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ORIGINAL RESEARCH ARTICLE

Impact of an extended audit on identifying heart failure patients in general practice: baseline results of the OSCAR-HF pilot study

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Abstract

Aims Identifying heart failure (HF) patients in general practice is challenging, and little is known about the current quality of care. We implemented an extended audit from the electronic health records (EHRs) of general practitioners (GPs) to identify HF patients and investigate patient characteristics and quality of care.

Methods and results This study describes the baseline results of the OSCAR-HF pilot study in eight general practices (51 GPs) in Flanders, Belgium. This prospective trial ran for 6 months. Interventions included an extended audit, an N-terminal pro-B-type natriuretic peptide point-of-care test, and assistance of a specialist HF nurse. The extended audit searched on risk factors for HF, HF symptoms, signs, and medication in the GPs' EHR to generate a list of possible HF patients. GPs determined which patients had HF. Those HF patients constituted the OSCAR-HF study population. Each patient file was manually revised to extract biomarker measurements, echocardiography data, and quality indicators. An independent panel of experts assessed the validity of GPs' HF diagnoses. Feedback about the validity of the HF diagnosis was given to the GP. Out of 18 011 patients $\geq$ 40 years, we identified 310 patients with a registered HF diagnosis before the study start (HF prevalence: 1.7%). The extended audit led to a 74% increase in identified HF patients (n = 538, HF prevalence: 3.0%) with a mean age of 79 ± 11 years. The prevalence of HF with reduced ejection fraction (HFrEF) was 20% (n = 110). A high proportion of patients underwent echocardiography in the past 5 years (86%, n = 462). Natriuretic peptides were rarely available in patients' files (19%, n = 100). Medical specialists should improve communication about the HF diagnosis because a specialist diagnosis was present in only 225 patients (42%) while 67% (n = 359) of the HF diagnoses were judged objectified by a panel of experts. Assigning a diagnosis of HF was particularly difficult in HF patients with preserved EF (HFpEF). HFrEF treatment rates with renin–angiotensin–aldosterone system blockers (84%, n = 92) and beta-blockers (86%, n = 94) were very good; however, target doses were hardly reached (34% and 14%, respectively).

Conclusions This study highlighted the need to improve case finding for HF in general practice and showed that an extended audit in the GPs' EHR was a successful strategy to do so. To improve the quality of HF care in general practice, specific strategies are needed to diagnose HFpEF and to reach target doses of disease-modifying drugs in HFrEF patients.

Keywords Heart failure; General practice; Audit; Clinical; Quality of care; Diagnosis; Treatment

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Introduction

General practitioners (GPs) play a central role in the management of patients with heart failure (HF).[1,2] Despite the importance of the general practice setting for HF management, most clinical trials take place in a hospital setting.[3] However, compared with the classic HF trial population, HF patients managed by GPs are generally older, multimorbid patients for whom a horizontal integrated care approach fits better than a vertical disease-specific approach.[3,4] High-quality data about general practice HF patients are limited.[3,5]

The main challenge is identifying HF patients in general practice.[3,6] The validity of a GP's HF diagnosis remains controversial,[6,7] and access to technical investigations, such as echocardiography and biomarkers, is often limited.[1,3] These limitations have resulted in a large heterogeneity in identification methods used in general practice.[3] Searching electronic health records (EHRs) for registered diagnoses of HF is widely used as an identification method but holds the risk of under-diagnosis and over-diagnosis.[3,8,9] Screening a population with echocardiography is the gold standard method; however, this method is neither realistic nor cost-effective on a larger scale.[3,10,11] Therefore, we developed an extended audit and feedback method in GPs' EHRs to optimize the identification of HF patients in general practice. GPs' EHRs are well placed as data sources for audits and feedback, which are defined as 'any summary of clinical performance of health care, given in a written, electronic or verbal form'.[12–14] To our knowledge, using a clinical audit as an intervention to optimize the identification of HF patients has not been previously described in the literature.[3,15]

Covering real-world HF patients is important because contemporary data on the quality of HF care in general practice are missing.[1,16] There is a particular need to distinguish between patients with HF, reduced ejection fraction (HFrEF), and HF with preserved EF (HFpEF).[3] Without the distinction between HFrEF and HFpEF or without reporting dosages of treatment, the quality of HF treatment is difficult to assess.[16,17] Additionally, important advances in the management of HF have occurred in the past two decades; moreover, the majority of HF studies in general practice collected their data before 2001.[1,3,11]

Therefore, this article aims to report the effect of an extended clinical audit in the GPs' EHR on the identification of HF patients in general practice. Additionally, the characteristics of HF patients in general practice and the current quality of care were evaluated.

We report the baseline results of the OSCAR-HF pilot study. The general aim of the OSCAR-HF pilot study was the optimization of HF care in general practice.[18] Apart from the extended clinical audit, OSCAR-HF study interventions consisted of individualized feedback about the validity of the HF diagnosis for GPs, an N-terminal pro-B-type natriuretic peptide (NT-proBNP) point-of-care test, and assistance of a specialist HF nurse to aid GPs in diagnosis and treatment of HF patients.

