Eur J Clin Pharmacol (2016) 72:965–975
DOI 10.1007/s00228-016-2052-y

PHARMACOEPIDEMIOLOGY AND PRESCRIPTION

How to best assess quality of drug treatment in patients with heart failure

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Received: 20 December 2015 / Accepted: 23 March 2016 / Published online: 11 April 2016

Abstract
Background The proportion of patients with heart failure (HF) treated with angiotensin-converting enzyme inhibitors (ACEI) or angiotensin receptor blockers (ARB) is frequently used as quality indicator. This study aimed to compare agreement between different methods of calculating this quality indicator. In addition, characteristics for patients and care providers associated with a high proportion treated with ACEI or ARB were analyzed.
Methods This Swedish cross-sectional register-based study was conducted in the Stockholm region (2.1 million inhabitants). The proportion of patients with HF treated with ACEI or ARB was calculated by different methods applied on an administrative database on healthcare consumption, diagnoses, and dispensed drugs and by self-reported data from all primary care centers in the region.
Results A total of 32,677 patients recorded with a HF diagnosis 2008–2012 and alive July–December 2012 were identified. The proportion treated with ACEI or ARB varied depending on observation period and care provider included (range register 52–74 %). There was a large variation between different primary care centers (range register 36–88 %, range self-reported 8–100 %) and a poor agreement between methods (Bland-Altman; rhoc range 0.07–0.23). Predictors for high proportion treated were low age, high socioeconomic status, cardiovascular comorbidity, and diagnosis recorded both in primary care and in hospitals.
Conclusions There is poor agreement between different methods to evaluate adherence to guidelines for drug treatment in HF. Differences between practices concerning patient age, socioeconomic status, comorbidity, and care given by different providers should be taken into account in quality assessment.

Keywords Drug utilization · Quality indicators · Heart failure · Angiotensin-converting enzyme inhibitors · Angiotensin receptor blocker

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Background

The prevalence of heart failure (HF) in the developed countries is approximately 1–2 % [1, 2]. The prognosis remains poor despite improvements in medical treatment and patient care [1, 3]. HF is the most common cause of hospitalization in the elderly and accounts for approximately 15 % of all circulatory causes of hospitalization [4]. The economic burden for care and treatment of patients with HF is considerable, corresponding to about 2 % of the total health budget [5].

The evidence for treatment with angiotensin-converting enzyme inhibitors (ACEI) or angiotensin receptor blockers (ARB) in patients with HF is strong, as reflected in current recommendations [5, 6]. However, several observational studies have shown that the guidelines are not followed in clinical practice, with a large variation between different care providers in the proportion of patients treated with ACEI or ARB [7]. Thus, there is a need for improvement in the management of patients with HF.

Quality indicators are used in many strategies to promote high adherence to guidelines [8]. These indicators have increasingly been linked to payment, accreditation, and financial incentives [9, 10]. In Sweden (Stockholm region), approximately 3 % of the overall payment in primary care is linked to a range of indicators focusing on various aspects of quality of care, from appropriate keeping of medical records to patient satisfaction. Considering the heavy disease burden of HF, strong evidence for treatment with ACEI or ARB, and insufficient implementation of guidelines in clinical practice, the proportion of patients with HF treated with ACEI or ARB has been included as one of quality indicators in the incentive program for primary care in the region. However, the implementation was done without preceded validation studies.

The development of electronic medical records and administrative databases has facilitated studies on disease patterns and drug utilization [11, 12]. These data can be used to produce disease-based quality indicators independent of subjective judgment [13]. However, many challenges in the construction of valid and reliable clinical quality indicators remain [14, 15]. Thus, the aim of this study was to compare agreement between different methods of measuring the proportion of patients with HF treated with ACEI or ARB. In addition, patient and care provider characteristics associated with high proportion treated with ACEI or ARB were analyzed.

Methods

Design and setting

This cross-sectional multilevel study based on register data and self-reported data on patients with HF was conducted in the Stockholm region, Sweden, which comprises 2.1 million inhabitants in the metropolitan city of Stockholm, rural districts, and a large archipelago. In 2012, there were 201 primary care centers in the region. Most primary care centers were group practices with, on average, 7.6 general practitioners (range 1–23). The average number of enrolled patients per practice was 12,453 (range 1602–28,926). A majority of primary care centers (66 %) were managed by private care providers with community governance.

