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Treatment of heart failure in nursing home residents

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Abstract

Background For the treatment of chronic heart failure (HF), both pharmacological and non-pharmacological treatment should be employed in HF patients. Although HF is highly prevalent in nursing home residents, it is not clear whether the recommendations in the guidelines for pharmacological therapy also are followed in nursing home residents. The aim of this study is to investigate how HF is treated in nursing home residents and to determine to what extent the current treatment corresponds to the guidelines. **Methods** Nursing home residents of five large nursing home care organizations in the southern part of the Netherlands with a previous diagnosis of HF based on medical records irrespective of the left ventricle ejection fraction (LVEF) were included in this cross-sectional design study. Data were gathered on the (medical) records, which included clinical characteristics and pharmacological- and non-pharmacological treatment. Echocardiography was used as part of the study to determine the LVEF. **Results** Out of 501 residents, 112 had a diagnosis of HF at inclusion. One-third of them received an ACE-inhibitor and 40% used a β-blocker. In 66%, there was a prescription of diuretics with a preference of a loop diuretic. Focusing on the residents with a LVEF ≤ 40%, only 46% of the 22 residents used an ACE-inhibitor and 64% a β-blocker. The median daily doses of prescribed medication were lower than those that were recommended by the guidelines. Non-pharmacological interventions were recorded in almost none of the residents with HF. **Conclusions** The recommended medical therapy of HF was often not prescribed; if prescribed, the dosage was usually far below what was recommended. In addition, non-pharmacological interventions were mostly not used at all.

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Keywords: Ejection fraction; Heart failure; Nursing home; Treatment

1 Introduction

Heart failure (HF) is a common disease in older adults and, as a consequence, also highly prevalent in nursing home residents.[1,2] Adequate treatment of HF may not only lead to reduced mortality and hospital admissions, but it may also relieve symptoms, lead to improvement in quality of life and increase functional capacity.[3,4] According to the current guidelines of the European Society of Cardiology and the American College of Cardiology/American Heart Association, both pharmacological and non-pharmacological therapies should be employed in HF patients.[5,6] The pharmacological treatment depends on the type of HF. Pharmacological treatment of HF in patients with reduced ejection fraction is clearly described, whereas, for HF with preserved ejection fraction, there is no evidenced pharmacological therapy available.[5,6] Every HF patient with reduced ejection fraction should receive an angiotensin converting enzyme (ACE)-inhibitor and, thereafter, also a β-blocker as soon as possible. A diuretic could be necessary to control fluid overload. For HF with preserved ejection fraction, adequate treatment of underlying diseases and symptoms, such as hypertension, myocardial ischaemia and oedema, is recommended. Non-pharmacological interventions consist of life style changes such as fluid- and sodium-restriction, daily weighing, adjustment of activity, vaccination against influenza, smoking cessation and limitation of the amount of alcohol ingested.[7]

Nursing home residents are frail, disabled, older adults

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with high levels of care dependency, who are mostly excluded from clinical and epidemiological studies.[8] Despite that, recommendations regarding diagnostics and therapeutic interventions do not differ depending on age.[5] Therefore, nursing home residents should be treated similarly to other patients, but previous studies conclude that this is often not the case. In a review of Litaker, 13 studies (published between 1991 and 2002) concerning the pharmacological treatment of HF in elderly nursing home residents were analysed with an overall conclusion that nursing home residents with HF did not receive pharmacological treatment according to the guidelines.[9] In addition, more recent studies in Sweden, Poland and the United States have demonstrated that the treatment of patients with HF in nursing homes and long-term care facilities is still not in accordance with current guidelines.[10–12] Unfortunately, it has not been properly investigated whether the recommendations for non-pharmacological HF treatment as described in the guidelines are also applied to nursing home residents. However, non-pharmacological treatment can have a positive impact on symptoms, functional capacity, well-being, morbidity and prognosis.[13] The aim of this study was to investigate how nursing home residents with HF are treated pharmacologically and non-pharmacologically in Dutch nursing homes. In particular, we determined to what extent the actual treatment corresponded with current international HF guidelines.[5,6]

2 Methods

This study followed a multi-center cross-sectional design and was nested in a larger study on HF in nursing home residents described in a previously published study protocol.[14] The study complied with the Declaration of Helsinki and has been granted approval from the Medical Ethics Committee of Maastricht University/Academic Hospital Maastricht (NL33281.068.10/MEC10-3-074). The study is registered in the Dutch trial register (NTR2663).

