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ORIGINAL ARTICLE

Burden of hospitalizations in newly diagnosed heart failure patients in Poland: real world population based study in years 2013–2019

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Abstract

Aims We aim to report trends in unplanned hospitalizations among newly diagnosed heart failure patients with regard to hospitalizations types and their impact on outcomes.

Methods and results A nation-wide study of all citizens in Poland with newly diagnosed heart failure based on ICD-10 coding who were beneficiaries of either public primary, secondary, or hospital care between 2013 and 2018 in Poland. Between 1 January 2013 and 31 December 2019, there were 1 124 118 newly diagnosed heart failure patients in Poland in both out- and inpatient settings. The median observation time was 946 days. As many as 49% experienced at least one acute heart failure hospitalization. Once hospitalized, 44.6% patients experienced at least one all-cause rehospitalization and 26% another heart failure rehospitalization. The latter had the highest Charlson co-morbidity index (1.36). The 30 day heart failure readmission rate was 2.96%. Kaplan–Meier analysis revealed very early readmissions (up to 1–7 days) were associated with better survival compared with rehospitalization between 8 and 30 days. All-cause mortality was related to the number of hospitalization with adjusted estimated hazard ratios: 1.550 (95% CI: 1.52–158) for the second HF hospitalization, 2.158 (95% CI: 2.098–2.219) for third, and 2.788 (95% CI: 2.67–2.91) for the fourth HF hospitalization and subsequent ones, as compared with the first hospitalization.

Conclusions Among newly diagnosed heart failure patients in Poland between 2013 and 2019, nearly half required at least one unplanned heart failure hospitalization. The risk of death was growing with every other hospital reoccurrence due to heart failure.

Keywords Incident heart failure; Hospitalizations; Rehospitalizations; Co-morbidities

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Introduction

Heart failure (HF) is a highly prevalent clinical syndrome and also a major cause of morbidity and mortality among cardiovascular reasons.[1] However, its prognosis significantly differs between chronic outpatients and deteriorating patients hospitalized for HF. Substantial evidence suggests that each symptomatic deterioration of HF, especially in cases requiring unplanned hospitalization, can contribute to HF progression and is associated with an increased risk of subsequent death.[2,3] In the recent decades, substantial efforts have focused on treatments with multiple medical (beta-blockers; angiotensin-converting enzyme inhibitors; angiotensin receptor blockers; aldosterone antagonists; valsartan/neprilysin blockers; ivabradine and more recently type 2 sodium-glucose co-transporter type 2 inhibitors) and device therapies

(implantable cardioverter defibrillator, ICD; cardiac resynchronization therapy, CRT) which have been implemented and lead to a reduction in hospitalization and mortality rates in clinical trials.[4] However, these promising results, obtained in studies conducted on highly selected populations, do not always apply to the real-world HF population.

On the other hand, the majority of HF patients suffer from co-morbidities with HF as the underlying disease. Both non-cardiovascular and cardiovascular co-morbidities and their severity significantly increase the prognostic risk of poor outcomes in HF populations.[5] They may also trigger episodes of HF exacerbation and constitute a greater hazard for hospitalizations and death in this population.

Moreover, the demography in Poland indicates an ageing population that is typical for the European Union.[6] In 2018, over 70-year-old patients accounted for over half of the HF population in Poland. The epidemiologic data of HF in the elderly are limited, despite that these patients constitute the majority in the real-world HF population.

Our study represents one of the largest retrospective, whole-population based analyses dedicated to newly diagnosed HF patients with acute hospitalizations. The aim was to evaluate the impact and importance of existing co-morbidities and acute recurrent HF, non-HF cardiovascular (CV), and non-CV hospitalizations on all-cause mortality with regard to changes over time (2013–2019).

Methods

Data source

This is a retrospective study that covers all newly diagnosed adult (≥18 years old) patients with HF from 1 January 2013 to 31 December 2019 in public sector in Poland. Data are based on the Nationwide Polish Ministry of Health Registry (NPMoH Registry). The registry collects data based on National Health Fund (Narodowy Fundusz Zdrowia; NFZ). The institution is responsible for public medical services in Poland and manages public funds for healthcare. The study population of this cross-sectional investigation included all residents who were recorded with a primary diagnosis of HF with any of codes: I50.0, I50.1, I50.9, I11.0, I13.0, or I13.2 according to the Tenth revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) during in either inpatients or outpatient clinic. Patients were included in the analysis if HF was diagnosed at least once in a cardiac hospital department or in cardiac outpatient clinic or at least twice by non-cardiologists either during inpatient or outpatient treatment. HF onset date was defined as the first diagnosis of HF recorded by any healthcare provider if confirmed by secondary care or during hospitalization. We also identified co-morbid conditions for prevalent patients in 2013–2019 by searching recorded ICD-10 diagnoses. Data regarding only unplanned hospitalizations were collected. This entails hospitalizations coded either as emergent or following emergency service delivery. All hospitalizations following patients' referral from primary or secondary outpatient care or transfers from other hospitals were excluded.