Data sources

All register data were collected from the regional administrative health data register (Vårdanalysdatabasen, VAL; Stockholm regional health care data warehouse), which is used for healthcare planning, remuneration, and quality assessment [16]. The database compiles demographic characteristics and patient-level health care consumption data for all inhabitants in the region. In 2012, there was a complete coverage of all consultations in primary care and hospitalizations (including procedures and discharge diagnoses) in the region and >90 % coverage of ambulatory consultations in secondary care. Since 2010, the database also contains patient-level data on all dispensed prescriptions, with information on substance and Anatomical Therapeutic Chemical (ATC) classification, dispensed amount, dosage, expenditure, and reimbursement, as well as age and sex, similar to the data available in the Swedish Prescribed Drug Register [17]. These register data, extracted in different ways, were compared with self-reported data from each primary care centre (see below).

Patient characteristics

We included all patients aged ≥40 years recorded with HF (I50; ICD-10) by any care provider between 2008 and 2012 and living in the Stockholm region between July 2012 and December 2012. The following information was collected:

- Age, sex, date of death, and date of migration into or out of the region
- Duration of HF, defined as time since first registration (since 1997)
- Enrollment in primary care (December 2012)
- Continuity of care in primary care, defined as number of years that a patient was enrolled at the same primary care center (2008–2012)
- Housing, e.g., if the patient was staying in retirement or in a nursing home
- Selected comorbidities: atrial fibrillation/flutter (I48.0–I48.9), chronic renal disease (N18, N19.9, I13), chronic obstructive pulmonary disease (J40–J44), diabetes (E10–E14), hypertension (I10–I15), and ischemic heart disease (I20–I25)
- Consultations in primary and secondary care and hospitalizations
- Dispensed prescriptions of ACEI or ARB (ATC-code C09, except C09X)

Care provider characteristics

The following information was extracted for each primary care center:

- A socioeconomic index for the population enrolled (Care Need Index (CNI)) [18]
- Type of management: private with community governance or public managed by the county council
- Number of patients per physician, i.e., number of enrolled patients in 2012 divided by number of full-time general practitioners
- The size of each primary care center, i.e., the number of enrolled patients in 2012
- Adherence to the regional Drug and Therapeutics Committee guidelines, defined as proportion of the volume of dispensed drugs included in the guidelines [19]
- Overall diagnosis reporting rate, i.e., the proportion of consultations with at least one recorded diagnosis

Self-reported data on quality

All primary care centers in the region annually report their performance on different aspects of quality of care in a quality report [20]. The quality report was collected by a web-survey (IBM SPSS Corporation, Chicago, IL, USA) including 22 questions, among others the total number of patients with HF and the proportion treated with ACEI or ARB. There were no detailed instructions on how this information should be acquired, but it was suggested that the primary care centers could extract the appropriate data from their medical record system.

Data analysis

The primary outcome measure (quality indicator) was the proportion of patients with HF treated with ACEI or ARB. This was assessed by using register data and self-reported data from each primary care center in 2012. Patients living in retirement or nursing homes and patients not enrolled in primary care were included in the description of the cohort only (Table 1). To avoid random variation, only primary care centers with more than ten enrolled patients with HF in 2012 (recorded by any care provider 2008–2012) were included in the analyses at primary care center level.

Based on the most likely management of patients, the agreement of methods in calculating the quality indicator was assessed, using different criteria for the numerator and denominator (Table 2). The numerator was defined as the number of patients with HF dispensed ACEI or ARB during July–December 2012 with variation in the selection of prescriber (i.e., any care provider, only primary care). The denominator was defined as the number of patients recorded with HF (overall and for each primary care center). Different length of observation periods (1–5 years during 2008–2012) and recording of HF diagnosis in different care providers (i.e., any care provider, primary care, only primary care) were applied for data extraction (Table 2).