2.1 Setting and sample

Nursing home residents in the southern part of the Netherlands allocated to five large long-term care organizations were recruited to participate. In the Netherlands, nursing homes provide a high-level of nursing, medical and paramedical care to frail older adults with chronic diseases and disabilities that are either physical or mental in nature (mainly dementia), or both.[15]

Five hundred and one residents over 65 years of age, who received long-term care on somatic or psychogeriatric wards, were eligible for participating in the larger study. Only residents with a diagnosis of HF in the medical record were included in this study, irrespective of how the diagnosis was made or who made it. In most patients, this meant that left-ventricular ejection fraction (LVEF) was not known. Patients with the diagnosis of HF were compared with those not having a diagnosis of HF. Data were gathered within a specified time period (January 2011 to June 2013). Informed consent for participating was obtained from the residents themselves or from their legal representatives in the case of psychogeriatric residents, or residents with aphasia.

2.2 Measurements and materials

Patients' characteristics were collected in all participating residents including age, gender, receiving psychogeriatric or somatic nursing home care, symptoms, cardiac history, co-morbidities, and cardiovascular risk factors. These predetermined variables of demographic data, cardiac history, co-morbidities and cardiovascular risk factors were obtained from medical records and registered on a case record file (CRF) by a research nurse. A nursing home physician, who had received a refresher course in diagnosing HF, was responsible for assessment of symptoms of HF on the CRF.

Regarding the pharmacological treatment, cardiac medications [diuretics, ACE-inhibitors, β-blockers and angiotensin receptor blocker (ARB) antagonists] as prescribed and processed by the pharmacist on the medication list were registered. Regarding non-pharmacological interventions, fluid restriction (< 1.5 L/day), sodium restriction (max 2.5 g/day), physiotherapy residents themselves or the nursing staff (in case of dementia or aphasia) were questioned about whether interventions were applied. After inclusion, participating residents underwent an echocardiography. A LVEF of ≤ 40% was considered as reduced ejection fraction.[5,6]

2.3 Statistical analyses

Statistical analyzes were performed using IBM SPSS statistics software version 22. Data are presented as frequencies or mean ± SD as appropriate. Differences between groups were tested using Student's *t*-tests for continuous (dependent) variables and Chi-square tests (cross-table analysis) for discrete variables.

3 Results

Of the 501 residents included in the main study, 112 were previously diagnosed with HF based on their medical records. The characteristics of the patients with and without the diagnosis of HF are shown in Table 1. In 15 residents, there were missing echocardiography results caused by poor image quality

Table 1. Clinical characteristics of the study population.

