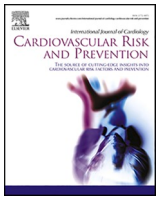
International Journal of Cardiology Cardiovascular Risk and Prevention 20 (2024) 200234

Contents lists available at ScienceDirect

International Journal of Cardiology Cardiovascular Risk and Prevention

journal homepage: www.journals.elsevier.com/international-journal-of-cardiology-cardiovascular-risk-and-prevention



Medication adherence in adults after hospitalization for heart failure: A cross-sectional study

Manuela Huber [a,e], Ada Katrin Busch [b], Irene Stalder-Ochsner [c], Andreas J. Flammer [c], Gabriela Schmid-Mohler [d,f,*]

[a] Educational Center for Health and Social, Weinfelden, Switzerland
[b] Institute of Nursing, ZHAW School of Health Science, Winterthur, Switzerland
[c] Department of Cardiology, University Heart Center, University Hospital Zurich, Switzerland
[d] Center of Clinical Nursing Science, University Hospital Zurich, Switzerland
[e] Clinic for General, Visceral, Transplant, Vascular and Thoracic Surgery, Cantonal Hospital St. Gallen, Switzerland
[f] Department of Pulmonology, University Hospital Zurich, Switzerland

ARTICLE INFO

Handling Editor: D Levy

Keywords:
Medication adherence
Heart failure
MARS-5

ABSTRACT

Background: Medication non-adherence in heart failure (HF) leads to increased mortality, morbidity and healthcare costs. However, no study has investigated HF patients' post-hospitalization medication non-adherence in Switzerland.
Objectives: Our primary aim was to assess the prevalence of post-discharge medication non-adherence in patients with HF. A secondary objective was to identify differences between fully and partially adherent patients regarding selected unplanned therapy-related inpatient/outpatient cardiology visits.
Methods: A non-experimental cross-sectional study was applied. The prevalence of medication adherence was assessed with a German-translated version of the Medication Adherence Report Scale (MARS-5) and analyzed descriptively. Differences between adherent and partially adherent patients' numbers of medications, dosing per day and 180-day unplanned inpatient stays or cardiology outpatient visits were explored.
Results: Of 153 recruited patients, 72 participated in the survey. Of these, 26.4 % were not fully adherent. Their most common reason was forgetfulness (23.7 %). There were no significant group differences regarding therapy-related variables or 180-day unplanned cardiology stays/visits.
Conclusions: Considering that over one-quarter of surveyed HF patients were not fully medication adherent, Swiss cardiology nurses need to be sensitized to this issue and trained in adherence-enhancing interventions. Reaching acceptable adherence levels in patients with HF will require further research and action.

1. Background

Heart failure (HF) is a clinical syndrome with high mortality and morbidity, resulting in high treatment costs for the general population [1]. The primary pillar of treatment is medication. If adhered to as indicated, i.e., regarding taking, timing and dosage, these medications control symptoms, slow disease progression and improve survival [2]. However, patients with heart failure commonly do not take their medication as prescribed. This is referred to as medication non-adherence [2,3]. Studies to date show rates of self-reported medication non-adherence across all HF patient groups between 14 and 28 % [4–7].

Patients who have been hospitalized for heart failure are particularly vulnerable for poor medication adherence, as hospitalization is often associated with changes in medication [8]. In this context, a US retrospective cohort study showed a 35 % prevalence of medication non-adherence in patients over 65 years of age at one year post-discharge [9]. In HF patients, medication non-adherence results in increased mortality, morbidity and healthcare costs [10–13].

A 2015 World Health Organization (WHO) report named therapy-related factors as especially relevant contributors to non-adherence [3]. Studies in heart failure found that greater dosing frequency as well as higher total daily numbers of cardiac medications were associated with decreasing medication adherence [14,15]. Another

* Corresponding author. University Hospital Zurich, Center of Clinical Nursing Science, Raemistrasse 100, CH-8091, Zurich, Switzerland.
E-mail address: gabriela.schmid@usz.ch (G. Schmid-Mohler).

https://doi.org/10.1016/j.ijcrp.2023.200234
Received 18 September 2023; Received in revised form 19 December 2023; Accepted 21 December 2023
Available online 24 December 2023

treatment-related factor is rehospitalization. Of all patients hospitalized with HF, 29.3 % are rehospitalized due to cardiac decompensation within six months of their initial discharge [14].

Medication non-adherence is a known contributor to rehospitalization [14–16]. In turn, as noted, medication changes during rehospitalization can contribute to non-adherence [19,20]. This cyclic relationship makes strong medication adherence doubly important. Therefore, it is crucial to ensure that, after discharge, HF patients continue to take their medications consistently and correctly in their home environment. To our knowledge, there is currently no study investigating medication non-adherence in patients after hospitalization for HF in Switzerland.

2. Objectives

Therefore, this study's primary objective was to investigate the prevalence of post-discharge medication non-adherence in patients' rehospitalizations—whether planned or unplanned—for heart failure.

Its secondary objective was to investigate whether fully adherent patients differ from partially adherent patients regarding selected treatment-related variables, i.e., number of cardiac medications, doses per day, as well as number of unplanned inpatient stays or outpatient cardiology visits within 180 days post-discharge.