The demographic data and hospitalizations details were also obtained from NPMoH Registry. The investigation conforms to the principles outlined in the Declaration of Helsinki. The Regional Ethical Review Board approved the study.

Statistical methods

Data are presented as mean values ± SD. Life table curves were calculated according to the Kaplan–Meier test. Cox proportional hazard regression was used to account for age, gender, and co-morbidities.

The study did not use a random sample. All patients using the public health sector in Poland participated in the study. Therefore, statistical significance cannot be verified—all conclusions are by definition statistically significant for patients using the public sector and cannot be extended to the entire population of Poland, as patients using the public sector do not constitute a random sample of the population.

Statistical analysis was performed using the R software version 3.6.2 and the IDE R Studio version 1.2.5001.

Results

Study population

Between 1 January 2013 and 31 December 2019, among the overall population of Poland (41 207 547), 1 124 118 patients were newly diagnosed with HF. The HF incidence was gradually decreasing to 130 483 cases in 2019 (*Figure S1*, *Table S1*). The median observation time was 946 days. As many as 51% of patients were ambulatory being diagnosed in outpatient clinics and never hospitalized due to HF during the study. Over one-third (36%) experienced isolated HF hospitalization, while 29% were rehospitalized, including 13% rehospitalizations for HF deterioration. Patients who were not hospitalized were slightly younger, and they more often presented with arterial hypertension. The burden of co-morbidities was higher among hospitalized and rehospitalized patients. Detailed characteristics of the subgroups are shown in *Table 1*.

Trends in all-cause hospitalizations

There were 6 022 366 acute hospitalizations in Poland during the study period with 8.9% (533 934) regarding HF pa-

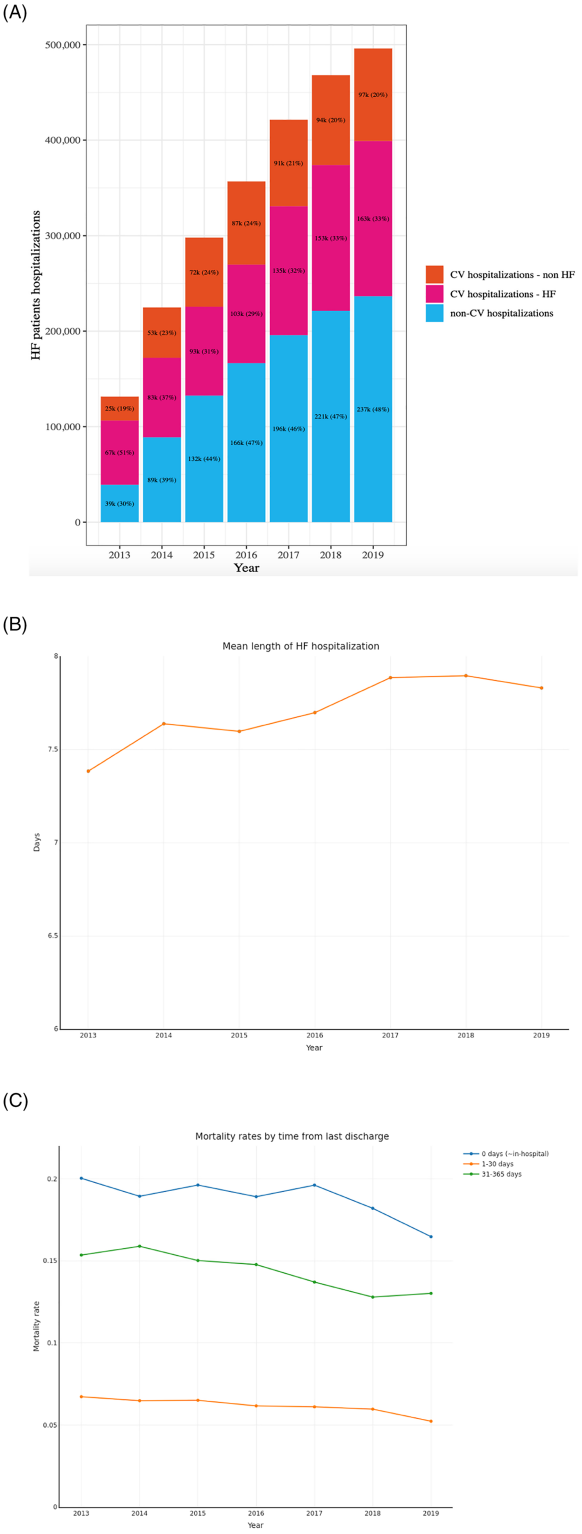
Table 1 Baseline demographic characteristic of the study population

