associated with adherence to ACEIs/ARBs and β-blockers was also observed at 1 and 3 months after discharge (table 3). Adherence to ACEIs/ARBs was also associated with a 22% reduction in readmission rates at 6 months, while adherence to β-blockers failed to achieve statistical significance (table 4). Adherence to aldosterone antagonists was unrelated to both mortality and readmission.

We also found that home care was associated with a higher mortality risk at 6 months (table 3) and with a higher risk of readmission at 1, 3 and 6 months after discharge (table 4). As in the medication adherence analysis, no evidence of association between outcomes and inclusion in the HF care pathway was found.

DISCUSSION

The main result of this observational study is that patients with HF managed by cardiologists in inpatient and outpatient settings are more adherent to evidence-based medications compared with patients managed by other specialists. In addition, medication adherence to ACEIs/ARBs and β-blockers was associated with reduced mortality after discharge, and adherence to ACEIs/ARBs was also associated with lower readmission rates.

Our results are consistent with earlier studies that highlighted the influence of cardiologist care on evidence-based treatment adherence,[6 8–10 13 20] and in contrast with other studies reporting a direct association of cardiologist care with mortality and readmissions.[4 6 7 9–11] It is worth noticing that in our study the influence of cardiologist care on mortality and readmission may be explained by adherence to evidence-based medications.

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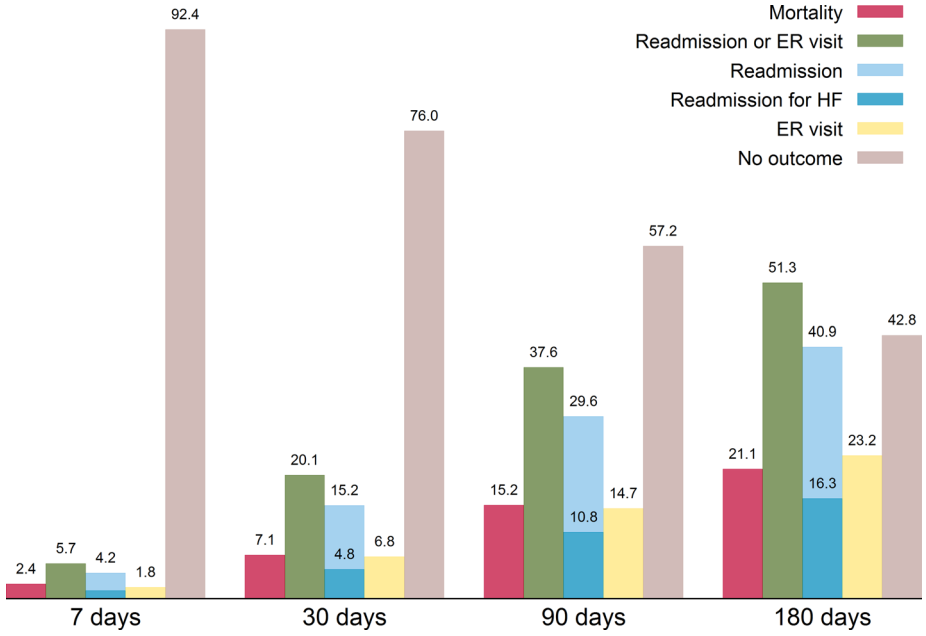

Figure 1 Mortality and readmission rates (%) at 7, 30, 90 and 180 days after discharge. ER, emergency room; HF, heart failure.

The reason for the favourable impact of cardiologist care on medication adherence might be that cardiologists are particularly skilled in decision making about medication dosing and titration, and are generally more likely to adhere to guideline recommendations. Some authors have also suggested that patients seen by cardiologists are younger, have more cardiovascular comorbidities than other diseases and are therefore at lower risk of contraindications or intolerance to treatments.[4 6 8 10 13 15] However, in our study the association between medication adherence and cardiologist care cannot be explained by differences in case mix because our regression analyses were adjusted for many potential confounders (ie, age, gender, comorbidities and length of stay in the index hospitalisation as a proxy of complexity).