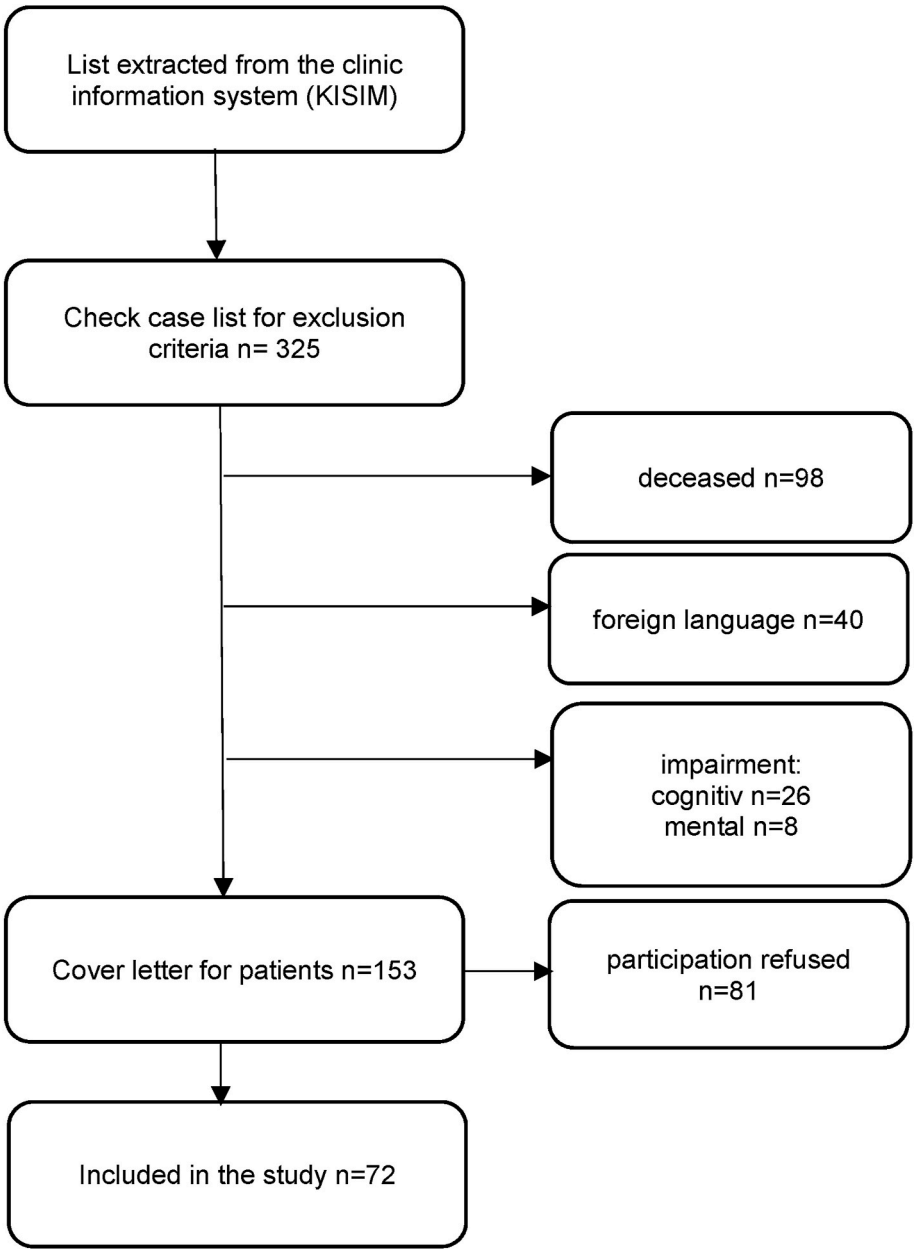


Fig. 1. Flowchart recruitment process.

3. Methods

3.1. Design

A non-experimental cross-sectional study was applied. A cross-sectional design is useful for testing relationships between variables with a single survey. It is also economical and easy to handle. [17] To enable good reporting, the authors followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [22].

3.2. Setting

The present study was conducted in a Swiss tertiary hospital that serves as a leading national and international reference center for the treatment and prevention of cardiovascular diseases. Medication adjustments follow national and international treatment guidelines.

3.3. Sample

Inclusion criteria were ≥18 years of age, a diagnosis of heart failure and hospitalization with DRG code F62 (F62A = heart failure and shock with extremely severe complications or comorbidities and dialysis or resuscitation or specific procedure or complicating diagnosis, or multidrug-resistant pathogens; F62B = heart failure and shock with extremely severe complications or comorbidities or specific procedure or evaluation for heart transplantation; F62C = heart failure and shock with severe complications or comorbidities; F62D = heart failure and shock) between 1 January 2020 and 31 July 2021 (19 months). Patients were excluded if they were unable to understand or answer a questionnaire in German due either to difficulty understanding German or to cognitive or mental illness.