					At least one HF hospitalization (n = 550 132; 49%)					
Overall (n = 1 124 118)			No-HF hospitalization (n = 573 983; 51%)		Isolated HF hospitalization (n = 406 978) (36% of all HF patients) (74% of patients hospitalized for HF)		HF readmissions[a] (n = 143 157) (13% of all HF patients) (26% of patients hospitalized for HF)		Any readmissions[a] (n = 328 298) (29% of all HF patients) (60% of patients hospitalized for HF)	
Age, years	72.89 (SD 12.54)		71.36 (SD 12.87)		74.62 (SD 12.15)		74.14 (SD 11.45)		73.57 (SD 11.77)	
Mean observation time (days)	1039 (SD 767)		1184 (SD 746)		799 (SD 753)		1140 (SD 718)		1064 (SD 741)	
Observation time (days): 1st quarter/median/3rd quarter	340/946/1679		532/1141/1811		99/593/1350		523/1072/1728		407/978/1673	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%
Sex: male	527 571	47%	257 502	45%	195 487	48%	74 582	52%	164 657	50%
Residence: urban	685 659	61%	353 807	62%	246 634	61%	85 218	60%	198 866	61%
HF aetiology ischaemic	608 103	54%	320 439	56%	204 711	50%	82 953	58%	180 791	55%
Arterial hypertension	631 739	56%	361 736	63%	185 156	45%	84 847	59%	187 29	57%
Heart rhythm, atrial flatter & fibrillation	276 382	25%	118 137	21%	98 872	24%	59 373	41%	114 311	35%
ICD/CRTD &P implantation	102 597	9%	44 743	8%	31 661	8%	26 193	18%	44 853	14%
Anaemia	110 368	10%	53 920	9%	35 565	9%	20 883	15%	43 134	13%
CCI: 0	484 135	43%	250 240	44%	185 688	46%	48 207	34%	127 796	39%
CCI: 1–2	486 936	43%	254 054	44%	164 342	40%	68 540	48%	145 25	44%
CCI: 3–4	125 664	11%	58 632	10%	45 850	11%	21 182	15%	44 211	13%
CCI: ≥5	27 383	2%	11 057	2%	11 098	3%	5228	4%	10 766	3%
Mean CCS (Charlson co-morbidity score)	1.10 (SD 1.33)		1.04 (SD 1.26)		1.09 (SD 1.37)		1.36 (SD 1.43)		1.25 (SD 1.42)	
Myocardial Infarction	79 868	7%	42 153	7%	23 588	6%	14 127	10%	26 071	8%
Peripheral vascular disease	169 168	15%	85 435	15%	59 351	15%	24 382	17%	52 461	16%
Cerebral vascular disease	148 900	13%	77 790	14%	51 566	13%	19 544	14%	44 320	13%
Dementia	65 824	6%	28 378	5%	30 052	7%	7394	5%	18 639	6%
COPD	172 683	15%	89 977	16%	55 954	14%	26 752	19%	54 871	17%
Obstructive sleep apnoea	8154	1%	4882	1%	2066	1%	1206	1%	2445	1%
Connective tissue disease	25 171	0.02%	14 351	0.03%	7781	0.02%	3039	0.02%	7068	0.02%
Peptic ulcer disease	22 326	2%	12 175	2%	7045	2%	3106	2%	6775	2%
Liver disease mild	16 185	1%	9184	2%	5086	1%	1915	1%	4536	1%
Liver disease moderate/severe	1796	0%	942	0%	616	0%	238	0%	531	0%
Diabetes mellitus uncomplicated	49 188	4%	24 750	4%	16 677	4%	7761	5%	16 242	5%
Diabetes mellitus end-organ damage	35 343	3%	15 932	3%	12 773	3%	6638	5%	13 460	4%
Moderate/severe CKD	47 562	4%	21 745	4%	17 381	4%	8436	6%	17 612	5%
Cancer	91 275	8%	46 482	8%	33 516	8%	11 277	8%	26 963	8%
Cancer with metastases	4527	0%	1750	0%	2322	1%	455	0%	1298	0%
AIDS/HIV	79	0%	46	0%	22	0%	11	0%	23	0%
Hemi/paraplegia	16 510	1%	8098	1%	6304	2%	2108	1%	5057	2%