Statistical methods

Data are presented as mean values ± SD or odds ratios and 95 % confidence intervals, as appropriate. Differences between groups were assessed by the Student's t test, the Mann-Whitney test, or the χ^2 test, as appropriate. The Bland-Altman method was used to assess the agreement between self-reported data and the different methods in calculation of the proportion of patients treated with ACEI or ARB [21]. The associations between patient characteristics and primary care centre characteristics and proportion of patients treated with ACEI or ARB were assessed by multilevel logistic regression. Data management was performed in MS Access (Microsoft Corporation, Redmond, WA, USA) and statistical analyses in STATA version 11 (Stata Corporation, College Station, TX, USA), including a two-level analysis (patients, level 1; primary care centers, level 2) performed by multilevel mixed-effects logistic regression models.

Results

In total, 32,677 patients (50 % women) were recorded with HF by any care provider and were living in Stockholm between July and December 2012. Table 1 includes further information on patient characteristics and the management of patients by different care providers.

Number of patients

The number of patients recorded with HF in the register increased markedly when the observation period was expanded from 1 to 5 years and also when more care provider categories were included (Table 2). Only 8 % of all HF patients were identified when the selection criteria were restricted to patients recorded with HF only in primary care during 1 year. Most patients (89 %) had a recorded consultation in primary care for any reason during 2011–2012, but only 40 % had a consultation recorded with a diagnosis of HF.

Self-reported data from the primary care centers identified 10,804 patients, which represents only 33 % of the total number of HF patients.

Proportion treated with ACEI or ARB

The most comprehensive way of calculating the crude proportion of treated patients with ACEI or ARB included all care providers and an observation time of 5 years and resulted in 68 % of the patients treated with ACEI or ARB (Table 2). The proportion was somewhat higher for patients recorded with a

Table 1 Characteristics of the study population according to gender and treatment with angiotensin-converting enzyme inhibitors/angiotensin receptor blockers

	Entire heart failure population		Proportion treated with ACEI or ARB (%)	
	Women	Men	Women	Men
Total study population, *n* (%)	16,389 (50)	16,364 (50)	58	70
Mean age, years ± SD	82 ± 11	75 ± 12	80 ± 10	74 ± 11
Age categories, *n* (%)				
40–49 years	174 (1)	422 (3)	59	73
50–59 years	518 (3)	1301 (8)	67	81
60–69 years	1579 (10)	3291 (20)	71	79
70–79 years	3456 (21)	4547 (28)	68	75
80–89 years	6750 (41)	5225 (32)	58	65
90–99 years	3777 (23)	1557 (9)	42	47
≥ 100 years	135 (1)	21 (0)	24	14
Age at diagnosis, years ± SD	78 ± 11	71 ± 12	76 ± 11	70 ± 12
Duration of heart failure diagnosis, years ± SD	3.9 ± 3.7	4.1 ± 3.9	4.0 ± 3.8	4.2 ± 3.9
Care provider management				
Primary care only, *n* (%)	3355 (20)	2808 (17)	58	66
Primary care and inpatient care, *n* (%)	2418 (15)	1743 (11)	62	68
Primary care and secondary care, *n* (%)	630 (4)	912 (6)	74	79
Primary care and secondary care and inpatient care, *n* (%)	2407 (15)	3495 (21)	74	82
Secondary care only, *n* (%)	847 (5)	1445 (9)	64	74
Secondary care and inpatient care, *n* (%)	1098 (7)	1927 (12)	71	81
Inpatient care only, *n* (%)	2814 (17)	2718 (17)	54	61
Not enrolled, *n* (%)	480 (3)	297 (2)	31	43
In retirement homes and nursing homes, *n* (%)	2340 (14)	1019 (6)	34	42
Comorbidities				
Hypertension, *n* (%)	12,934 (79)	12,223 (75)	62	73
Diabetes mellitus, *n* (%)	4222 (26)	5075 (31)	66	75
Atrial fibrillation/flutter, *n* (%)	7779 (47)	8566 (52)	59	71
Ischemic heart disease, *n* (%)	7505 (46)	8903 (54)	62	73
Chronic obstructive pulmonary disease, *n* (%)	3649 (22)	3342 (20)	56	65
Chronic renal failure, *n* (%)	1516 (9)	2358 (14)	53	62