3.4. Recruitment

Participants were recruited in three steps (see Fig. 1): First, relevant cases were extracted from the study hospital's digital clinical information system (KISIM). The resulting list included all patients who fulfilled the inclusion criteria. Second, the first author reviewed and adapted the initial list by checking the available information from the electronic patient file. If all inclusion criteria were fulfilled and no exclusion criteria were present, the clinical and project managers sent each involved patient a letter informing them about the study and inviting them to participate in a third step. The information pack also included a consent form and a stamped, preaddressed envelope. One week later, the first author contacted the patients by telephone and informed them verbally about the study. Patients who consented to participate then signed the consent form and mailed it back to the study group. When the consent form was received, a questionnaire were sent to each patient. If the completed questionnaire was not received within three weeks, a reminder letter was sent. In case of incomplete questionnaires, a telephone enquiry was made by the first author.

3.5. Variables

3.5.1. Socio-demographic variables

Age, gender, language, nationality, marital status, living situation, educational attainment and employment data were collected by written questionnaire.

3.5.2. Therapy-related variables

Therapy-related variables were assessed by questionnaire. These included a list of all current cardiac medications, their dosage(s) and dosing time(s) and the person responsible for preparing them. The cause of each patient's heart failure and its applicable New York Heart Association (NYHA) classification, as well as comorbidities and number of unplanned inpatient stays or outpatient cardiology visits in the first 180 days following discharge from the study hospital, were extracted from their electronic patient file.

3.5.3. Medication adherence

Self-reported medication adherence was assessed with the 5-Item Medication Adherence Report Scale (MARS-5 -©Professor Rob Horne) [18]. The instrument originates in England, and was developed with the help of people with diabetes, hypertension and asthma [19]. It consists of five items about non-adherent behavior: (1) I forget to take my medication; (2) I change the dose of my medication; (3) I do not take the medication for a certain period of time; (4) I deliberately skip a dose of medication; and (5) I take less medication than prescribed. These questions are answered on a 5-point Likert-type scale (1 = always, 2 = often, 3 = sometimes, 4 = seldom, 5 = never), with possible sum scores ranging between 5 and 25 points and higher scores indicating higher adherence. Testing of the German version of the MARS-5 (the MARS-D) showed acceptable internal consistency (Cronbach's alpha = 0.60–69) and test-retest reliability (Pearson's r = 0.61–0.63) [25]. As has been done in previous studies, we dichotomized the total scores into partially adherent (≤24 points) and fully adherent patients (25 points) [20–22].

3.6. Data analysis

Socio-demographic and therapy-related data were analyzed descriptively using frequencies, means and standard deviations or medians and interquartile ranges (Q75-Q25) as appropriate to the distribution of data.

Medication non-adherence prevalence was calculated based on the number of affected patients classified as partially adherent expressed as a percentage of the overall number of persons included in the study [23]. For the group comparison of the two samples (numbers of daily cardiac medications, daily dosing times and unplanned inpatient stays or outpatient cardiology visits in the 180 days following hospital discharge), the Mann-Whitney *U* test was used because the dependent variable was not normally distributed [30]. For this statistical test procedure, the significance level was set at alpha <0.05 [24]. The data were analyzed using the SPSS version 28.0 statistical software package.

4. Ethical considerations

The study complies with the Declaration of Helsinki [31], the

Table 1
Sample characteristics (n = 72).

Variable	Missing data (%)	Mean (SD) or absolute numbers (% from *n*)
Number of participants		72
Age in years	0	71,33 (SD 13,25)
Sex	0	
Female		23 (31,9 %)
Male		49 (68,1 %)
Civil status	0	
Single		14 (19,4 %)
Married, (registered) partnership		32 (44,4 %)
Separated, divorced, widowed		26 (36,1 %)
Mother language	0	
German		60 (83,3 %)
Other language		12 (16,7 %)
Education degree	0	
Compulsory school		14 (19,4 %)
Secondary education II		40 (55,6 %)
Tertiary education		18 (25,0 %)
Medication preparation	0	
Patient himself		55 (76,4 %)
Others (pharmacy, spouse, nursing home, home care nursing, general practitioner)		17 (23,6 %)
Number of heart medications taken daily per day	0	5,21 (SD 1,59)
2–3 medications		8 (11,1 %)
4–5 medications		35 (48,6 %)
≥ 6 medications		29 (40,3 %)
Active ingredients taken daily	0	
ACE-Inhibitor, angiotension II receptor blocker (ARB), angiotensin receptor neprilysin inhibitor		40 (55,6 %)
Sodium-glucose cotransporter 2 (SGLT2 inhibitor)		13 (18,1 %)
Loop diuretics		59 (81,9 %
Thiazide diuretics		10 (13,9 %)
Mineralocorticoid receptor antagonist		17 (13,9 %)
Beta blockers		53 (73,6 %)
Calcium channel blockers		19 (26,4 %)
Digitalis glycosides		3 (4,2 %)
Other antiarrhythmic		10 (13,9 %)
Combination preparations (isosorbide dinitrate + hydrochlorothiazid/ACE-II + amlodipine/diuretics + ACE-inhibitors etc.)		3 (4,2 %)
Other antihypertensives		14 (19,4 %)
Platelet aggregation inhibitors		19 (26,4 %)
Anticoagulants		54 (75,0 %)
Statins		50 (69,4 %)
Number of dosing times for heart medication per day	0	2.19 (SD 0,54)
One dosing time		5 (6,9 %)
Two dosing times		48 (66,7 %)
Three dosing times		19 (26,4 %)
Cause of heart failure	0	
Ischemic heart disease		25 (35,2 %)
Hypertensive heart disease		8 (11,3 %)
Non-ischemic cardiomyopathy		15 (21.1 %)
Cardiac arrhythmias		4 (5,6 %)
Valvular disease		17 (23,9 %)
Congenital heart disease		8 (11,3 %)
Pericardial disease		1 (1,4 %)
Unclear cause		12 (16,9 %)
Comorbidities		
Cardiac arrhythmias		44 (61,1 %)
Coronary heart disease		35 (48,6 %)
Valvular disease		36 (50,0 %)
Hypertension		46 (63,9 %)
Diabetes mellitus		25 (34,7 %)
Obesity		13 (18,1 %)
Kidney disease		58 (80,6 %)
Chronic respiratory disease		38 (52,8 %)
Gout and arthritis		15 (20,8 %)
Neurological disease		22 (30,6 %)
Peripheral vascular disease		25 (34,7 %)
Cancer		11 (15,3 %)
Mental illness		4 (5,6 %)
Other disease		71 (98,6 %)
NYHA-classification	29.2 (%)	
NYHA 2		8 (11,1 %)
NYHA 3		32 (44,4 %)
NYHA 4		11 (15,3 %)
Number of unplanned inpatient stays outpatients cardiological visits within 180 days of leaving the hospital	0	0,32 (SD 0,64)
No cardiological case		54 (75,0 %)
One cardiological case		13 (18,1 %)
Two cardiological cases		4 (5,6 %)
Three cardiological cases		1 (1,4 %)