Demographic data: age, sex, place of residence – urban; cardiac data: HF aetiology, arterial hypertension, heart rhythm (sinus vs. atrial flatter & fibrillation); implanted devices: ICD/CRTD &P, implantation, anaemia and additional co-morbidities related with Charlson co-morbidity index; every single component: myocardial infarction, peripheral vascular disease, cerebral vascular disease, dementia, COPD, obstructive sleep apnoea, connective tissue disease, peptic ulcer disease, liver disease mild/moderate/severe, diabetes mellitus uncomplicated/end-organ damage, moderate to severe chronic kidney disease, cancer, cancer with metastases, AIDS/HIV hemi/paraplegia.

[a]Patients readmitted due to HF and other causes could overlap.

Figure 1 (A) (Central illustration) Acute hospitalizations in newly diagnosed HF patients – proportion among major causes of hospitalization. (B) Acute hospitalizations due to HF deterioration in HF patients – mean length of stay. (C) Mortality rates by time from the last acute HF discharge



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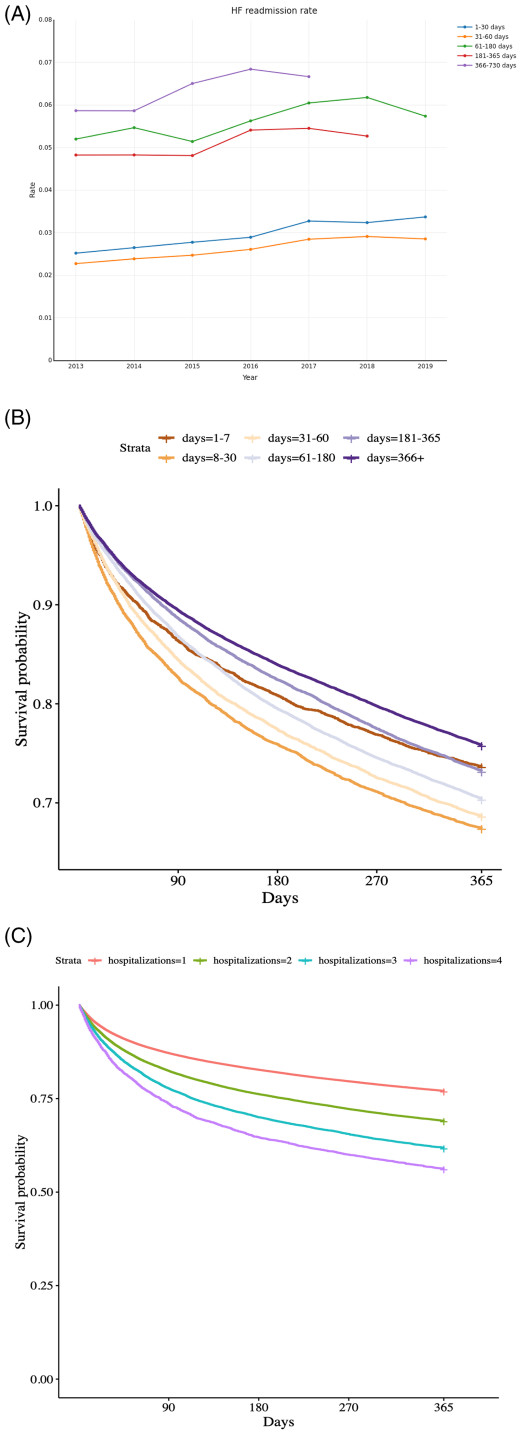
tients. The number of all-cause unplanned hospitalizations in newly diagnosed HF patients increased significantly over the study period (*Figure 1A*). Except for the two initial years with a higher number of HF hospitalizations (*Figure 1A*, *Table S2*), the proportion between HF, CV, and non CV-hospitalization was relatively

Figure 2 (A) Rates of first heart failure rehospitalizations following the index HF hospital stay with regards to time from discharge (1–30, 31–60, 61–180, 181–365, 366–730 days). (B) Kaplan–Meier curves displaying the estimated survival probability after the first acute re-admission due to HF within different periods (1–7, 8–30, 31–60, 61–180, 181–365, >366 days). (C) Kaplan–Meier curves displaying the estimated survival probability after acute readmissions due to HF with regard to their frequency (1, 2, 3, 4 or more hospitalizations)



stable with non-CV ones reaching up to 48% (*Figure 1A*, *Table S2*).