Mean values ± SD or proportions, as appropriate. Patients not enrolled in primary care and patients living in retirement homes or nursing homes are excluded from all further calculations

ACEI angiotensin-converting enzyme inhibitors, *ARB* angiotensin receptor blockers

diagnosis of HF both in primary care and by other care providers but was lower for patients recorded with a HF diagnosis only in primary care (Table 2). Patients not enrolled at any primary care center and patients living in retirement or in nursing homes had the lowest proportion of ACEI or ARB treatment (Table 1). The proportion increased somewhat when the observation time was reduced from 5 to 1 year. More men than women were treated with ACEI or ARB (70 vs 58 %, odds ratio 1.70 [1.63–1.78], $P < 0.001$). This finding remained after adjustment for age, type of management, comorbidity, CNI, and duration of HF (odds ratio 1.32 [1.25–1.39], $P < 0.001$).

Variations between primary care centers

There was a large variation (36–88 %) in the proportion of patients treated with ACEI or ARB between different primary care centers, calculated by the most comprehensive way of calculating the indicator (i.e., prescription by any care provider/diagnosis by any care provider) (Fig. 1).

The proportion of patients treated with ACEI or ARB according to self-reported data varied between 8 and 100 %. The correlation between the most comprehensive way of calculating the indicator and self-reported data was poor ($r^2 = 0.063$), and a majority of primary care centers overestimated the

Table 2 The proportion of heart failure patients treated with angiotensin-converting enzyme inhibitors/angiotensin receptor blockers, calculated by different methods

	Observation periods (years) for a recorded diagnosis				
	2008–2012 5 years	2009–2012 4 years	2010–2012 3 years	2011–2012 2 years	2012 1 year
1 Prescription by any care provider/diagnosis by any care provider					
Number of patients (%)	28,617 (100)	26,721 (93)	24,223 (85)	21,120 (74)	16,537 (58)
Proportion (%) with ACEI or ARB[a]	68	68	69	70	72
2 Prescription by any care provider/diagnosis by primary care[b]					
Number of patients (%)	17,769 (62)	16,435 (57)	14,657 (51)	12,496 (44)	9212 [32]
Proportion with ACE or ARB[a]	69	70	71	72	74
3 Prescription only in primary care/diagnosis only in primary care					
Number of patients (%)	6163 (22)	5451 (19)	4561 (16)	3623 (13)	2454 (9)
Proportion with ACEI or ARB[a]	52	53	54	56	59

[a] Proportion of patients dispensed at least one prescription of angiotensin-converting enzyme inhibitors/angiotensin receptor blockers (ACEI or ARB) between July and December 2012[b] Patients had at least one recorded diagnosis with heart failure in primary care but could also have been recorded with this diagnosis by other care providers

proportion of patients treated with ACEI or ARB (Fig. 2a). Bland-Altman plots confirmed also the poor agreement between the most comprehensive way of calculating the indicator and other methods including self-reported data (Fig. 2b–d).

The adjusted odds ratio for treatment with ACEI or ARB decreased with increasing age for both women and men (Table 3). High socioeconomic status was associated with a higher proportion of patients treated with ACEI or ARB. Patients with hypertension, diabetes, ischemic heart disease, or atrial fibrillation also had higher odds of ACEI or ARB treatment, while patients with chronic renal failure and chronic obstructive pulmonary disease had lower odds. The odds of treatment with ACEI or ARB also increased when patients had been recorded with HF diagnosis ≥5 years.