Variables	No HF recorded, *n* = 389	Diagnosed with HF, *n* = 112	*P*-value
Age, yrs	82 ± 7	83 ± 7	0.114
Gender, male	131 (34%)	48 (43%)	0.074
Psychogeriatric	259 (67%)	67 (60%)	0.186
NYHA-class			
Class Ⅰ	260 (67%)	47 (41%)	< 0.001
Class Ⅱ	74 (19%)	34 (31%)	0.023
Class Ⅲ	36 (9%)	21 (29%)	0.014
Class Ⅳ	19 (5%)	9 (8%)	0.336
Symptoms			
Edema	203 (52%)	72 (64%)	0.018
Orthopnea	38 (10%)	24 (21%)	< 0.001
Cardiac history			
Hypertension	181 (47%)	55 (49%)	0.63
Myocardial infarction	51 (13%)	30 (27%)	0.001
Arrhythmia	60 (15%)	39 (35%)	< 0.001
Coronary ischaemia	73 (19%)	40 (36%)	0.001
Valvular heart disease	20 (5%)	18 (16%)	0.001
Coronary bypass graft	27 (7%)	13 (12%)	0.275
Pace maker	13 (3%)	6 (5%)	0.603
Co-morbidity			
Diabetes mellitus	79 (20%)	28 (25%)	0.286
COPD	51 (13%)	32 (29%)	< 0.001
CVA	162 (42%)	45 (40%)	0.781
Renal insufficiency, eGFR < 60 mL/min per 1.73 m^2	106 (27%)	56 (50%)	< 0.001
Anaemia	114 (29%)	43 (38%)	0.058
Cardiac risk factors			
BMI, kg/m^2	25 ± 5	26 ± 5	0.224
Hypercholesterolaemia	105 (27%)	25 (22%)	0.520
Smoking	54 (14%)	14 (13%)	0.931
Heart rate, beats/min	73 ± 13	73 ± 15	0.921
Systolic blood pressure, mmHg	142 ± 24	132 ± 29	< 0.001
Diastolic blood pressure, mmHg	76 ± 14	72 ± 15	0.026
Creatinine, μmol/L	83 ± 45	102 ± 66	0.001
Echocardiography			
LVEF, *n* = 405	56% ± 11%	52% ± 14%	0.001
LVEF > 40%	276 (71%)	75 (67%)	
LVEF ≤ 40%	32 (8%)	22 (20%)	0.002
Unknown	81 (21%)	15 (13%)	

Data are presented as mean ± SD or *n* (%). BMI: body mass index; COPD: chronic obstructive pulmonary disease; CVA: cerebrovascular accidents; eGFR: estimated glomerular filtration rate; LVEF: left ventricular ejection fraction; NYHA: New York Heart Association.

due to obesity or chronic obstructive pulmonary disease (COPD) and/or resistance to the echocardiography mainly by psychogeriatric residents. Of the remaining residents (*n* = 97) with a diagnosis of HF 22 residents (20%) had a LVEF ≤ 40%. When comparing the two groups of residents with and without HF, residents with HF had more complaints of dyspnea shown by the percentages of the New York Heart Association classes. Peripheral edema was highly prevalent in both groups. There was a significantly higher prevalence of cardiovascular diseases, except for hypertension, in residents with HF. COPD was more prevalent in residents with HF compared to those without HF. The mean blood pressure (systolic and diastolic) was lower in residents with HF as compared to those without.

3.1 Pharmacological and non-pharmacological treatment of HF

An overview of the pharmacological and non-pharmacological treatment is presented in Table 2. 46% of the residents with an LVEF ≤ 40% used an ACE-inhibitor and 64% a β-blocker. Diuretics were prescribed in two thirds of the residents diagnosed with HF. Only one third of residents with a reduced ejection fraction received a combination of an ACE-inhibitor/ARB-antagonist and a β-blocker. Spironolactone was prescribed in only a minority of patients, irrespective of LVEF.

Non-pharmacological treatment, such as fluid-restriction, sodium-restriction or physiotherapy, was recorded in 5% or less of the residents. Many more patients without the diagnosis of HF received physiotherapy as compared to nearly none with HF.

3.2 Prescribed cardiac medication

As shown in Table 3, there was no preference for the use of a specific ACE-inhibitor in our patient population with HF. The median daily doses of ACE-inhibitors and ARBs were lower than those recommended by the guidelines.

For the β-blockers, metoprolol was the drug of preference with a median dose of 87 mg, which is < 50% of the target dose stated in the guidelines. Loop diuretics were the medication of choice if patients received diuretic therapy. The median daily dose varies per drug in both LVEF ≤ 40% as LVEF > 40%.

4 Discussion

In our group of nursing home residents with the previous diagnosis of heart failure, the recommended medical therapy for HF was often not prescribed and, if prescribed, dosage was usually far below what was recommended by the guidelines, whereas non-pharmacological interventions were rarely used.

The prescription of an ACE-inhibitor in 30% of the residents with HF irrespective of the LVEF was in line with the results presented in the review by Litaker, where the prevalence of ACE-inhibitor use ranged from 21%–35%.[9] A

Table 2. Pharmacological and non-pharmacological treatment of HF in nursing home residents.