Trends in hospitalizations due to heart failure deterioration

As many as 49% (n = 550 135) of newly diagnosed HF patients in Poland in the years 2013–2019 experienced at least one acute HF hospitalization (*Table 1*). The mean length of hospital stay was 7.5 days with a smooth uptrend over the study (*Figure 1B*, *Table S3*). By the end of 2019, the mortality rates from the last discharge improved over time 16.5%, 5.2%, and 13% in 2019 (in-hospital, 1–30 days, and 31–365 days, respectively). That add up to the total of 18.2% 1 year mortality. Standardization for age and sex did not affect results markedly (*Figure 1C*, *Table S4*).

Trends in heart failure rehospitalizations

Once hospitalized due to HF, every fourth patient was readmitted for a worsening HF at least once over the study with a median observation time of 1072 days (*Table 1*). Patients rehospitalized for HF had the highest Charlson co-morbidity index (CCI) (*Table 1*). In terms of the first HF rehospitalization following the index hospital stay, 30 day admission rate was on average as low as 2.96% (*Figure 2A*, *Table S5*); however, the risk was growing along with time from the hospital stay and so was readmission rate over the study period (*Figure 2A, Table S5*).

Kaplan–Meier analysis revealed a relationship between survival and rehospitalization for worsening of HF at different time-points post-discharge (*Figure 2B*). The greater the distance from initial hospitalization, the better the prognosis. The only exception to the pattern was in relation to the earliest rehospitalizations within the first week post-discharge (*Figure 2B*). Moreover, survival was highly dependent on rehospitalization frequency. Kaplan–Meier curves indicated that along with an increased number of HF rehospitalizations, the survival was declining (*Figure 2C*).

After adjusting for demographic and clinical variables the estimated hazard ratios (HR) for all-cause mortality amounted to 1.550 (95% CI: 1.52–158) for the 2nd, 2.158 (95% CI: 2.098–2.219) for the 3rd and 2.788 (95% CI: 2.67–2.91) for the 4th and subsequent HF hospitalizations, as compared with the first hospitalization (*Table 2*).

Table 2 Cox regression proportional hazards model-estimated hazard ratios (HR) for all-cause mortality with regard to the number of acute hospitalizations, as compared with the first HF hospitalization

Number of hospitalizations	HR[a]	Lower 95% CI	Upper 95% CI	*P*
2	1.550	1.523	1.578	0.0001
3	2.158	2.098	2.219	0.0001
4	2.788	2.670	2.911	0.0001

After adjusting for age, sex, place of residence, and aetiology, the presence of arterial hypertension, atrial fibrillation/flutter, ICD/CRTD implantation, anaemia, and CCI burden.
[a]Hazard ratio of death compared with the risk after one hospitalization.

Trends in all-cause readmissions after the first heart failure hospitalization

After the index HF hospitalization, over half (60%) of patients experienced at least one acute all-cause rehospitalization over a median time of 978 days (*Table 1*).

The rate of the first all-cause readmission following the index HF stay was the highest within the first 30 days (11.69%; *Figure 3A*, *Table S6*). With regard to changes over time, readmission rates declined except for the early (1–30 days) period (*Figure 3A*, *Table S6*). Of note, the non-CV disorders were responsible for about half of all acute readmissions with their contribution growing along with time from the first HF hospital stay (*Figure 3B*, *Table S7*). Cardiovascular non-HF hospitalization contribution was in its peak in the first 30 days and levelled off at 24% afterwards (*Figure 3B*, *Table S7*).