As shown in Table 3, men enrolled in primary care centers with private management had lower odds of treatment with ACEI or ARB, with a similar trend also in women. Patients with recorded diagnosis of HF in both primary care, secondary care, and inpatient care had higher odds of treatment with ACEI or ARB, as compared to patients where fewer levels of care were involved. Care provider continuity at the primary care center level, physician density, the size of primary care center, adherence to the regional Drug and Therapeutics Committee guidelines, and overall diagnosis reporting rate showed no associations with high proportion of patients

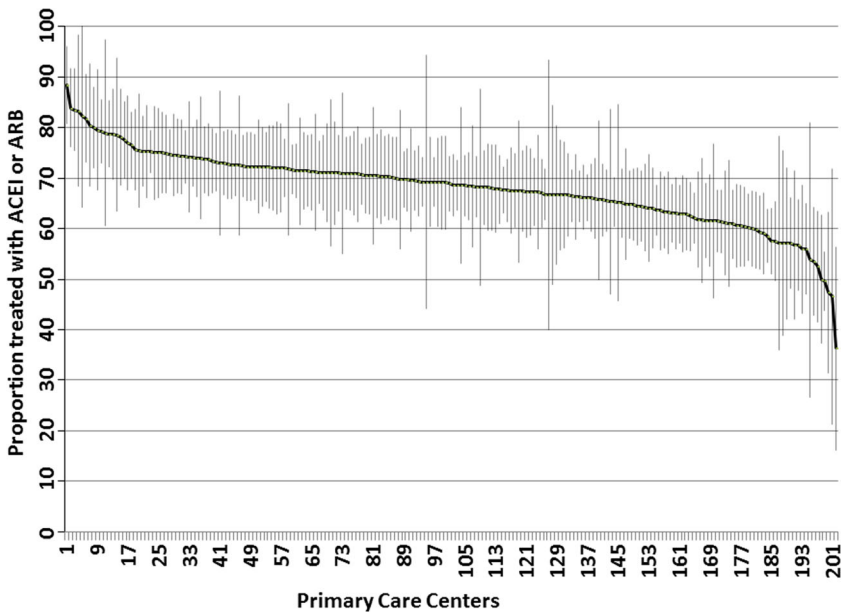

Fig. 1 The proportion of all recorded patients with heart failure in each primary care center, treated with ACEI or ARB prescribed by any care provider, including 95 % confidence intervals. Results from 202 primary care centers with more than ten enrolled patients with heart failure