guidelines of Good Clinical Practice (GCP) and all relevant Swiss regulations. The Ethics Committee of the Canton of Zurich has granted approval for this study (BASEC No. 2021–01733).

5. Results

5.1. Sample

Of the 153 patients we invited, 72 participated in the study, a response rate of 47.1 %. The sample consisted of 49 male (68.1 %) and 23 female (31.9 %) patients. The mean age was 71.3 (SD = 13.3) years. Almost half (44.4 %) of participants were married or in a relationship. On average, respondents took five heart medications per day (SD = 1.6) across two dosing times (SD = 0.5). All but one (98.6 %, n = 71) had comorbidities; and one-fourth (25.1 %, n = 18) had been rehospitalized within six months of their initial hospital discharge. Further socio-demographic and treatment-related data are displayed in Table 1

5.2. Medication adherence

The mean MARS-D sum score measuring self-reported medication adherence as 23.9 points (SD = 2.7; range: 11–25). The median score was 25 points, the 25th percentile 24 points and the 75th percentile 25 points. Overall, 73.6 % of patients (n = 53) were classified as fully adherent and 26.4 % (n = 19) as partially adherent. The most common reason for partial adherence, given by 23.7 % (n = 17) of all patients was forgetting to take the medication. An eighth (12.5 %; n = 9) of patients deliberately changed their dosages, and 11.1 % (n = 8) deliberately skipped a dose. Eight stopped taking all of their cardiac medication for a period of time (11.1 %) or took less than their prescribed dosage (11.1 %). Table 2 shows the relative and absolute frequencies of the five relevant MARS-D items.

5.3. Group ***comparison***

There were no statistically significant differences between the groups of fully adherent and partially adherent patients with respect to the number of daily cardiac medications taken ($p = 0.341$, $z = -0.953$), number of daily medication dosing times ($p = 0.775$, $z = -0.286$) and number of unplanned inpatient stays or outpatient cardiological visits within 180 days after hospital discharge ($p = 0.737$, $z = -0.336$). Table 3 illustrates the subdivision of the groups of fully adherent and partially adherent patients and presents the clinical and treatment-related variables in both groups.

Table 2
Descriptive statistics for the MARS-5. Relative and absolute frequencies of n (n = 72).

Total number of cases $n = 72$	Absolute frequencies (% from n)				
	never n (%)	rare n (%)	sometimes n (%)	often n (%)	always n (%)
I forgot to take my heart medication.	55 (76,4 %)	11 (15,3 %)	4 (5,6 %)	1 (1,4 %)	1 (1.4 %)
I altered the dose of my heart medication.	63 (87,5 %)	4 (5,6 %)	4 (5,6 %)	1 (1,4 %)	0 (0 %)
I stopped taking my heart medication for a while.	64 (88,9 %)	4 (5,6 %)	3 (4,2 %)	1 (1,4 %)	0 (0 %)
I decided to miss out a dose of my heart medication.	64 (88,9 %)	6 (8,3 %)	3 (4,2 %)	1 (1,4 %)	0 (0 %)
I took less heart medication than prescribed.	64 (88,9 %)	4 (5,6 %)	3 (4,2 %)	1 (1,4 %)	0 (0 %)

Table 3
Group comparison of fully adherent and partially adherent patients with respect to treatment-related variables (n = 72).