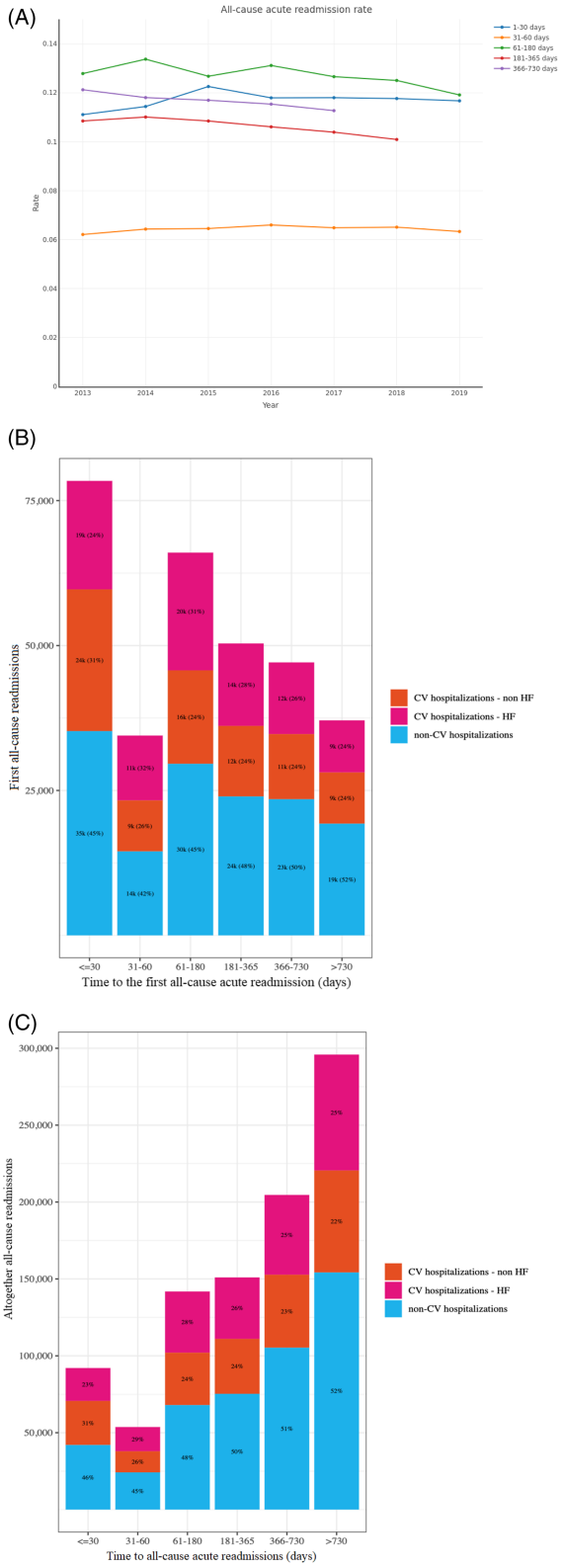
The total number of rehospitalizations was gradually growing over time from the index HF stay (*Figure 3C*, *Table S8*). Again, acute non-CV hospitalizations accounted for about 50% and with a growing share (*Figure 3C*, *Table S8*).

Discussion

This whole-population study provides data regarding newly diagnosed HF patients from Poland, the third-largest population in Central and Eastern Europe. It reports trends in unplanned hospital stays with regard to types of hospitalizations cardiovascular (CV) HF/non-HF and non-CV) as well as patients' outcomes in years 2013–2019.

Despite decreasing incidence, there is an alarming uptrend in HF prevalence in the World, including Poland.[7,8] This comes with rapid growth in the number of hospitalizations either for HF or non-HF reasons. It was found that nearly half (49%) of newly diagnosed HF patients in Poland in years 2013–2019 experienced at least one acute HF hospitalization. In the USA, hospital admissions were

Figure 3 (A) Rates of first all-cause acute readmissions rate following the index HF hospital stay with regards to time from discharge (1–30, 31–60, 61–180, 181–365, 366–730 days). (B) Types of the first all-cause acute readmissions following the index hospital stay with regards to time from discharge (1–30, 31–60, 61–180, 181–365, 366–730, >730 days). (C) Altogether all-cause acute readmissions following the index HF in different time periods (1–30, 31–60, 61–180, 181–365, >366 days)