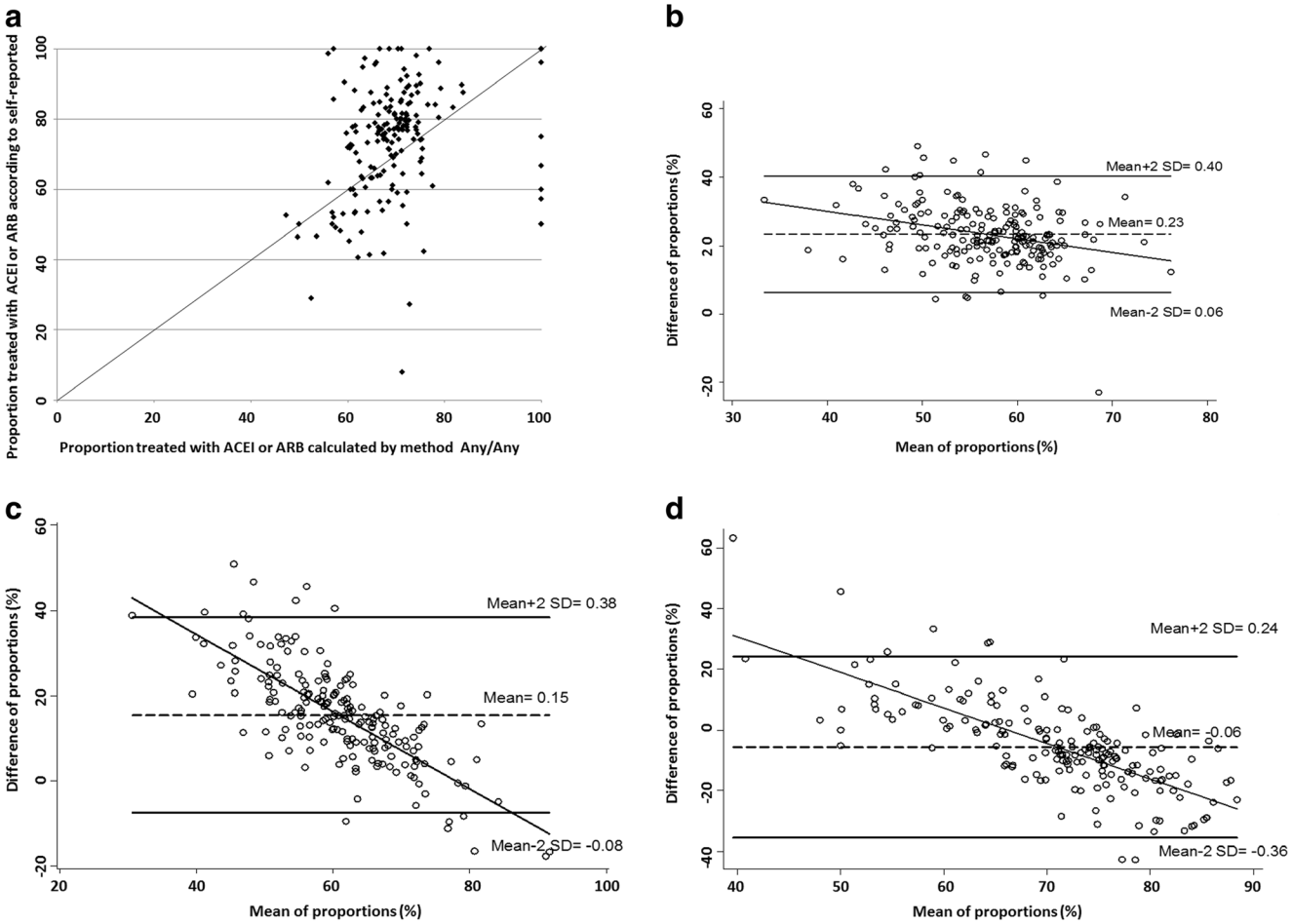

Fig. 2 Agreement between different methods to calculate the proportion of patients with heart failure treated with ACE or ARB, in each primary care centers. **a** Correlation between register-based calculation and self-reported data ($r^2 = 0.062$). **b** Bland-Altman graph comparing the proportion of treated patients, calculated by method prescribing from all providers to all patients (any/any) with the method prescribing from all providers to patients identified in primary care (any/primary care). rhoc = 0.07 (0.05–0.10). **c** Bland-Altman graph comparing the proportion of treated patients, calculated by method prescribing from all providers to all patients (any/any) with the method prescribing from primary care to patients identified only in primary care (only primary care/only primary care); rhoc = 0.23 (0.18–0.29). **d** Bland-Altman graph comparing the proportion of treated patients, calculated by method prescribing from all providers to all patients (any/any) with the method self-reported data from each primary care center; rhoc = 0.19 (0.11–0.28). *Open circles* represent observation with mean value of measurements as "*x*" and their difference as "*y*." *Dashed black lines* show mean measurement error, and *solid black lines* show limits of agreement at 95 %

treated with ACEI or ARB in the multi-level analysis (data not shown).

Discussion

The major findings in this large cross-sectional population-based study are that the number of patients recorded with HF, as well as the calculated proportion of patients treated with ACEI or ARB, is critically dependent on methods for data collection and analysis. Second, we observed considerable variation between different primary care centers in the proportion of treated patients. This variation was explained by patient characteristics, as well as characteristics of the different primary care centers.

We identified more than 32,000 patients with a diagnosis of HF recorded by any care provider during a 5-year period. As expected, a shorter period of observation, restricted to patient only recorded in primary care, reduced the number of patients substantially. Although most patients (89 %) consulted their general practitioner for other health problems during a 2-year period, a diagnosis of HF had been recorded for just half of them. This might imply that many patients did not have a regular follow-up for HF by their general practitioner. In support of our previous findings, a correct assessment of the number of patients with HF requires a long observation period and should include all care providers [1].