	No HF	Diagnosed with HF			
	Total ***n*** **= 389**	**Total** ***n*** **= 112**	**[b]LVEF < 40%** ***n*** **= 22**	**LVEF > 40%** ***n*** **= 75**	**No echocardiography,** ***n*** **= 15**
Pharmacological treatment					
Diuretics	117 (30%)	74 (66%)	18 (82%)	45 (60%)	11 (73%)
β-blocker	112 (29%)	44 (39%)	14 (64%)	24 (32%)	6 (40%)
ACE-inhibitor	59 (15%)	33 (30%)	10 (46%)	20 (27%)	3 (20%)
ARB-antagonist	46 (12%)	7 (6%)	2 (9%)	3 (4%)	2 (13%)
Spironolactone	7 (2%)	18 (16%)	3 (14%)	11 (15%)	4 (27%)
ACE-inhibitor and ARB antagonist		1	1		
ACE-inhibitor/ARB antagonist and β-blocker	43 (11%)	19 (17%)	8 (36%)	8 (11%)	1 (7%)
β-blocker and diuretics	47 (12%)	32 (29%)	12 (55%)	16 (21%)	5 (33%)
ACE-inhibitor/ARB antagonist and diuretics	45 (12%)	34 (30%)	8 (36%)	17 (23%)	5 (33%)
[a]Trias medication	16 (4%)	17 (15%)	8 (36%)	8 (11%)	1 (7%)
Non-pharmacological treatment					
Fluid-restriction, 1.5 L/day	4 (1%)	6 (5%)			
Sodium-restriction, 2.5 g/day	3 (1%)	4 (4%)			
Physiotherapy/activity training	171 (44%)	1 (1%)			

Data are presented as *n* (%). [a]Trias medication = ACE-inhibitor/ARB-antagonist and β-blocker and diuretics; [b]Information of echocardiography available in *n* = 97 residents. ACE: angiotensin converting enzym; ARB: angiotensin receptor blocker; HF: heart failure; LVEF: left ventricle ejection fraction.

Table 3. Prescribed cardiac medication in nursing home residents with HF.

	Diagnosis of HF [*n* (%), *n* = 112]	**Median daily dose (mg, *n* = 112)**	**Range (mg)**	**Median daily dose in mg based on LVEF**			**Maximum doses in ACCF/AHA, mg/day**	**Target dose in ESC, mg/day**
				LVEF > 40%, *n* = 75	**LVEF ≤ 40%, *n* = 22**	**No echocardiography, *n* = 15**		
Diuretics	[*]74 (66%)							
Hydrochlorothiazide	5 (5%)	15	12–25	15	-	25	200	
Furosemide	47 (42%)	44	20–160	46	38	35	600	
Bumetanide	21 (19%)	2.6	1–12	2,6	2,9	1	10	
Spironolactone	18 (16%)	30	12.5–50	30	25	31	50	25–50
β-blocker	44 (39%)							
Bisoprolol	4 (4%)	3.75	2.5–5	3,75	5	2.5	10	10
Carvedilol	5 (5%)	43.75	6.25–150	6,25	67	12.5	100	50–100
Metoprolol	30 (27%)	87	25–200	86	81	100	200	200
Nebivolol	1 (1%)	5		5	-	-		10
Sotalol	4 (4%)	100	40–160	140	60	-		
ACE-inhibitor	33 (30%)							
Quinapril	8 (7%)	8.75	5–20	5	11	-	40	
Perindopril	9 (8%)	3	2–5	3	2	-	16	
Fosinopril	3 (3%)	20	10–40	40	10	10	40	
Captopril	5 (5%)	50	12.5–125	58	50	25	150	150
Enalapril	5 (5%)	11	5–20	11	-	-	40	20–40
Lisinopril	3 (3%)	17.5	2.5–40	25	40	10	40	20–35
ARB-antagonist	6 (6%)							
Irbesartan	2 (2%)	225	150–300	150	-	300		
Losartan	4 (4%)	58.75	5–100	37,5	62,5	-	150	150