estimated to account for more than one-half of expenditure dedicated to HF treatment.[9,10] In the analysed period, nearly every 9th patient admitted to hospital due to an acute condition suffered from HF. The present study illustrates the snow-ball effect of heart failure in terms of hospital admission rate. In a relatively small group of patients involving only newly diagnosed HF cases between 2013 and 2019, it was found that along with incidence drop by 32%, there was a nearly four-fold increase in the number of all-cause hospitalizations. Interestingly, the greatest contribution to the overall temporal uptrend in hospitalization rate was due to non-cardiovascular reasons responsible for nearly half of all hospitalizations (*Figure 1A*). As shown in *Table 1*, Charlson co-morbidity index (CCI) was the highest among patients rehospitalized either for all causes or HF. An intriguing finding is that chronic kidney disease (CKD) or diabetes mellitus were more common in patients rehospitalized for heart failure versus all-cause. This could reflect the frequent coexistence of co-morbidities and the fact that the main reason for hospitalizations in these particular subpopulations are due to cardiovascular reason with heart failure as the leading cause.[11] According to the British registry, the mean number of co-morbidities in patients diagnosed with HF rose from 3.4 in 2002 to 5.4 in 2014 as a result of which as many as 87% of patients had at least three co-morbidities at the time of HF diagnosis.[12] It should be understood that heart failure is a broad spectrum condition and often more a manifestation of diverse cardiac and non-cardiac abnormalities rather than a separate disease.[13] The current study also fills the gap in data describing rates of hospitalizations over the course of HF syndrome after the initial diagnosis of HF including outpatient settings.[14]

Despite down-trend in in-hospital mortality to the level of 16% in 2019, it was one of the most disadvantageous outcomes reported in Western World recently (*Figure 1C*). Nevertheless, the present data are in agreement with findings by Sierpiński *et al*. who reported a 14% in-hospital mortality in Poland in all prevalent HF patients over a 10 year period.[15] On the other hand, they observed a gradual uptrend in in-hospital deaths between 2010 and 2019. The opposite trend in our study could result from a more recent population (dating back to 2013 vs. 2010 in Sierpiński's study) thus treated in a unified manner according to new HF recommendations that were published in 2012 and updated in 2016. Definitely, the fact that only newly diagnosed patients were included in contrast to all-comers in the referenced study played a significant role. Consequently, it might be assumed that in the present study patients presented at an early disease stage as the majority (74%) were hospitalized only once. If so, the high in-hospital mortality seems even more alarming.

Postdischarge outcomes were much more favourable for patients hospitalized due to HF in Poland. The 30 day and 1 year postdischarge all-cause mortality following the last HF admission was 5.2% and 18.2% respectively (*Figure 1C*). The results outstood findings of the most recent meta-analysis by Kimmoun et al. who reported a 30 day mortality of 7% based on data of over 15 million patients hospitalized due to acute heart failure around the World. The 1 year mortality in the present study was also satisfactory.[16] It was in line with data from the REPORT-HF registry that found mortality in Eastern Europe at the level of 16%.[17] In the eastern Mediterranean region and Africa, 1 year mortality was reported at 22% and in Latin America at 22%.[17] Interestingly, data from high-income Western countries are even less favourable with rates varying between 20% and 30%. Such discrepancies might be due to differences in definitions and inclusion criteria used. The present study was based on ICD coding that poses several limitations including the fact of overuse for economic purposes. However, to minimize the risk of bias in case of diagnosis in an outpatient setting, a second (confirmatory) diagnosis was required as described in the methods.

Increased mortality in developed countries might also reflect the fact these populations present with more advanced stages of HF due to improvement in the treatment of other cardiac.[18] Additionally, report from Canadian Institute for Health Information database shown that 30 day and 1 year mortality ranged from 2.3% and 7.6%, respectively, in the youngest subgroup to 23.8% and 60.7%, respectively, in the oldest subgroup.[19] Thus, the demographic profile plays an essential role in outcomes. Finally, extremely high in-hospital mortality in the current study may contribute to relatively favourable post-discharge outcomes.

Rehospitalizations due to deteriorating heart failure place a great burden on health care and are closely related to poor prognosis.[13] As much as 13% of the total study population was hospitalized at least twice. The readmission rate due to HF after the index hospitalization was 26% over a median follow-up time of 1072 days. The results seem satisfactory given the findings of an international study that reported HF recurrence after the first HF hospitalization to be as high as 28% over a shorter −5 year period.[20] Also, results from a 3 year study within the Cardiovascular Disease in Norway Project in a population of 142 109 incident HF showed a readmission rate of 26.95% with a mean follow-up of 460 days.[21]