Methods

Study population

Baseline data collection took place within the prospective non-randomized OSCAR-HF pilot study in eight general practices in Flanders, Belgium.[18] In brief, four general practices were recruited from the Eastern part of Flanders (Bilzen, Limburg), and four general practices were recruited from the central part of Flanders (Leuven, Vlaams-Brabant). Physicians were eligible if they actively used EHRs in their daily practice. Patients were eligible if they were 40 years or older, had their electronic medical records registered with one of the participating GPs, and had a confirmed HF diagnosis by their GP. We chose to focus on patients aged 40 years or older because younger HF patients often require more specialized care and therefore differ from the common HF population in general practice. There were no exclusion criteria set prior to the beginning of the study. However, GPs could advise on the exclusion of patients on the basis of their knowledge of the patient and contextual factors. Patients were recruited between January and June 2017. The OSCAR-HF pilot study was registered at clinicaltrials.gov on 14 September 2016 (NCT02905786).

Ethical considerations

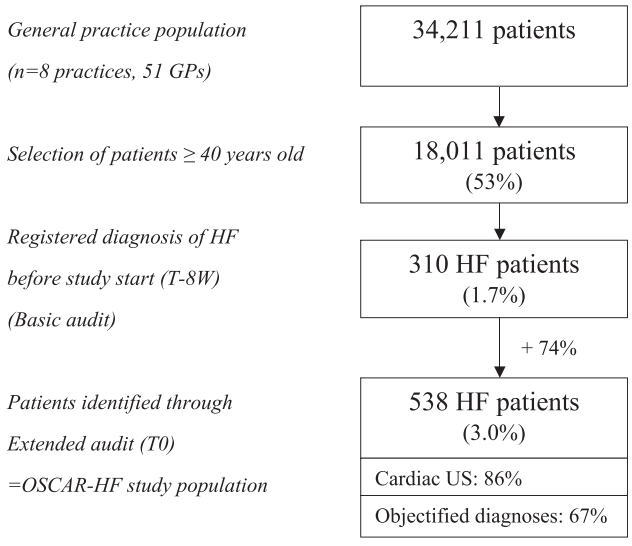
This study conformed to the principles outlined in the Declaration of Helsinki. Before the study began, all participating GPs provided informed consent. An opt-out procedure was used for the identification of HF patients and the description of baseline characteristics and quality of care of the patient. Additionally, all identified HF patients were invited to a study visit with the HF nurse and were asked if they would provide informed consent. Patients were only eligible for further study interventions if they gave informed consent. Quality-of-life questionnaires and grip strength at baseline were only collected from patients who gave informed consent. Ethics committee approval was obtained from the University Hospitals Leuven Ethics Committee in November 2016 (B322201630391).

Interventions

All GPs had access to an e-learning course covering the HF diagnosis and attended a meeting where the European Society of Cardiology (ESC) definition of HF and the

challenges of diagnosing HF were discussed.[11] First, a basic audit search for registered diagnoses of HF (coded and/or free-text diagnosis) was performed by the principal investigator (PI) to generate a benchmark (Data S1). Second, an extended audit in GPs' EHRs was performed by the PI to optimize the identification of the HF population. This extended search in EHRs included coded or free-text diagnoses of risk factors for HF, symptoms, and signs of HF and medications for HF in different combinations (Data S2) (*Figure* 1). The list of all possible HF patients was then presented to each treating physician, and they were asked to judge whether or not patients had HF or possible HF, on the basis of their knowledge of the patient file. The patients reported to be suffering from HF by the respective GPs constituted the OSCAR-HF study population. To assess the validity of GPs' HF diagnoses and to judge the presence of objectified HF, an expert panel was formed and consisted of an independent cardiologist who specialized in echocardiography and a geriatrician with specific interest in heart disease; neither was involved in the care of the OSCAR-HF patients. The panel also included a GP with a special interest in HF (M. S.). The expert panel discussed each 10th case using the ESC guideline as a reference standard.[11] Based on these discussions, a diagnostic flowchart was constructed to facilitate a standardized approach for each case (*Figure* 2). In the diagnostic flowchart, the cut-off for B-type natriuretic peptide (BNP) and NT-proBNP was set at 400 and 2000 ng/L, respectively, because a diagnosis of HF is plausible with these cut-off values.[19] Clinically relevant valvular disease was defined as mitral stenosis of any severity, severe aortic stenosis (aortic valve area < 1 cm^2), moderate or severe mitral regurgitation, and moderate or severe aortic regurgitation.[7] Severe diastolic dysfunction was defined as grade III diastolic dysfunction or any grade with increased cardiac filling pressures. On the basis of available echocardiographic data, patients were classified as follows: HFrEF $< 40\%$, HF with mid-range EF (HFmrEF) 40–50%, or HFpEF $\geq 50\%$.[11] Patients with an antecedent of a reduced EF were considered HFrEF patients. Patients with no echocardiographic data (no data from the past 5 years or longer) were judged as non-classifiable.

Figure 1 Study flowchart.



Data collection

We collected all variables manually from each individual's electronic patient file in general practice. The baseline data described in this study were retrospective data. A comprehensive overview of all collected variables can be found in the study protocol.[18] Target doses of renin–angiotensin–aldosterone system (RAAS) blockers and beta-blockers were based on the Belgian Centre for Pharmacotherapeutic Information (www.bcfi.be).[11,20] A registered HF diagnosis in the problem list of the electronic patient file was extracted as a quality indicator, together with a specialist HF diagnosis. The latter meant that a medical specialist assigned the HF diagnosis formally in the patient report. HF hospitalization during the last 3 years was registered at baseline. Moreover, at the first study visit, the validated Dutch version of the Minnesota living with HF questionnaire [Minnesota Living with Heart Failure Questionnaire (MLHF-Q)] (Data S3) was collected,[21] together with grip strength measured in the dominant hand using a JAMAR® Plus digital hand-held dynamometer. The maximal value of three attempts was reported.[22,23] Strength values of <30 kg for men and <20 kg for women were used as cut-off values to define sarcopenia.[22,23]

Data analysis

Continuous variables were presented as the mean ± standard deviation (SD) or as medians and inter-quartile ranges. Categorical data were presented as frequencies and proportions. Baseline variables were compared using the χ^2 test (categorical variables), and the independent samples *t*-test or Kruskal–Wallis test (continuous variables). All data analyses were performed using SPSS 24.0 for Windows (SPPS Inc., Chicago, Illinois, USA).