ACCF/AHA: American College of Cardiology Foundation/American Heart Association; ACE: angiotensin converting enzyme; ARB: angiotensin receptor blocker; ESC: European Society of Cardiology; HF: heart failure; LVEF: left ventricle ejection fraction. [*]*N* = 17 used a combination of two diuretics.

more recent publication by Hancock showed a use of 44% in residents with a reduced LVEF and 26% in residents with a preserved LVEF.[1] This was also seen in the study of Foreman, where all participating residents had a LVEF ≤ 40%, and 35% of the residents used an ACE-inhibitor.[16] These findings are similar to our findings, showing an underuse of ACE-inhibitors in our nursing home residents. Although there is only an evidence based treatment of HF with a reduced EF, previous studies did not find major differences in the prescription rate of cardiac medication in patients with reduced LVEF as compared to preserved LVEF.[17,18] This is also demonstrated in this study.

A possible reason for the underuse might be that residents were at a greater risk for adverse drug reactions, such as renal dysfunction and hypotension due to polypharmacy and co-morbidity.[18,19] However, we do not have any information to what extent this might have explained the underuse seen in our study. In addition, average renal function was not severely reduced. Another explanation for the underuse of treatment with ACE-inhibitors could be that the time of onset of HF is not always obvious and, as a result, no medication adjustment as recommended by the guidelines occurs.

Although β-blocker use was 64% in residents with HF and LVEF ≤ 40%, only 36% of these residents received a combination of a β-blocker with an ACE-inhibitor or ARB-antagonist. In the studies by Bolmsjo and Hancock, 59% and 30%, respectively, of the residents used a β-blocker.[1,10] Compared to the early 2000s, this seems to be a positive development in the use of β-blockers. As in the studies by Ruths and Lien, only 3 (n = 1552) and 5 (n = 116) residents, respectively, used a β-blocker.[20,21] However, it might be that this increase in the use of β-blockers is not only a consequence of a better compliance with the guidelines to treat HF, but also the result of prescribing a β-blocker due to another indication. These other indications, such as hypertension, CAD or arrhythmia are also very prevalent in our nursing home population. In addition, focusing on morbidity and mortality, the SENIORS study investigated the effect of nebivolol, and found that it was well tolerated and effective in reducing mortality and morbidity in patients > 70 years old, regardless of the ejection fraction.[22] It is remarkable that, in our study, only one resident used nebivolol. Studies on other β-blockers in HF, such as the drug of preference, metoprolol, included much younger patient populations.[23]

In our study, loop diuretics were the most frequently used therapeutics for residents with HF, as seen in many other cohort studies, particularly in elderly patients.[24] A relatively high rate of diuretic use is expected because diuretics are recommended for symptomatic treatment of fluid overload irrespective of LVEF. Still, it is noteworthy that a significant proportion of patients without the diagnosis of HF also received diuretics and had peripheral edema.

This study showed that, in almost none of the residents, the recommended daily target dose of cardiac medication was achieved. Comparing the median daily dose by LVEF, a higher median daily dose in residents with LVEF ≤ 40% might be expected. However on average, this was not the case. Given the low rate of HF specific treatment, this may be seen as not surprising knowing that nursing home residents are at a greater risk for adverse drug reactions due to polypharmacy and co-morbidities.[11] Older patients on β-blocker medication have a higher risk of side effects when compared to younger persons, and diuretics could have a negative effect such as the development of the cardio-renal syndrome.[25]

An overall reason for not prescribing and/or prescribing cardiac medication in a low dosage could be due to the fact that reducing mortality may be seen as unimportant in nursing home residents, but relieving symptoms and improving quality of life may be seen as even more crucial. It is, however, important to note that the treatment with ACE-inhibitors was not only found to reduce mortality in HF, but also to reduce symptoms and significantly improve quality of life. Although there seems to be no benefit regarding the quality of life by adding a β-blocker or spironolactone, there is still the need for appropriate diagnostics and therapy of HF, given the effects on reducing hospitalisations, taking age into account and the fact that a patient is living in a nursing home.[26]