Two thirds of all HF patients were treated with ACEI or ARB in our study. The proportion of patients treated with ACEI or ARB varies between 30 and 93 % in different studies

Table 3 Multi-level analysis for patients with a diagnosis of heart failure in 2012 and the odds ratio for treatment with angiotensin-converting enzyme inhibitors or angiotensin receptor blockers (ACEI/ARB)

	Multilevel odds ratio with 95% confidence intervals	
	Women	**Men**
Age categories		
40– 59 years	1	1
60– 69 years	1.15 (0.94–1.41)	0.92 (0.79–1.07)
70– 79 years	0.89 (0.74–1.08)	0.70 (0.60–0.81)
80– 89 years	0.61 (0.51–0.73)	0.44 (0.39–0.51)
≥90 years	0.32 (0.26–0.38)	0.21 (0.17–0.25)
Type of tenure		
Public	1	1
Private	0.93 (0.85–1.02)	0.85 (0.78–0.94)
Care need index		
– 30 welfare	1.20 (1.09–1.34)	1.19 (1.07–1.32)
-20	1.14 (1.06–1.22)	1.12 (1.05–1.20)
-10	1.07(1.03–1.10)	1.06 (1.02–1.10)
-5	1.03 (1.01–1.05)	1.03 (1.01–1.05)
0	1	1
5	0.97 (0.95–0.99)	0.97 (0.95–1.00)
10	0.94 (0.91–0.97)	0.94 (0.91–0.98)
20	0.88 (0.82–0.94)	0.89 (0.83–0.95)
30 deprivation	0.83 (0.75–0.92)	0.84 (0.76–0.93)

Table 3 (continued)

Comorbidities		
Heart failure only	1	1
Hypertension	2.52 (2.30–2.76)	1.97 (1.81–2.15)
Diabetes mellitus	1.25 (1.15–1.37)	1.24 (1.13–1.35)
Ischemic heart disease	1.18 (1.09–1.27)	1.36 (1.26–1.47)
Atrial fibrillation/flutter	1.09 (1.01–1.17)	1.13 (1.04–1.22)
Chronic obstructive pulmonary disease	0.73 (0.67–0.80)	0.68 (0.62–0.74)
Chronic renal failure	0.66 (0.58–0.75)	0.55 (0.50–0.62)
Duration of heart failure		
<2 years	1	1
2–4 years	0.82 (.75–0.90)	0.85 (0.78–0.93)
5–9 years	1.06 (0.96–1.18)	1.04 (0.94–1.16)
≥10 years	1.19 (1.03–1.37)	1.29 (1.12–1.49)
Care provider		
Primary care only	1	1
Primary care and secondary care and inpatient care	1.65 (1.50–1.82)	1.86 (1.67–2.07)
Inpatient care and secondary care	1.00 (0.91–1.10)	1.09 (0.98–1.21)
Variance	0.05 (0.03–0.08)	0.024 (0.02–0.06)
Mean Odds Ratio	1.16	1.16
Intraclass Correlation Coefficient	0.01(0.003–0.020)	0.01(0.003–0.015)

Including care providers characteristics, where Care Need Index (CNI) is a measure of socioeconomic status associated with proportion of treated patients with ACE inhibitors or angiotensin receptor blockers (ACEI/ARB)

depending on methodology and study populations [22, 23]. Shortening the observation period suggested slightly higher proportions. However, this overestimation is anticipated as newly diagnosed patients and those with a recent medical consultation are expected to have better adherence to a prescribed regimen. These findings further support the use of a prolonged period of observation in order to obtain reliable assessment of the quality indicator.

Self-reported data by the care provider on the quality of drug treatment showed poor agreement with the calculations based on register data. This agrees with findings that self-reported data largely overestimates adherence to guidelines, and the magnitude of bias may be greater than the degree of improvement after guideline implementation interventions [24]. Self-reports, in general, are also marred with many problems in the absence of both technical and scientific skills for making reliable and valid reports, while it takes time from the care of patients. Thus, the rapid technological developments, which have opened the way for safer and more valid analyses of large data sets, should be used to provide appropriate estimates of drug treatment in HF.

Our results showed that the proportion of patients treated with ACEI or ARB varied substantially between different primary care centers. This was only partly explained by differences in patient and care provider characteristics. Other pathophysiological and contextual factors may also contribute, e.g., the proportions of patients with HF with preserved and reduced ejection fraction, continuity of care, HF management programs and their implementation, access to consultations with cardiology specialists, and patient adherence to drug therapy [25, 26]. It is also important to recognize the random variation in small practices with few patients recorded with HF. Nevertheless, it is likely that there is room for improvement in most practices. HF management programs in primary care adapted to the patient population may be a useful strategy to improve the care [27].