Results

Fifty-one GPs working in eight practices participated in the study. *Table* 1 describes the characteristics of the participating practices. These GPs cared for a total (registered) patient

Figure 2 Diagnostic flowchart used in the OSCAR-HF pilot study.

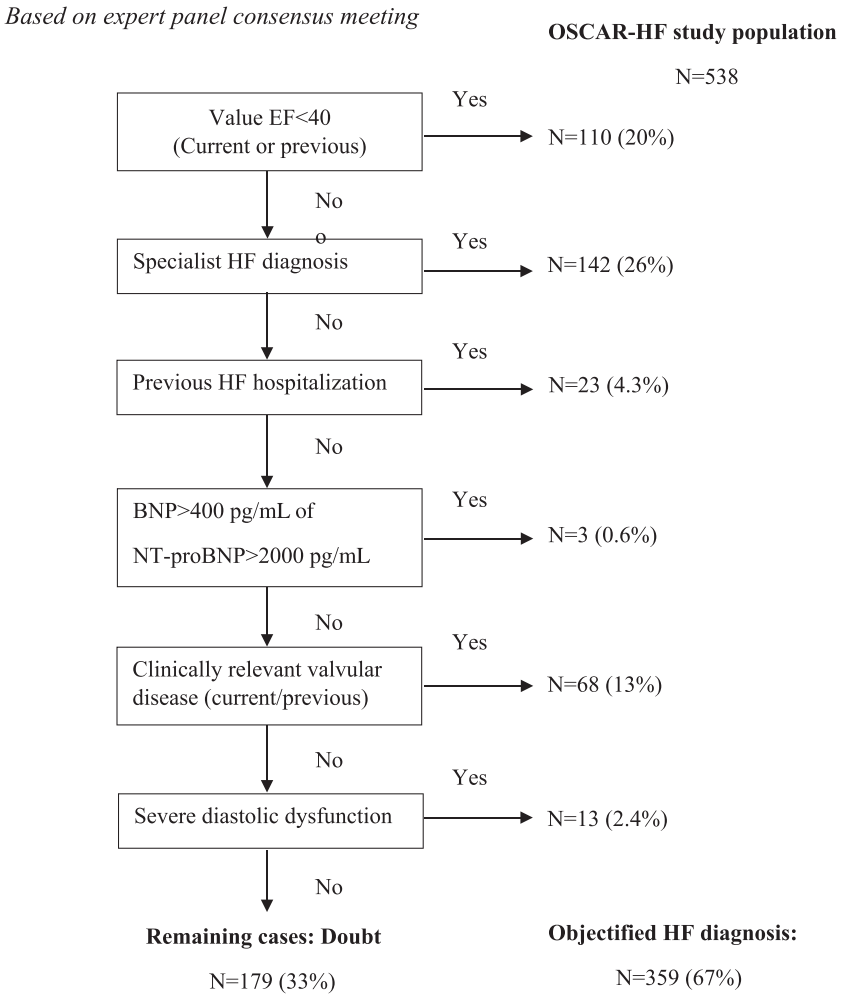


Table 1 Characteristics of the participating practices

	Number of GPs	Total practice population	Region	Distance to hospital in time (min)
1	6, 1 trainee	4816	Rural	13–20
2[a]	4, 1 trainee 2 1	7679	Rural	11–28
3[a]	2, 1 trainee 1	2933	Rural	11–23
4	6, 1 trainee	5179	Rural	12–22
5	7, 2 trainees	5169	Urban	8–12
6	6, 1 trainee	3502	Suburban	6–8
7	5, 2 trainees	3526	Urban	7–10
8	2	1407	Urban	4–9

[a]These practices work together in a network. They share the same electronic health record system but work at different locations.

population of 34 211 patients. Our study population consisted of 18 011 patients (53%) aged 40 years and older (*Figure* 1).

Identification of heart failure patients

The search for a registered HF diagnosis (coded and/or free-text diagnosis of HF) in GPs' EHRs found 310 patients, representing a prevalence of HF for 1.7% of patients aged 40 years and older before the study start. The extended audit increased this number by 74% to include 538 patients appointed by their GPs, which represented the OSCAR-HF study population and amounted to a prevalence of HF for 3.0% of patients aged 40 years and older (*Figure* 1). A recent echocardiography (<5 years) was available in 86% (n = 462), and objective evidence for a HF diagnosis was judged present in 359 patients (67%) (*Figure* 2). In the remaining 33% (n = 179), the HF diagnosis remained uncertain. In 60 of these 179 patients (34%), a recent echocardiography (<5 years) was missing. In the remaining 119 patients (66%), their echocardiography results were inconclusive, and natriuretic peptides were available for only six of these patients (3.4%).