Of note, consistent with other studies,[3 21–25] we found that medication adherence improved patient mortality. In addition, we found that adherence to ACEIs/ARBs was associated with a reduction in readmission rates at 3 and 6 months, despite the general difficulty of identifying factors affecting hospital readmissions.[26–29] The predictive power of risk-adjustment models for readmissions after HF has indeed been shown to be scanty and generally lower than the predictive power of mortality models, suggesting that

Table 3 Effect of healthcare factors and medication adherence on mortality at 1, 3 and 6 months after discharge

Organisational factors and medication adherence	1 month		3 months		6 months	
	OR*	99% CI	OR*	99% CI	OR*	99% CI
Discipline of the ward of discharge						
Internal medicine	1.00		1.00		1.00	
Cardiology	1.39	0.61 to 3.19	1.16	0.68 to 1.98	0.92	0.58 to 1.49
Geriatrics	1.59	0.93 to 2.73	1.28	0.89 to 1.84	1.34	0.98 to 1.82
Other	1.75	0.71 to 4.33	1.32	0.68 to 2.57	1.34	0.77 to 2.32
Cardiology visit	0.60	0.12 to 3.01	0.57	0.32 to 1.04	0.83	0.56 to 1.22
Home care	0.97	0.62 to 1.51	1.13	0.83 to 1.53	1.40†	1.08 to 1.82
HF care pathway	0.99	0.41 to 2.41	1.20	0.72 to 2.02	1.26	0.83 to 1.92
RCFE	1.56	0.79 to 3.08	1.43	0.87 to 2.37	1.55†	1.02 to 2.34
Medication adherence after discharge						
ACEIs/ARBs	0.36†	0.18 to 0.72	0.43†	0.29 to 0.63	0.47†	0.35 to 0.65
β-blockers	0.59†	0.36 to 0.99	0.73†	0.53 to 1.00	0.72†	0.55 to 0.95
Aldosterone antagonists	0.84	0.48 to 1.48	0.95	0.68 to 1.34	0.94	0.71 to 1.24

*Adjusted for length of stay, malignant tumours, previous HF, and previous use of β-blockers and diuretics.
†OR significant at the 0.01 level.
ACEIs/ARBs, ACE inhibitors/angiotensin receptor blockers; HF, heart failure; RCFE, residential care facility for the elderly.

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Table 4 Effect of healthcare factors and medication adherence on readmissions (including ER visits) at 1, 3 and 6 months after discharge

Organisational factors and medication adherence	1 month		3 months		6 months	
	OR*	99% CI	OR*	99% CI	OR*	99% CI
Discipline of the ward of discharge						
Internal medicine	1.00		1.00		1.00	
Cardiology	0.96	0.65 to 1.41	0.93	0.70 to 1.24	0.88	0.69 to 1.13
Geriatrics	1.08	0.77 to 1.52	1.08	0.84 to 1.39	1.13	0.91 to 1.40
Other	1.31	0.78 to 2.20	1.15	0.77 to 1.72	1.14	0.81 to 1.62
Home care	1.29†	1.00 to 1.66	1.35†	1.12 to 1.63	1.35†	1.15 to 1.58
HF care pathway	1.28	0.83 to 1.97	1.09	0.79 to 1.51	1.05	0.79 to 1.39
Cardiology visit	1.00	0.59 to 1.72	1.08	0.81 to 1.43	1.15	0.93 to 1.43
RCFE	1.61	0.98 to 2.65	1.59†	1.10 to 2.31	1.32	0.95 to 1.84
Medication adherence after discharge						
ACEIs/ARBs	0.78	0.59 to 1.03	0.76†	0.63 to 0.93	0.78†	0.66 to 0.92
β-blockers	1.08	0.83 to 1.41	1.08	0.90 to 1.31	1.03	0.88 to 1.21
Aldosterone antagonists	0.98	0.74 to 1.31	0.92	0.75 to 1.12	0.93	0.79 to 1.10

*Adjusted for 'other cardiac diseases', previous percutaneous coronary intervention and previous HF.
†OR significant at the 0.01 level.
ACEIs/ARBs, ACE inhibitors/angiotensin receptor blockers; ER, emergency room; HF, heart failure; RCFE, residential care facility for the elderly.

the determinants of readmissions are difficult to be identified and recorded.[30] Readmissions might depend on the quality of hospital management and, of note, also on the implementation and the quality of organisational models of care in the early postdischarge period.[31–34] Earlier literature suggests that a coordinated approach to develop a seamless and effective transition between hospital and home is essential to promote the integration between inpatient and outpatient services and to prevent readmissions for patients with chronic diseases as well as HF.[35–39] In particular, the days immediately following discharge are critical because of the addition of new therapies or changes to existing medical therapy that may deteriorate patients' clinical status outside of the highly structured hospital setting.[40 41] In line with other studies,[23 41 42] we found that patients with cardiology visits after discharge were more adherent to evidence-based medications, suggesting that these care services improve outcomes and should be offered routinely to patients with HF.