It was observed from the previous studies that early readmissions are frequent and pose the greatest risk.[20,22] In the current study, a relatively low readmission rate following the first HF stay might again be due to high in-hospital mortality. Some researchers claim there is reverse relation between in-hospital mortality and early readmission rate.[23,24] Nevertheless, a poor prognosis with early readmissions was confirmed. With exception for a relatively good prognosis across patients rehospitalized as soon as within the first week. This may be explained by the fact that they returned in a very early phase of decompensation. An early readmis-

sion could also be an equivalent of the early follow-up with physicians being more prone to admission. Unfortunately, data regarding very early, up to 7–10 days, rehospitalizations are scarce. In line with the present findings, Lam *et al*. reported that that early (up to 10 days) all-cause readmissions after HF hospitalization were associated with favourable outcomes compared with reoccurrence between 11 and 30 days.[25] However, analysis limited to HF rehospitalizations showed no difference.[25]

The early vulnerable phase reflects two aspects of care that need to be addressed to reverse the alarming trends in HF readmissions. The first mirrors acute care during the index hospitalization, the second reflects the quality of ambulatory care. The former includes conventional treatment as per guidelines along with emerging goals such as individualized nutrition as shown in the EFFORT study.[4,26] In the out-patient phase, education and monitoring with therapy optimization are a prerequisite. Nevertheless, new therapies such as CARDIO-MEMs come up at the same time.

The previously reported association between co-morbidities and readmissions was also confirmed with the highest CCI among patients with HF readmissions.[27] The study was also in agreement with available reports that regardless of time of rehospitalization, readmissions affect survival.[3,20] The risk of death rose by leaps and bounds with every new HF admission following the natural disease course (*Figure* 2C).

Last but not the least, regardless of time from the index hospitalization, nearly one-third of the first rehospitalizations was due to non-HF reasons (*Figure 3C*); therefore, interventions targeting co-morbidities in this population should not be neglected.

Conclusions

As many as half of incident HF inpatients and outpatients required at least one hospital admission due to worsening HF within over 3 years of observation. Despite declining HF incidence, newly diagnosed HF patients generated a snowball effect on the hospitalization burden. The majority of hospital stays were due to non-cardiovascular reasons. Early and repeating readmissions were related to dismal prognoses.

Limitations

The main limitations of the study include its retrospective and administrative nature. The diagnosis of HF was based on ICD-10 coding, so it was impossible to distinguish the type of HF identification (reduced or preserved ejection fraction). However, in terms of hospitalization and rehospitalization, studies prove that acute cardiovascular and non-cardiovascular rehospitalizations in HF patients have a similar impact on mortality regardless of the type of HF (preserved vs. reduced HF) and across the spectrum of ejection fraction.[2,14] Moreover, in terms of the group payment system, there might be bias related to hospital discharge diagnosis preferences as previously published. We also analysed the number of deaths in patients with HF only. Due to the lack of reliable data on the cause of death, it was not taken into account. Additionally, the registry covers only public health sector. However, the private sector of the inpatient care in Poland is limited and thus can be neglected.

Clinical perspectives

There is a world-wide downtrend in heart failure incidence. Nevertheless, many countries including Poland experience increase in the number of all-cause hospitalizations. Non-cardiovascular causes contribute to nearly 50% of all unplanned hospital stays.

Translational outlook

Heart failure need to be acknowledge as a complex entity requiring multidisciplinary care. In the light of high burden of noncardiovascular hospitalizations, interdisciplinary care bundles may contribute to outcome improvement.

Acknowledgement

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Conflict of interest

None declared.

Supporting information

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

Figure S1. The proportion between patients newly enrolled and already in the study in HF population in 2013–2019.
Table S1. The proportion between newly vs previously diagnosed patients in HF population in 2013–2019.
Table S2. Acute hospitalizations in HF patients in Poland in 2013–2019—proportion between major causes of hospitalization.

Table S3. Hospitalizations due to HF deterioration in HF patients—mean length of stay.

Table S4. Mortality following hospitalizations due to HF deterioration in HF patients.

Table S5. Readmission rate for the first HF rehospitalization following the index HF stay.

Table S6. Readmission rate for the first all-cause rehospitalization following the index HF stay.

Table S7. Types of the first acute all-cause readmissions following the index hospital stay with regards to time from discharge (1–30, 31–60, 61–180, 181–365, 366–730, > 731 days).

Table S8. The number of, and the proportion between, major causes of the total number of acute re - hospitalizations within different periods (1–30, 31–60, 61–180, 181–360, 361–720, > 720 days) after an admission for HF).

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