Characteristics of heart failure patients in general practice

The mean age of the OSCAR-HF study population was 79 ± 11 years, with an equal distribution of men and women, and 11% (n = 57) of the study population were institutionalized patients (*Table* 2). Hypertension was the leading co-morbidity (64%, n = 345), followed by atrial tachycardia (49%, n = 266) and ischaemic heart disease (44%, n = 239). A high prevalence of cancer (22%, n = 117), depression (21%, n = 113), and obesity (body mass index $\geq$ 25, 45%, n = 242) was observed. Additionally, HF patients received a high number of chronic medications (8.2 ± 3.5) and were treated for multiple chronic diseases (5.6 ± 2.4) (*Table* 2).

Patients with an objectified diagnosis did not differ from patients with an uncertain diagnosis with respect to their mean age and the proportion of men (*Table* 2). Inherent to the diagnostic flowchart used to classify the cases (*Figure* 2), HFrEF patients and patients with clinically relevant valve disease were automatically judged objectified cases, leading to significant differences in these areas. However, patients with an uncertain HF diagnosis also had a significant lower number of chronic medications (7.4 vs. 8.6, P = 0.05) and lower proportion of atrial tachycardia (29% vs. 60%, $P < 0.001$) (*Table* 2).

In general, HFrEF accounted for 20% (n = 110) of the study population and 31% (n = 110/359) of the objectified diagnosis group; however, 42% of these HFrEF patients (n = 46) had a recuperated EF (≥40) at the time of the study. The mean age was 75 ± 13 years for HFrEF patients, 80 ± 9.9 years for HFpEF patients, and 82 ± 13 years for non-classifiable patients.

Evaluating heart failure care in general practice

Heart failure diagnosis

A small part of the study population (8.7%, n = 47) was non-classifiable. These patients were older, significantly more institutionalized (12/47, 26%, $P < 0.001$), and less hospitalized in the past 3 years than the classifiable study population (30% vs. 64%, respectively). In total, natriuretic peptides were only available in 19% (n = 100) of the patient files at baseline with 2/3 NT-proBNP vs. 1/3 BNP. The EF was described quantitatively in 58% (n = 279) of the available echocardiography reports. A specialist HF diagnosis was missing in 24% (n = 27) of the HFrEF patients, 49% (n = 37) of the HFmrEF patients, and 66% (n = 202) of the HFpEF patients. This corresponded with the low percentages of registered HF diagnoses in GPs' EHRs (*Table* 3).

Heart failure treatment

High percentages of RAAS blockers and beta-blockers were observed in HFrEF patients (84% and 86%, respectively). However, target doses were seldom reached (34% for RAAS blockers and 14% for beta-blockers). Contraindications to start or titrate medication were withheld by the PI in a small part of the study population (*Table* 3). Mineralocorticoid receptor antagonists (MRAs) were prescribed in 58% of HFrEF patients with an EF $\leq$ 35 (n = 87). It was not possible to reliably distinguish symptomatic patients in the HFrEF group that were not treated with MRAs. In general, the prescription of loop diuretics was rather low (39%, n = 207), although in patients with an objectified HF diagnosis, the prescription rate was 51% (n = 183). Angiotensin receptor neprilysin inhibitors were only recently introduced and reimbursed in Belgium, which explains their low prevalence (n = 2, 0.4%) in this study.

Heart failure follow-up

In total, 495 patients (92%) had a GP consultation in the past 6 months. In the remaining 8% of patients, nothing was registered in their EHRs, but possibly the GP made notes in a chronic care facility file or at patients' homes. This result corresponds with the lower percentage of GP follow-ups in non-classifiable patients (81%, n = 38/47) who were more frequently institutionalized. A cardiologist follow-up (in the past 18 months) was documented in 70% (n = 373) of the total population, with the highest rates in HFrEF and HFmrEF patients (88 and 84%, respectively). In the objectified diagnosis group, 80% of patients (n = 287) had a cardiologist follow-up in the recent past compared with 48% (n = 86) in the patient group with an uncertain HF diagnosis. In total, 64% (n = 345) of the OSCAR-HF population was hospitalized at least once in the past 3 years for any cause, with the highest rates in HFrEF and HFmrEF patients (74 and 72%, respectively). However, repeated hospitalizations for any cause were frequently observed in HFmrEF and HFpEF patients (20 and 22%, respectively, vs. 12% in HFrEF patients). The proportions of cardiovascular hospitalizations were equal for all HF phenotypes (32–33%), while HF hospitalizations were clearly more prevalent in HFrEF patients (41%) than those in HFmrEF (36%) and HFpEF patients (22%) (*Table* 3).

Discussion

The extended audit was a successful strategy to identify HF patients in general practice and led to a 74% increase in our study population, extending from 310 patients with HF before the study start to 538 patients with HF after the extended audit. The identified HF population was old with a high burden of co-morbidity and polypharmacy and consisted of 20% HFrEF patients. The proportion of patients with an echocardiography in the past 5 years was high (n = 462, 86%), while natriuretic peptides were hardly available in patients' EHRs. However, caution is needed with regard to over-diagnosis, as only 67% of the HF diagnoses could be objectified. Specialists need to pay attention to the communication of the HF diagnosis to GPs. The lack of clear specialist HF diagnoses correlated with poor registration of the HF diagnosis in the GPs' EHR.