Variable		Fully adherent (n = 53)	Partially adherent (n = 19)	z	p
Number of heart medications taken daily	M ± SD	5,34 ± 1,60	4,84 ± 1,53	−0,953	0,341
	Mdn	5,00	5,00		
	Q.25-Q.75 %	4,00–6,00	4,00–6,00		
	min-max	3–10	2–8		
Number of drug dosing times per day	M ± SD	2,21 ± 0,532	2,16 ± 1,53	−0,286	0,775
	Mdn	2,00	2,00		
	Q.25-Q.75 %	2,00–3,00	2,00–3,00		
	min-max	1–3	1–3		
Number of unplanned cardiology treatments inpatient/outpatients within 180 days after hospital discharge	M ± SD	0,34 ± 0,678	0,32 ± 0,582	−0,336	0,737
	Mdn	0,00	0,00		
	Q.25-Q.75 %	0,00-0,50	0.00–1,00		
	min-max	0–3	0–2		

6. Discussion

This study investigated the prevalence of self-reported medication non-adherence and therapy-related risk factors for non-adherence in adult patients who had been hospitalized due to heart failure within the past 18 months. Roughly one quarter of those who participated (26.4 %) reported partial adherence, most commonly giving forgetfulness as the reason. Intentional non-adherence was rare.

The reported 26.4 % HF medication non-adherence rate is in line those reported elsewhere in HF. Previous studies' prevalence rates have ranged from 14 to 28 % [4–7]. However, as adherence rates depend on the study group's operationalization and definition of adherence, they vary widely. In our study, we used a cut-off point of 24 (any indication of non-total adherence), which has also been applied in other studies [25,26]. Only one other heart failure study has used the MARS-5. However, that research group used an adherence threshold of 23 points, which yielded an 86 % adherence rate [5].

As noted, forgetting to take medication was the current study's most commonly-given reason for non-adherence. Once again, these data are congruent with those of similar studies, which give forgetfulness rates ranging from 50 % to 84.9 % [27–29]. The reason for non-adherence is critical because each dosage missed increases patients' risk of disease progression, secondary diseases and other health disadvantages.

Given the high prevalence of mobile technologies in Switzerland, the use of smartphone apps to remind patients to take their medication has great potential to improve adherence in heart failure. A 2020 systematic review and meta-analysis reported that, in chronic disease populations, the use of mobile apps was generally well accepted and accompanied significant improvements in medication adherence [30].

In our study, no statistically significant difference was found between the fully adherent and partially adherent groups regarding either the complexity of their medication regimes, i.e., the number of cardiac medications taken daily, or the number of medication dosing times per day. While other studies have reported not finding significant correlations between regimen complexity or numbers of dosing times and non-adherence [38–40], the majority indicate that the prevalence of non-adherence correlates significantly both with regimen complexity and with the number of single doses prescribed per day [31–34]. Considering this tendency's prominence in the literature, our results must be interpreted with caution. If interpreted independently, the limited power of our rather small sample size may have obscured significant correlations.

Our rehospitalization rate of 25.1 % within six months due to heart failure is comparable to results reported by Wideqvist et al. who reported a 6-month rehospitalization rate of 29.1 % [14], increasing over one year to 38.4 % [14].

Our study also revealed no statistically significant differences between the fully adherent and partially adherent patients regarding their numbers of unplanned cardiac outpatient visits or inpatient stays within 180 days of hospital discharge. This contradicts a published finding that poor medication adherence was a predictor of rehospitalizations. Additionally, our analyses suggest that the number of unplanned rehospitalizations is predominantly related to comorbidities [14], while rehospitalizations for heart failure per se are multifactorial [14,35]. Again, these results must be interpreted with caution due to the small sample size.

7. Strengths and weaknesses

One notable strength of the present study was the use of a validated instrument to measure self-reported medication adherence [36]. Our early assessment of this study's feasibility the survey instrument's

feasibility also offered a relevant advantage. Knowing that patients could reliably self-assess their medication adherence using the questionnaire greatly reduced the organizational effort and costs.[56] Because it was sent to the respondents' homes, they could complete it according to their own schedule, at a pace of their choosing.

However, certain limitations should also be noted. First, the sample size (72 patients) was rather small. As a result, its limited statistical power could have obscured the significance of inter-group differences. Another limitation is that the numbers of unplanned inpatient stays/outpatient visits were only counted if they occurred at the study hospital. Patients could also have been treated in other hospitals or in their cardiologists' or general practitioners' practices. Also, medication adherence was assessed solely by self-report, with no objective measurement methods used. Due to the possibility of social desirability bias, which plays a particularly important role in the context of medication adherence, it is possible that non-adherence was underestimated [37].

Further research is recommended to expand this study to multiple centers, which would greatly enhance sample size. For this purpose, a nationwide study on medication adherence in heart failure, including an investigation of the influencing factors, may be considered. As no suitable measurement instruments yet exist to optimally capture adherence in individual patient situations,[57] any instrument developed for this purpose will need to be fully validated regarding medication adherence.

8. Conclusions and recommendations

Poor medication adherence in Swiss patients with heart failure after hospitalization is frequent, with forgetting reported as the main barrier. Considering the possible negative consequences of such non-adherence, further attention and action are needed to tackle this problem in clinical practice. This will require multi-level interventions that are embedded in both inpatient and outpatient paths, and that account for patients' comorbidities.