The use of non-pharmacological interventions was nearly absent in our residents. We are not aware of any other studies that described the non-pharmacological treatment in nursing home residents with HF. Non-pharmacological therapy, including exercise training and dietary and life-style advice, showed beneficial effects in relieving symptoms and improving both quality of life and prognosis.[7] Several studies showed benefits of exercise in older adults on tiredness and breathlessness that limited daily activities.[27,28] Unfortunately, it appears that there is insufficient attention on the benefits of non-pharmacological interventions of HF in nursing home residents, which is an important area of attention for improving HF care in nursing homes. The possible reasons for this discrepancy remain speculative. One could be that nursing home physicians do not have enough knowledge regarding the benefits of non-pharmacological interventions.

There are several limitations of this study. First, the diagnosis of HF was retrieved out of medical records; how-

ever in many patients, as is often the case in clinical practice, original records of cardiologic examinations were not available. Thus, LVEF related to the previous diagnosis of HF was not known and we could separate patient groups based on LVEF after inclusion in the study only. Moreover, in some patients, LVEF could not be determined. Furthermore, there was no information available about possible adverse drugs reactions. Thus, we do not understand precise indications of medication in individual patients.

Guidelines assume that the elderly should be treated the same way as the younger patients with HF. However, the guideline treatment of hypertension has demonstrated adjustments of the target values of systolic blood pressure and the TIME-CHF study showed that there were no differences in outcomes for the elderly when HF was treated more intensively, in contrast to the younger patients.[29,30] This suggests that, it might be necessary to adjust the guidelines to optimize HF treatment in older adults and more specific nursing home residents, but this should be tested prospectively in appropriate clinical trials.

In conclusion, this study demonstrates that the current pharmacological treatment of nursing home residents with HF was not according to the guidelines specified, and the non-pharmacological treatment was almost absent in nursing residents with HF. The clinical consequences are unknown and require specific studies on this frail population.

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References

1 Hancock HC, Close H, Mason JM, *et al*. High prevalence of undetected heart failure in long-term care residents: findings from the Heart Failure in Care Homes (HFinCH) study. *Eur J Heart Fail* 2013; 15: 158–165.
2 Daamen MA, Schols JM, Jaarsma T, *et al*. Prevalence of heart failure in nursing homes: a systematic literature review. *Scand J Caring Sci* 2010; 24: 202–208.
3 Fonarow GC. Heart failure: recent advances in prevention and treatment. *Rev Cardiovasc Med* 2000; 1: 25–33, 54.
4 Ekman I, Swedberg K. Patients' persistence of evidence-based treatment of chronic heart failure: a treatment paradox. *Circulation* 2007; 116: 693–695.
5 McMurray JJ, Adamopoulos S, Anker SD, *et al*. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2012: The task force for the diagnosis and treatment of acute and chronic heart failure 2012 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association (HFA) of the ESC. *Eur Heart J* 2012; 33: 1787–1847.
6 Yancy CW, Jessup M, Bozkurt B, *et al*. 2013 ACCF/AHA guideline for the management of heart failure: a report of the American College of Cardiology Foundation/American Heart Association Task Force on practice guidelines. *Circulation* 2013; 128: e240–e327.
7 Coats AJ. Advances in the non-drug, non-surgical, non-device management of chronic heart failure. *Int J Cardiol* 2005; 100: 1–4.
8 Schols JM, Crebolder HF, van Weel C. Nursing home and nursing home physician: the Dutch experience. *J Am Med Dir Assoc* 2004; 5: 207–212.
9 Litaker JR Chou JY. Patterns of pharmacologic treatment of congestive heart failure in elderly nursing home residents and related issues: a review of the literature. *Clin Ther* 2003; 25: 1918–1935.
10 Bolmsjo BB, Molstad S, Ostgren CJ, *et al*. Prevalence and treatment of heart failure in Swedish nursing homes. *BMC Geriatr* 2013; 13: 118.
11 Michalik C, Matusik P, Nowak J, *et al*. Heart failure, comorbidities, and polypharmacy among elderly nursing home residents. *Pol Arch Med Wewn* 2013; 123: 170–175.
12 Sloane PD, Gruber-Baldini AL, Zimmerman S, *et al*. Medication undertreatment in assisted living settings. *Arch Intern Med* 2004; 164: 2031–2037.
13 van der Wal MH, Jaarsma T, van Veldhuisen DJ. Non-compliance in patients with heart failure; how can we manage it? *Eur J Heart Fail* 2005; 7: 5–17.
14 Daamen MA, Hamers JP, Gorgels AP, *et al*. The prevalence and management of heart failure in Dutch nursing homes; design of a multi-centre cross-sectional study. *BMC Geriatr* 2012; 12: 29.
15 Ribbe MW, Ljunggren G, Steel K, *et al*. Nursing homes in 10 nations: a comparison between countries and settings. *Age Ageing* 1997; 26 Suppl 2: S3–S12.
16 Forman DE, Chander RB, Lapane KL, *et al*. Evaluating the use of angiotensin-converting enzyme inhibitors for older nursing home residents with chronic heart failure. *J Am Geriatr Soc* 1998; 46: 1550–1554.
17 Alagiakrishnan K, Banach M, Jones LG, *et al*. Update on diastolic heart failure or heart failure with preserved ejection fraction in the older adults. *Ann Med* 2013; 45: 37–50.
18 Cheng JW, Nayar M. A review of heart failure management in the elderly population. *Am J Geriatr Pharmacother* 2009; 7: 233–249.
19 Sztramko R, Chau V, Wong R. Adverse drug events and associated factors in heart failure therapy among the very elderly. *Can Geriatr J* 2011; 14: 79–92.
20 Ruths S, Straand J, Nygaard HA, *et al*. Drug treatment of heart failure--do nursing-home residents deserve better? *Scand J Prim Health Care* 2000; 18: 226–231.