Table 2 Baseline characteristics of OSCAR-HF patients

	Total population $n = 538$	Objectified HF diagnosis		P-value[a]
		Yes $n = 359$	No $n = 179$	
Socio-demographic characteristics				
Age (years), mean ± SD	79 ± 11	79 ± 11	79 ± 12	0.74[b]
Male, n (%)	268 (50)	176 (49)	92 (51)	0.60
Institutionalized, n (%)	57 (11)	37 (10)	20 (11)	0.76
Type of HF				
HFrEF, n (%)	110 (20)	110 (31)	0 (0)	<0.001
With recuperated EF, n (%)	46 (42)			
Recuperation to EF 40–50, n (%)	18 (39)			
Recuperation to EF ≥ 50, n (%)	28 (61)			
HFmrEF, n (%)	75 (14)	56 (16)	19 (11)	0.12
HFpEF, n (%)	306 (57)	192 (54)	114 (64)	0.024
Non-classifiable, n (%)	47 (8.7)	1 (0.3)	46 (26)	<0.001
Echocardiographic variables				
Diastolic dysfunction, n (%) (n = 489)	230 (47)	165 (46)	65 (49)	0.69
Ejection fraction (n = 491)				
Described quantitatively, n (%)	279 (52)	214 (60)	65 (36)	<0.001
Mean EF ± SD (n = 279)	52 ± 14	50 ± 15	59 ± 10	0.004[b]
Clinically relevant valve disease,[c] n (%) (n = 489)	196 (40)	196 (55)	0 (0)	<0.001
Left atrial enlargement, n (%) (n = 487)	231 (48)	189 (54)	42 (31)	<0.001
Left ventricular hypertrophy, n (%) (n = 488)	157 (32)	129 (37)	28 (21)	0.001
Co-morbidities				
Ischaemic heart disease, n (%)	239 (44)	170 (47)	69 (39)	0.05
Valvular heart disease, n (%)	78 (15)	68 (19)	10 (5.6)	<0.001
Hypertension, n (%)	345 (64)	228 (64)	117 (65)	0.67
Diabetes, n (%)	164 (31)	112 (31)	52 (29)	0.61
Cerebrovascular disease, n (%)	95 (18)	67 (19)	28 (16)	0.39
Atrial tachycardia, n (%)	266 (49)	214 (60)	52 (29)	<0.001
Peripheral arterial disease, n (%)	53 (9.9)	37 (10)	16 (8.9)	0.62
COPD, n (%)	76 (14)	50 (14)	26 (15)	0.85
Asthma, n (%)	47 (8.7)	32 (8.9)	15 (8.4)	0.84
Hyperthyroidism, n (%)	51 (9.5)	36 (10)	15 (8.4)	0.54
Hypothyroidism, n (%)	48 (8.9)	32 (8.9)	16 (8.9)	0.99
Cancer, n (%)	117 (22)	72 (20)	45 (25)	0.18
Congenital heart disease, n (%)	14 (2.6)	11 (3.1)	3 (1.7)	0.34
Dementia, n (%)	60 (11)	39 (11)	21 (12)	0.76
Depression, n (%)	113 (21)	74 (21)	39 (22)	0.75
Cardiovascular risk factors				
Blood pressure (n = 441)				
Last systolic blood pressure, mean ± SD	128 ± 16	128 ± 16	131 ± 17	0.37[b]
Last diastolic blood pressure, mean ± SD	74 ± 9.0	74 ± 8.9	76 ± 9.2	0.78[b]
Kidney function (n = 511)				
eGFR, mean ± SD	60 ± 21	58 ± 21	65 ± 20	0.24[b]
eGFR < 30, n (%)	39 (7.6)	31 (8.6)	8 (4.4)	0.10
Lipid metabolism				
Last total cholesterol, mean ± SD (n = 511)	172 ± 39	171 ± 38	177 ± 40	0.51[b]
Last LDL, mean ± SD (n = 482)	96 ± 32	95 ± 32	98 ± 31	0.96[b]
Last HDL, mean ± SD (n = 485)	53 ± 15	53 ± 16	53 ± 13	0.007[b]
Haemoglobin, mean ± SD	13.4 ± 1.8	13.2 ± 1.8	13.7 ± 1.8	0.54[b]
Obesity, n (%)	n = 349	n = 244	n = 105	
BMI 25–30, n (%)	130 (37)	95 (39)	35 (33)	0.11
BMI ≥ 30, n (%)	112 (32)	72 (30)	40 (38)	0.041
Number chronic medications and diseases				
Number of chronic medications, mean ± SD	8.2 ± 3.5	8.6 ± 3.5	7.4 ± 3.3	0.05[b]
Number of chronic diseases, mean ± SD	5.6 ± 2.4	5.8 ± 2.3	5.0 ± 2.3	0.70[b]

BMI, body mass index; COPD, chronic obstructive pulmonary disease; EF, ejection fraction; eGFR, estimated glomerular filtration rate; HDL, high density lipoprotein; HF, heart failure; HFmrEF, heart failure with mid-range ejection fraction; HFpEF, heart failure with preserved ejection fraction; HFrEF, heart failure with reduced ejection fraction; LDL, low density lipoprotein; SD, standard deviation.

[a] χ^2 test.

[b] Independent samples t-test.

[c] Defined as mild as mitral stenosis of any severity, severe aortic stenosis (aortic valve area < 1 cm^2), moderate or severe mitral regurgitation, and moderate or severe aortic regurgitation.