Our findings have direct practical implications. This group's high rehospitalization rate highlights strong needs both to identify patients at risk for rehospitalization and to assess risk factors for non-adherence. Further, in addition to newly-admitted patients' standard medical information, their extended medication and adherence histories should be assessed, including dosages and any adverse drug reactions [38]. Most HF patients enter the hospital directly through the central emergency department, where time constraints, resource shortages and urgent patient needs often rule out the gathering of information that is not immediately necessary. Therefore, time-intensive tasks such as extended medication histories could be added to the standard patient history taken in the cardiology unit. This would allow care teams to detect potential medication-related issues in their early stages and interventions chosen to target the necessary adherence dimensions. Where no such interventions exist, they can be developed with patient input [39]. Later, as the patient's stay is drawing to a close, the care team's discharge plans should address the issue of medication adherence. At this point, to train patients to adhere to their prescribed regimens, nurses can play key roles, providing not only information, but also counselling and training regarding medication self-management [40].

As medication non-adherence leads to increased healthcare use and higher costs, there is a strong economic argument for medication adherence training. However, regarding lasting behavioral changes, single education sessions are ineffective [41]. For patients to develop the necessary skills, they need ongoing post-discharge adherence support.[17,51]

Patient motivation plays a major role [3]. Bolstering it requires more frequent patient contact, training and participatory decision-making. In consultations with advanced practice nurses (APNs), interventions to improve adherence should address multiple aspects of training, including communicative counselling on drug therapy, combined with behavior-modifying interventions [42,43]. As shown by our data, forgetting to take medication was the most common reason for partial adherence behavior. To prevent this and other types of unintentional non-adherence, the use of medication dosing systems or reminder apps should also be topics of individual APN counselling [30,44].

Credit author statement

Ada Katrin Busch: Conceptualization, Writing – review & editing. Gabriela Schmid-Mohler: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing. Andreas Flammer: Conceptualization, Writing – review & editing. Irene Stalder-Ochsner: Conceptualization, Writing – review & editing. Manuela Huber: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing.

Declaration of competing interest

AJF received personal fees from Alnylam, Amgen, Bayer, Boehringer Ingelheim, Bristol-Myers Squibb, Fresenius, Imedos, Medtronic, MSD, Mundipharma, Orion, Pierre Fabre, Pfizer, Roche, Schwabe, Vifor and Zoll, and grants and personal fees from AstraZeneca and Novartis, all of which are independent of and outside the submitted work. All other authors have no funding or conflicts of interest to disclose. There were no clients or sponsors.

Acknowledgments

We thank Chris Shultis for editing support.

We thank the Department of General Practice and Health Services Research and the Departement of Internal Medicine VI, Clinical Pharmacology and Pharmacoepidemiology, University Hospital Heidelberg, Heidelberg, German, for permission to use the German translation of the MARS-5.

References

[1] N.L. Bragazzi, W. Zhong, J. Shu, et al., Burden of heart failure and underlying causes in 195 countries and territories from 1990 to 2017, Eur J Prev Cardiol 28 (15) (2021) 1682–1690, https://doi.org/10.1093/eurjpc/zwaa147.

[2] M.M. Sherrod, D.J. Cheek, A. Seale, Improving patient Outcomes with oral heart failure medications, Home Healthc. Nurse 34 (5) (2016) 242–253, https://doi.org/10.1097/NHH.0000000000000388.

[3] W.H. Organization, Adherence to Long-Term Therapies: Evidence for Action, World Health Organization, Geneva, 2003. https://ebookcentral.proquest.com/lib/kxp/detail.action?docID=284583.

[4] B.B. Granger, Self-reported medication adherence for heart failure is associated with lower risk of all-cause hospitalisation and death, Evid. Base Nurs. 18 (4) (2015) 123, https://doi.org/10.1136/eb-2014-102011.

[5] M. Percival, W.N. Cottrell, R. Jayasinghe, Exploring the beliefs of heart failure patients towards their heart failure medicines and self care activities, Int. J. Clin. Pharm. 34 (4) (2012) 618–625, https://doi.org/10.1007/s11096-012-9655-x.

[6] Z.U. Rehman, A.K. Siddiqui, M. Karim, H. Majeed, M. Hashim, Retraction: medication non-adherence among patients with heart failure, Cureus 11 (11) (2019) r17, https://doi.org/10.7759/cureus.r17.

[7] J.-R. Wu, D.A. DeWalt, D.W. Baker, et al., A single-item self-report medication adherence question predicts hospitalisation and death in patients with heart failure, J. Clin. Nurs. 23 (17–18) (2014) 2554–2564, https://doi.org/10.1111/jocn.12471.

[8] F.K. Yam, T. Lew, S.A. Eraly, H.-W. Lin, J.D. Hirsch, M. Devor, Changes in medication regimen complexity and the risk for 90-day hospital readmission and/or emergency department visits in U.S. Veterans with heart failure, Res. Soc. Adm. Pharm. 12 (5) (2016) 713–721, https://doi.org/10.1016/j.sapharm.2015.10.004.

[9] L.L. Chang, H. Xu, A.D. DeVore, et al., Timing of Postdischarge follow-Up and medication adherence among patients with heart failure, J. Am. Heart Assoc. 7 (7) (2018), https://doi.org/10.1161/JAHA.117.007998.