21 Lien CT, Gillespie ND, Struthers AD, *et al*. Heart failure in frail elderly patients: diagnostic difficulties, co-morbidities, polypharmacy and treatment dilemmas. *Eur J Heart Fail* 2002; 4: 91–98.
22 Flather MD, Shibata MC, Coats AJ, *et al*. Randomized trial to determine the effect of nebivolol on mortality and cardiovascular hospital admission in elderly patients with heart failure (SENIORS). *Eur Heart J* 2005; 26: 215–225.
23 Poole-Wilson PA, Swedberg K, Cleland JG, *et al*. Comparison of carvedilol and metoprolol on clinical outcomes in patients with chronic heart failure in the Carvedilol Or Metoprolol European Trial (COMET): randomised controlled trial. *Lancet* 2003; 362: 7–13.
24 Crawford T, Segars LW, Rasu RS. Prescribing trends for management of congestive heart failure from 2002 to 2004. *Res Social Adm Pharm* 2013; 9: 482–489.
25 Iacoviello M, Antoncecchi V. Heart failure in elderly: progress in clinical evaluation and therapeutic approach. *J Geriatr Cardiol* 2013; 10: 165–177.
26 Dobre D, van Jaarsveld CH, Ranchor AV, *et al*. Evidence-based treatment and quality of life in heart failure. *J Eval Clin Pract* 2006; 12: 334–340.
27 Yu DS, Lee DT, Woo J, *et al*. Non-pharmacological interventions in older people with heart failure: effects of exercise training and relaxation therapy. *Gerontology* 2007; 53: 74–81.
28 Witham MD, Struthers AD, McMurdo ME. Exercise training as a therapy for chronic heart failure: can older people benefit? *J Am Geriatr Soc* 2003; 51: 699–709.
29 Mancia G, Fagard R, Narkiewicz K, *et al*. 2013 ESH/ESC Guidelines for the management of arterial hypertension: the Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *J Hypertens* 2013; 31: 1281–357.
30 Troughton RW, Frampton CM, Brunner-La Rocca HP, *et al*. Effect of B-type natriuretic peptide-guided treatment of chronic heart failure on total mortality and hospitalization: an individual patient meta-analysis. *Eur Heart J* 2014; 35: 1559–1567.