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Table 3 Evaluation of baseline quality of care for heart failure patients in OSCAR-HF pilot study

	Total population *n* = 538	HFrEF *n* = 110	HFmrEF *n* = 75	HFpEF *n* = 306	Non-classifiable *n* = 47	*P*-value[a]
Diagnosis						
Objectified HF diagnosis						
Echocardiography						
Echocardiography past 5 years, n (%)	462 (86)	109 (99)	75 (100)	278 (91)	0 (0)	<0.001
Natriuretic peptides						
Natriuretic peptides present in EHR, n (%)	100 (19)	32 (29)	10 (13)	57 (19)	1 (2.1)	0.005
BNP (lab value), n (%)	34 (34)	10 (9.1)	2 (2.7)	22 (7.2)	0 (0)	0.083
Median value (IQR)	571 (255–910)	700 (320–4956)	896 (616–896)	490 (171–781)	/	
NT-proBNP (lab value), n (%)	67 (67)	22 (20)	8 (11)	36 (12)	1 (2.1)	0.013
Median value (IQR)	1700 (877–4137)	1192 (677–4203)	984 (376–9263)	2099 (1271–4096)	1562	
Objectified HF diagnosis (panel of experts), n (%)						<0.001
Yes, n (%)	359 (67)	110 (100)	56 (75)	192 (63)	1 (2.1)	
Doubt, n (%)	179 (33)	0 (0)	19 (25)	114 (37)	46 (98)	
Registration of HF diagnosis						
Registered diagnosis of HF in GPs' EHR, n (%)	177 (33)	56 (51)	31 (41)	86 (28)	4 (8.5)	<0.001
Specialist diagnosis of HF, n (%)	225 (42)	83 (76)	38 (51)	104 (34)	0 (0)	<0.001
Treatment						
Medical treatment						
RAAS blocker, n (%)	336 (63)	92 (84)	54 (72)	164 (54)	26 (55)	<0.001
Higher than starting dose, n (%)	279 (52)	75 (68)	48 (64)	133 (44)	23 (49)	<0.001
Target dose reached, n (%)	163 (30)	37 (34)	23 (31)	83 (27)	20 (43)	0.058
Contraindication to start or titrate RAAS blocker, n (%)	68 (13)	24 (22)	11 (15)	30 (9.8)	3 (6.4)	0.033
Beta-blockers, n (%)	387 (72)	94 (86)	58 (77)	209 (69)	26 (58)	<0.001
Higher than starting dose, n (%)	350 (65)	91 (83)	52 (69)	185 (61)	22 (47)	0.001
Target dose reached, n (%)	63 (12)	15 (14)	9 (12)	32 (11)	7 (15)	0.001
Contraindication to start or titrate beta-blockers, n (%)	43 (8)	11 (10)	5 (6.7)	26 (8.6)	1 (2.2)	0.79
Loop diuretics, n (%)	207 (39)	57 (52)	29 (39)	114 (37)	7 (16)	<0.001
Thiazide diuretics, n (%)	98 (18)	14 (13)	11 (15)	57 (19)	16 (36)	0.008
MRA, n (%)	150 (28)	55 (51)	21 (28)	66 (22)	8 (18)	<0.001
Digoxin, n (%)	30 (5.6)	7 (6.4)	6 (8.0)	14 (4.6)	3 (6.7)	0.65
Statins, n (%)	319 (59)	68 (62)	57 (76)	173 (57)	21 (47)	0.005
Ivabradine, n (%)	7 (1.3)	6 (5.5)	0 (0)	1 (0.3)	0 (0)	<0.001
ARNI, n (%)	2 (0.4)	1 (0.9)	1 (1.3)	0 (0)	0 (0)	0.43
Devices						
Pacemaker, n (%)	63 (12)	10 (9.1)	10 (13)	42 (14)	1 (2.1)	0.098
CRT/ICD, n (%)	34 (6.3)	29 (26)	3 (4.0)	2 (0.7)	0 (0)	<0.001
Functional status (n = 301)						
Grip strength (n = 293)						
Maximal grip strength,[b] median (IQR)	27 (19–40)	32 (21–46)	28 (20–42)	26 (18–36)	22 (15–34)	0.003[c]
Sarcopenia,[d] n (%)	115 (39)	21 (33)	11 (31)	76 (43)	7 (41)	0.43
Quality of life[e] (n = 298)						
Total score, median (IQR)	19 (8–32)	20 (8–32)	17 (4–30)	19 (8–34)	14 (8–23)	0.61[c]
Physical wellbeing, median (IQR)	10 (3–19)	9.5 (4–20)	11 (2–17)	10 (3–19)	7 (3–15)	0.86[c]
Emotional wellbeing, median (IQR)	4 (1–9)	3 (1–8)	4 (1–10)	5 (1–9)	3 (1–6)	0.38[c]

(*Continues*)

Table 3 (continued)

	Total population $n = 538$	HFrEF $n = 110$	HFmrEF $n = 75$	HFpEF $n = 306$	Non-classifiable $n = 47$	P-value[a]
Follow-up						
By GP						
Past 6 months GP consultation, n (%)	495 (92)	103 (94)	69 (92)	285 (93)	38 (81)	0.031
By cardiologist						
Past 18 months cardiologist consultation, n (%)	373 (70)	97 (88)	63 (84)	205 (67)	8 (17)	<0.001
Past 5 years cardiologist consultation, n (%)	459 (85)	108 (98)	75 (100)	267 (87)	9 (19)	<0.001
Hospitalizations						
At least one hospitalization past 3 years, n (%)	345 (64)	81 (74)	54 (72)	196 (64)	14 (30)	<0.001
n = 1	134 (39)	30 (37)	26 (48)	70 (36)	8 (57)	
n = 2	96 (28)	26 (32)	10 (19)	58 (30)	2 (14)	
n = 3	52 (15)	15 (19)	7 (13)	28 (14)	2 (14)	
n > 3	63 (18)	10 (12)	11 (20)	44 (22)	2 (14)	
Type of hospitalization, n (%)						
Cardiovascular, n (%)	162 (30)	36 (33)	25 (33)	98 (32)	3 (6.4)	0.003
Heart failure, n (%)	139 (26)	45 (41)	27 (36)	67 (22)	0 (0)	<0.001