[10] A.A. Fitzgerald, J.D. Powers, P.M. Ho, et al., Impact of medication nonadherence on hospitalizations and mortality in heart failure, J. Card. Fail. 17 (8) (2011) 664–669, https://doi.org/10.1016/j.cardfail.2011.04.011.

[11] S.R. Hood, A.J. Giazzon, G. Seamon, et al., Association between medication adherence and the outcomes of heart failure, Pharmacotherapy 38 (5) (2018) 539–545, https://doi.org/10.1002/phar.2107.

[12] T.M. Ruppar, J.M. Delgado, J. Temple, Medication adherence interventions for heart failure patients: a meta-analysis, Eur. J. Cardiovasc. Nurs. 14 (5) (2015) 395–404, https://doi.org/10.1177/1474515115571213.

[13] J.-R. Wu, D.K. Moser, Medication adherence mediates the relationship between heart failure symptoms and cardiac event-free survival in patients with heart failure, J. Cardiovasc. Nurs. 33 (1) (2018) 40–46, https://doi.org/10.1097/JCN.0000000000000427.
[14] M. Wideqvist, X. Cui, C. Magnusson, M. Schaufelberger, M. Fu, Hospital readmissions of patients with heart failure from real world: timing and associated risk factors, ESC Heart Fail 8 (2) (2021) 1388–1397, https://doi.org/10.1002/ehf2.13221.
[15] U. Laufs, Medikamentenadhärenz bei chronischen Erkrankungen : bedeutung und neue Ansätze, Nervenarzt 82 (2) (2011) 153–154, https://doi.org/10.1007/s00115-010-3115-4, 156-154.
[16] T.M. Ruppar, P.S. Cooper, D.R. Mehr, J.M. Delgado, J.M. Dunbar-Jacob, Medication adherence interventions improve heart failure mortality and readmission rates: systematic review and meta-analysis of controlled trials, J. Am. Heart Assoc. 5 (6) (2016), https://doi.org/10.1161/JAHA.115.002606.
[17] D.F. Polit, C.T. Beck, Essentials of Nursing Research: Appraising Evidence for Nursing Practice, ninth ed., Wolters Kluwer, Philadelphia, Baltimore, New York, London, Buenos Aires, Hong Kong, Sydney, Tokyo, 2018.
[18] R. Horne, J. Weinman, Patients' beliefs about prescribed medicines and their role in adherence to treatment in chronic physical illness, J. Psychosom. Res. 47 (6) (1999) 555–567, https://doi.org/10.1016/s0022-3999(99)00057-4.
[19] A.H.Y. Chan, R. Horne, M. Hankins, C. Chisari, The Medication Adherence Report Scale: a measurement tool for eliciting patients' reports of nonadherence, Br. J. Clin. Pharmacol. 86 (7) (2020) 1281–1288, https://doi.org/10.1111/bcp.14193.
[20] C. Berner, L. Erlacher, K.H. Fenzl, T.E. Dorner, Medication adherence and coping strategies in patients with rheumatoid arthritis: a cross-sectional study, Internet J. Rheumatol. 2019 (2019) 4709645, https://doi.org/10.1155/2019/4709645.
[21] G.J. Molloy, N. Messerli-Bürgy, G. Hutton, A. Wikman, L. Perkins-Porras, A. Steptoe, Intentional and unintentional non-adherence to medications following an acute coronary syndrome: a longitudinal study, J. Psychosom. Res. 76 (5) (2014) 430–432, https://doi.org/10.1016/j.jpsychores.2014.02.007.
[22] M.L. Scribano, Translation and initial validation of the medication adherence report scale (MARS) in Italian patients with crohn's disease, Dig. Liver Dis. 51 (5) (2019) 640–647, https://doi.org/10.1016/j.dld.2018.09.026.
[23] M. Dreier, S. Kramer, K. Stark, Epidemiologische Methoden zur Gewinnung verlässlicher Daten, in: Public Health, Elsevier, 2012, pp. 409–449.
[24] R.-D. Hilgers, K.U. Heitmann, P. Bauer, V. Scheiber, *Einführung in die Medizinische Statistik*. 2., verb. u. überarb. Aufl. 2007, Springer Berlin Heidelberg, Berlin, Heidelberg, 2007. Statistik und ihre Anwendungen, http://nbn-resolving.org/urn:nbn:de:bsz:31-epflicht-1582091.
[25] A. Farmer, A.-L. Kinmonth, S. Sutton, Measuring beliefs about taking hypoglycaemic medication among people with Type 2 diabetes, Diabet. Med. 23 (3) (2006) 265–270, https://doi.org/10.1111/j.1464-5491.2005.01778.x.
[26] C.S. Lee, J.H.M. Tan, U. Sankari, Y.L.E. Koh, N.C. Tan, Assessing oral medication adherence among patients with type 2 diabetes mellitus treated with polytherapy in a developed Asian community: a cross-sectional study, BMJ Open 7 (9) (2017) e016317, https://doi.org/10.1136/bmjopen-2017-016317.
[27] B. Aggarwal, A. Pender, L. Mosca, H. Mochari-Greenberger, Factors associated with medication adherence among heart failure patients and their caregivers, J. Nurs. Educ. Pract. 5 (3) (2015) 22–27, https://doi.org/10.5430/jnep.v5n3p22.