Our findings also suggest that home care was negatively associated with adherence to ACEIs/ARBs, mortality and readmission. A possible explanation is that patients managed in home-based services are more often characterised by social complexity, that is, tend to live alone without family support or have poor economic conditions that we could not evaluate in our risk-adjustment models.

Concerning the HF care pathway, it had no significant impact on patient outcomes. It may be possible that in the catchment area of the LHA of Bologna, this pathway still has a weak or heterogeneous implementation especially in terms of communication between different physicians (including cardiologists), engagement of patients and caregivers in their pathway of care, follow-up plans, and monitoring of clinical conditions. However, because our databases lack information on specific interventions provided to individual patients enrolled in the HF care pathway, this result should be interpreted with caution and deserve further investigation.

To sum up, our results point out that in any setting of care, the management of drug therapies should be considered as a key element for patients with HF, and should be not only a prerogative of cardiologists but also an essential component of non-specialty models of care. Joynt *et al*[43] found that clinician expertise may play an important role in HF care, and that high-volume and experienced physicians (including cardiologists) achieved better outcomes when compared with physicians with less experience on HF treatment. Consistent with other research,[3 16–18] our study suggests that, in essence, cardiologists should play an important role in the organisational models tailored to patients with HF, and that both early physician involvement and collaborative approach between specialists and non-specialists might lead to an improved care quality.

Results of the present study should be interpreted in light of some strengths and limitations. Methodological strengths include the study design for the mortality and readmission analyses, in which cases and controls were matched by follow-up duration, thereby preventing time-related bias.[44] Second, adherence to medication was derived using the 'minimum effective doses' of clinical trials instead of the more commonly used 'defined daily doses', which are generally higher than what is actually prescribed for secondary prevention after HF. Third, we mapped healthcare use of each individual patient, thanks

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to the possibility to link different administrative data sources using the patient's unique identifier.

Limitations include, first, the absence of lifestyle behaviours (eg, diet, physical activity), socioeconomic factors (eg, education level, income) and relevant clinical information (eg, body mass index, left ventricular ejection fraction) in the HDR Database. Although analyses were adjusted for many factors including comorbid conditions and previous use of drug therapies, it is possible that the lack of more detailed data has left room for some residual confounding. However, when we reran all regression analyses by including serum creatinine at hospital admission (n=2187), which in a previous study has been shown to be strongly associated with short-term mortality following HF,[45] results did not change appreciably (data not presented). Second, adherence was estimated using pharmacy data on filled prescriptions, but no information on actual medication consumption was available. Moreover, the adherence cut-off point of 75% was defined a priori and not in a data-driven way. To address this limitation, we carried out sensitivity analyses using different cut-off points (50%–90%) and alternative adherence measures (ie, pill count and proportion of days covered), and results were unchanged (data not presented). The last limitation is the potential lack of generalisability to other settings; however, this study included all patients with HF from one of the largest Italian LHAs and it is likely that our findings would be generalisable to other regions or countries with a population composition and healthcare delivery system similar to those of this study.

In conclusion, the results of the present study suggest that policy makers and healthcare organisation managers should reconsider the role of cardiologists in the management of patients with HF. Cardiologists can be involved not necessarily as main professionals, but also as consultants to plan and monitor pharmacological treatment during the hospital stay and early postdischarge period. Further research is needed to evaluate in more detail which are the key elements of the specialty and non-specialty management of HF that influence patient outcomes and to identify for what type of patients or in which setting cardiologists provide the greatest value.

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Ethics approval The study was exempt from notification to the Ethics Committee of the LHA of Bologna. It was conducted in conformity with the regulations for data management from the Regional Health Authority of Emilia-Romagna, and with the Italian Code of conduct and professional practice applying to processing of personal data for statistical and scientific purposes (art 20–21, legislative decree 196/2003;) published in the Official Journal No 190 of 14 August 2004, which explicitly exempts the need for approval from the Ethics Committee when using anonymous data (preamble number 8).

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