ARNI, angiotensin receptor neprilysin inhibitor; BNP, B-type natriuretic peptide; CRT, cardiac resynchronization therapy; EHR, electronic health record; GP, general practitioner; HF, heart failure; ICD, implantable cardioverter-defibrillator; IQR, inter-quartile range; Max., maximal; MRA, mineralocorticoid receptor antagonist; NT-proBNP, N-terminal pro-B-type natriuretic peptide; RAAS-blockade, renin–angiotensin–aldosterone system blockade.

[a] χ^2 test.

[b] Maximal value of three consecutive grip strength measurements.

[c] Kruskal–Wallis test.

[d] Defined as maximal grip strength < 30 kg for men, <20 kg for women.

[e] Measured by the Minnesota Living with HF questionnaire; physical wellbeing, added score of Questions 2, 3, 4, 5, 6, 7, 12, and 13; emotional wellbeing, added score of Questions 17, 18, 19, 20, and 21.

Identification of heart failure patients

Prevalence rates for HF depend highly on the setting, the mean age of the population, the definition of HF, and the identification method used, which were confirmed by the current study.[3,9,24,25] The prevalence of HF was 1.7% of the patient population on the basis of a search for a registered diagnosis in GPs' EHRs, and the prevalence of HF increased to 3.0% after implementing an extended audit. The 1.7% HF prevalence is in agreement with other primary care studies, which confirms the need for case finding in general practice[6,9,26] and supports the methodological approach in our OSCAR-HF study. However, more research is needed on the effect of enhanced case findings for long-term clinical endpoints.[27]

Possible over-diagnosis of HF remains an issue. A recent meta-analysis stated that most HF diagnoses in administrative databases correspond to true HF cases,[28] although many other studies contradict these findings.[8,29] Our proportion of 67% of objectified diagnoses is in agreement with two other primary care studies.[8,29] To counter the risk of over-diagnosis, an extended audit to improve case finding requires feedback on the validity of the HF diagnosis, as we did in the OSCAR-HF pilot study. However, providing feedback on the validity of HF diagnoses is particularly challenging for HFpEF patients. The diagnosis of HFpEF can only be validated using strict abnormal findings of diastolic function and remodelling indices on a standard echocardiogram.[30] For a subgroup of HFpEF patients, a standard echocardiogram was not sufficient to conclude on a diagnosis of HFpEF; and natriuretic peptides, exercise testing, or invasive haemodynamics were rarely available.[30] Therefore, the low validity of HF diagnoses in GPs' EHRs or the judgement of GPs on the presence of HF in patients does not necessarily reflect true diagnostic mistakes. These patients likely exhibit clinical manifestations suggestive of HF, but objective evidence of structural or functional cardiac abnormalities is missing at the time of the cardiologist investigation or was not reported.[6,7,30] For this reason, we chose to report the characteristics of the total OSCAR-HF population, especially, because in the continuation of the OSCAR-HF pilot study, our aim was to optimize the diagnostic accuracy and treatment of this study population. However, the characteristics of patients with an objectified HF diagnosis were reported separately to provide all necessary information (*Table* 2).

Characteristics of heart failure patients in general practice

In the OSCAR-HF population, the typical HF phenotype of general practice patients (older, high proportion of women, and high prevalence of hypertension) was confirmed and was even more pronounced than in other primary care cohorts.[1,3,8,29,31] The latter can be explained by our non-selective identification method and reporting; for example, the exclusion of the non-classifiable patients would have led to a lower mean age. A low percentage of HFrEF patients was reported, as in most recent primary care studies; however, this percentage is strongly dependent of the total number of HF patients in the cohort (total vs. objectified diagnoses alone—20% vs. 31%).[1,25,29,31] Importantly, 42% of our HFrEF patients currently had some recovery of EF, also described as HF with recovered EF. A lack of data remains to guide the management of this patient group, while they clearly form a relevant part of the HFrEF population.[32]

Evaluating heart failure care in general practice

Heart failure diagnosis

The proportion of echocardiography was high, showing that barriers for referral for echocardiography hardly exist in Belgium.[1] These findings were in agreement with those of a Spanish study (94%) and were better than those of a Dutch study (74%).[8,29] On the other hand, the availability of natriuretic peptides was low because they are not reimbursed in Belgium. The same result was described in the Spanish study,[29] while natriuretic peptides were clearly more widely used in the Netherlands (69% availability).[8] The remaining uncertainty in HFpEF diagnoses, despite available echocardiography data, pleads for a wider availability of natriuretic peptides in primary care.[11,30,33,34] Another important theme is the communication about the HF diagnosis by specialists that should be improved. Uniform terminology, unequivocal diagnostic terms (e.g. ischaemic cardiomyopathy with reduced EF instead of HFrEF), and clear descriptions of echocardiographic parameters (only in 58% the EF was described quantitatively) were often not used. This led to missing specialist diagnoses in 24% of the HFrEF cases and 66% of the HFpEF cases. Registration of the HF diagnosis by GPs correlated directly with the specialist HF diagnosis. From the perspective of GPs, HF diagnoses often remained uncertain despite specialist referral.[35]