The strongest predictor of treatment was patient age. Fewer elderly were treated with ACEI or ARB. This is in agreement with previous studies and can be explained by the more complex comorbidities, concomitant drug therapy, and impaired renal function [7]. Socioeconomic deprivation is a strong predictor of HF morbidity and mortality, but the evidence on the association between socioeconomic status and quality of drug treatment is limited and conflicting [28]. We showed an inverse association between socioeconomic deprivation and the quality of care (i.e., treatment with ACEI or ARB). The inconsistencies in previous studies are likely due to differences in reimbursement systems or study populations or the difficulties in most countries to link medication with socioeconomic data. We also found that patients recorded with HF diagnoses in both primary care, secondary care, and inpatient care were more likely treated. However, patients with no diagnosis recorded in primary care were, to a larger extent, untreated. This finding may depend on a lack of communication between care providers, which is a known problem in patients with chronic disease [29, 30].

The strength of this study is that it is based on data from 2.1 million persons. This comprises close to a quarter of the Swedish population and makes the results likely to be highly representative for Sweden. Furthermore, data were obtained unbiased from a unique population-based database with all healthcare consumption and recorded diagnoses in the region. Finally, we had complete data on dispensed drugs, which provide a more appropriate picture on how patients actually are treated than prescription data from medical records [31].

However, we acknowledge some important study limitations. First, the diagnosis of HF was obtained from patient records through the administrative registers and relies on the accuracy in diagnosing and recording by each physician. However, most patients (79 %) attended secondary or hospital care at least once, suggesting that the recorded diagnosis may have been supported by more objective methods (e.g., echocardiography or natriuretic peptides) and should be considered reliable. Previous studies have shown a high validity of a recorded HF diagnosis in Swedish hospital records [32, 33]. Second, we had no data on how management and care of patients with HF were organized in the individual primary care centers, and we could not adjust our data for socioeconomic differences at an individual patient level. Third, information on functional class (by New York Heart Association class or by assessment of quality of life) and on left ventricular ejection function was not available in this study. Others have shown that the prevalence of HF with preserved ejection fraction is comparable to HF with reduced ejection fraction in primary care [2]. In contrast to HF with reduced ejection fraction, there is currently no evidence for specific treatment with ACEI or ARB in HF with preserved ejection fraction. However, HF with preserved ejection fraction is mostly complicated by hypertension, where treatment with ACEI or ARB is recommended and widely used. Thus, the Swedish Heart Failure Registry with more than 63,000 patients reported that 68 and 87 % of HF patients with preserved and reduced ejection fraction, respectively, were prescribed ACEI or ARB in 2014 [34]. Nevertheless, differences in the case mix of patient populations between practices could make it more difficult to set fixed target levels for the quality indicator. In conclusion, there is poor agreement between different methods to calculate adherence to guidelines for drug treatment in HF. Long observation periods and unbiased data extraction from registries including all care providers facilitate the most appropriate estimate. Differences between practices concerning patient age, socioeconomic status, comorbidity, and the care given by different care providers should be taken into account in assessing target levels for indicators measuring quality of drug treatment in patients with HF.

Author's contributor RZ was responsible for the design, analyses, and manuscript writing. TK and BW contributed to the design and provided critical advice throughout the study. RZ and SEJ were responsible for data management, data analysis, and statistical analysis. PW and MM provided scientific input and critical advice to the planning, analyses, and interpretation of findings. All authors critically revised the manuscript and approved the final manuscript.

Compliance with ethical standards The study conforms to the principles outlined in the Declaration of Helsinki. The regional Ethical Review Board in Stockholm approved the study. All data were extracted electronically and obtained in non-identifiable form.

Funding The study was funded by the Stockholm County Council Drug and Therapeutics Committee and Karolinska Institutet Research Foundations.

Conflict of interest The authors declare that they have no conflict of interest.

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