[28] H. Arnipalli, S. Bala, H. Pandve, Medication adherence and its determinants among women of cardiovascular disease of tertiary care hospital, Hyderabad. IJCDW. 5 (2020) 315–321, https://doi.org/10.1055/s-0040-1708573.
[29] R. Khatib, K. Marshall, J. Silcock, C. Forrest, A.S. Hall, Adherence to coronary artery disease secondary prevention medicines: exploring modifiable barriers, Open Heart 6 (2) (2019) e000997, https://doi.org/10.1136/openhrt-2018-000997.
[30] Y. Peng, H. Wang, Q. Fang, et al., Effectiveness of mobile applications on medication adherence in adults with chronic diseases: a systematic review and meta-analysis, J Manag Care Spec Pharm 26 (4) (2020) 550–561, https://doi.org/10.18553/jmcp.2020.26.4.550.
[31] J.P. Bae, P.P. Dobesh, D.G. Klepser, et al., Adherence and dosing frequency of common medications for cardiovascular patients, Am. J. Manag. Care 18 (3) (2012) 139–146.
[32] B. Riegel, C.S. Lee, S.J. Ratcliffe, et al., Predictors of objectively measured medication nonadherence in adults with heart failure, Circ Heart Fail 5 (4) (2012) 430–436, https://doi.org/10.1161/CIRCHEARTFAILURE.111.965152.
[33] M. Viana, O. Laszczynska, S. Mendes, et al., Medication adherence to specific drug classes in chronic heart failure, J Manag Care Spec Pharm 20 (10) (2014) 1018–1026, https://doi.org/10.18553/jmcp.2014.20.10.1018.
[34] E.R. Weeda, C.I. Coleman, C.A. McHorney, C. Crivera, J.R. Schein, D.M. Sobieraj, Impact of once- or twice-daily dosing frequency on adherence to chronic cardiovascular disease medications: a meta-regression analysis, Int. J. Cardiol. 216 (2016) 104–109, https://doi.org/10.1016/j.ijcard.2016.04.082.
[35] L. Madanat, M. Saleh, M. Maraskine, A. Halalau, F. Bukovec, Congestive heart failure 30-day readmission: descriptive study of demographics, Co-morbidities, heart failure knowledge, and self-care, Cureus 13 (10) (2021) e18661, https://doi.org/10.7759/cureus.18661.
[36] C. Mahler, K. Hermann, R. Horne, et al., Assessing reported adherence to pharmacological treatment recommendations. Translation and evaluation of the Medication Adherence Report Scale (MARS) in Germany, J. Eval. Clin. Pract. 16 (3) (2010) 574–579, https://doi.org/10.1111/j.1365-2753.2009.01169.x.
[37] C. Demetriou, B.U. Ozer, C.A. Essau, Self-report questionnaires, in: R.L. Cautin, S. O. Lilienfeld (Eds.), The Encyclopedia of Clinical Psychology, John Wiley & Sons, Inc, Hoboken, NJ, USA, 2014, pp. 1–6.
[38] C. Hoornaert, S. Pochet, S. Lorent, Development and delphi validation of a best possible medication history form, Eur. J. Hosp. Pharm. (2022), https://doi.org/10.1136/ejhpharm-2021-003095.
[39] C.I. Fernandez-Lazaro, J.M. García-González, D.P. Adams, et al., Adherence to treatment and related factors among patients with chronic conditions in primary care: a cross-sectional study, BMC Fam. Pract. 20 (1) (2019) 132, https://doi.org/10.1186/s12875-019-1019-3.
[40] K.S. Mutsch, M. Herbert, Medication discharge planning prior to hospital discharge, Qual. Manag. J. 17 (4) (2010) 25–35, https://doi.org/10.1080/10686967.2010.11918290.
[41] J.-R. Wu, B. Mark, G.J. Knafl, S.B. Dunbar, P.P. Chang, D.A. DeWalt, A multi-component, family-focused and literacy-sensitive intervention to improve medication adherence in patients with heart failure-A randomized controlled trial, Heart Lung 48 (6) (2019) 507–514, https://doi.org/10.1016/j.hrtlng.2019.05.011.
[42] X. Cui, X. Zhou, L. Ma, et al., A nurse-led structured education program improves self-management skills and reduces hospital readmissions in patients with chronic heart failure: a randomized and controlled trial in China, Rural Rem. Health 19 (2) (2019) 5270, https://doi.org/10.22605/RRH5270.
[43] J.N. Clarkson, S.D. Schaffer, J.J. Clarkson, The effect of an interprofessional heart failure education program on hospital readmissions, J. Healthc. Qual. 39 (2) (2017) 78–84, https://doi.org/10.1097/JHQ.0000000000000027.
[44] V.W. Lee, L.M. Choi, W.J. Wong, H.W. Chung, C.K. Ng, F.W. Cheng, Pharmacist intervention in the prevention of heart failure for high-risk elderly patients in the community, BMC Cardiovasc. Disord. 15 (2015) 178, https://doi.org/10.1186/s12872-015-0173-3.