Heart failure treatment

Guideline-recommended therapies disseminated progressively into practice, showing a clear improvement in our study compared with older studies.[1,3,9,16,33] Even to this extent, there is currently little room for improvement in starting RAAS blockers and beta-blockers, especially in a population with a mean age of 75 years. This result was confirmed by recent international studies.[17,36] On the other hand, the need to optimize target doses of RAAS blockers and beta-blockers was emphasized.[36] Possibly, contraindications were not sufficiently registered, and there is less room for improvement, as previously shown by interviewing GPs about their reasons not to prescribe or optimize dosing.[36] Nevertheless, reaching

target doses is certainly a point of attention and calls for a multidisciplinary approach to be optimized.[37] The prescription rate of loop diuretics in this study was much lower than in other primary care studies (39% vs. 54–75%, respectively).[3,8,29] This rate increased to 51% in patients with objective evidence of HF. The main explanation is probably that we explicitly encouraged GPs to consider the HF diagnosis not only in patients with congestion but also in patients with an antecedent of an episode of HF because they are at risk to decompensate again.

To summarize, our data showed that with respect to both HF diagnosis and HF treatment, GPs need continuous education, clear cardiologist communication, and close collaboration.

Heart failure follow-up

Cardiologist involvement was high in our study compared with data reported in a Dutch study.[8] This result is an important quality indicator because it improves adherence to evidence-based treatments and outcomes.[38] Three-year HF hospitalization rates in this study were similar (26% to 24%, respectively)[31] or were slightly higher (18%)[16] than those in other primary care studies. Importantly, a major part of the frequently hospitalized patients (>3 hospitalizations) was HFpEF and HFmrEF patients, most likely driven by non-cardiovascular co-morbidities.[39] Baseline quality-of-life scores measured by the MLHF-Q in this study were low compared with those in other studies (total score 19 vs. 24–29 and 47, respectively) without significant differences between HFrEF and HFpEF.[31,40] Possible explanations are the low percentage of patients on loop diuretics as a proxy for being currently symptomatic. Additionally, Moser *et al*. showed that health-related quality of life (HRQoL) in HF patients improves with age because expectations towards HRQoL change.[40] Based on these findings, there is room for improvement in the reduction of (HF) hospitalizations. Because the QoL in the general population is high, it will be important to stratify interventions on the basis of patients' needs.[31]

Strengths and limitations

The strength of this study is the comprehensive identification method that combines registered EHR data with GPs' judgements and manual reviews of echocardiographic reports. In previous primary care studies, the distinction between HFpEF and HFrEF was only made in 10% of the HF patients, and echocardiographic data were limited, making our study extra valuable.[3] However, a few limitations should be noted. First, there are limitations inherent to the extended audit method. The success of the method depended on the quality of data registration in EHRs. Based on our data, we can assume that not using EHRs only occurs in a small proportion of patients (8%). Additionally, in most practices, the audit procedure led to an increased awareness towards HF diagnoses, stimulating GPs to register HF patients. Furthermore, the success of the audit method was also dependent on the quality of GPs' judgements on HF, which were influenced by GPs' time, rigorousness, and knowledge about HF diagnoses. Therefore, the final step of manually reviewing echocardiographic reports was indispensable when combined with the audit, feedback, and stimulated objectification. Optimally, the audit method would be repeated in time as part of a continuous quality improvement process. Second, judging the validity of a HF diagnosis remains subjective, especially for the diagnosis of HFpEF. We tried to counter this by forming the expert panel and setting up the diagnostic flowchart. Third, as mentioned above, the selection of the study population defines the results. We deliberately chose to report on the full OSCAR-HF population because this is a reflection of the real-world HF population as judged by their GPs; however, there was a risk of over-diagnosing HF in part of the study population. Therefore, we described the characteristics of the patients with an objectified HF diagnosis separately.

Conclusions

This comprehensive general practice study showed that an extended audit combined with feedback in GPs' EHRs was a successful strategy to identify HF patients. Further attention is needed for case finding of HF in general practice, diagnosing HFpEF, and reaching target doses of RAAS blockers and beta-blockers in HFrEF patients. Additionally, HF hospitalization rates remain high. Future studies should consider that >50% of the general practice HF population is neglected if only registered HF diagnoses are taken into account in GPs' EHRs.

Ethics approval and consent to participate

Ethics committee approval was obtained from the University Hospitals Leuven Ethics Committee in November 2016 (B322201630391).

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Conflict of interest

The authors declare that they have no competing interests.

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Author Contributions

All authors (M.S., B.V., B.A., W.R., J.P., J.V., W.D., W.M., and S.J.) contributed to the concept and design of the study. M.S., W.M., J.V., B.V., and B.A. participated in the recruitment of the practices. M.S. performed and supervised the execution of the intervention and the data collection. Data analyses were performed by M.S. and B.V. All authors gathered on a regular basis to contribute to the interpretation of the data. M.S. and B.V. wrote the manuscript. All authors approved the final version of the manuscript.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Data S1. Queries used for basic AUDIT.
Data S2. Queries used for extended audit.
Data S3. Minnesota Living with Heart Failure Questionnaire (MLHF-Q).

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