The effect of the day of the week of discharge on mortality and readmissions in patients hospitalized due to heart failure

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Abstract

Background: The effect of the day of the week of discharge on mortality and readmissions in patients hospitalized due to heart failure (HF) remains unclear. The aim was to determine the effect of the day of the week of discharge of HF patients on 30-day and one-year mortality and rehospitalizations.

Material and methods: Inclusion criteria were hospitalization due to HF exacerbation in the 2013 year according to the National Health Fund data. The primary outcome variable was all-cause mortality and the secondary the first readmission due to HF exacerbation. Survival analysis was performed for outcomes according to the day of the week of discharge adjusting for age, sex, duration of the hospitalization, HF severity, type of ward, and fulfilling prescription for selected medications within the 30-day post-hospitalization period.

Results: The analysis included 96,219 patients (median age 77.0 yrs., 46.3% males). The mean all-cause one-year mortality was the highest on Sundays when compared with other days separately in the Cox analysis [hazard ratio (HR): 1.40; 95% confidence interval (CI): 1.23–1.59; $p < 0.001$] and also when compared with the other weekdays pulled (27.8% *vs.* 21.8%, $p < 0.001$). The 30-day mortality was the highest for Sunday discharges in the Cox analysis (HR: 2.14; 95% CI: 1.78–2.57; $p < 0.001$). The day of the week of discharge did not affect rehospitalization rates.

Conclusions: The day of the week of discharge of HF patients matters as it may be related to the prognosis.

Key words: day of the week; heart failure; mortality; readmission

Arterial Hypertens. 2024, vol. 28, no. 1, pages: 1–8
DOI: 10.5603/ah.99867

Introduction

High post-hospital mortality and high rates of readmissions are significant problems in heart failure (HF) [1]. The day of the week of admission may influence the length of stay and in-hospital death, but this association has been inconsistent in HF patients among studies [2, 3–5]. It should be noted that the most common causes of heart failure development worldwide remain hypertension and coronary artery disease. When admitting a patient with an exacerbation of heart failure, it is necessary to evaluate and determine the causes of newly diagnosed heart failure or its exacerbation. Likewise, before the patient is discharged, it is important to determine whether potentially exacerbating factors

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are well managed, such as blood pressure control or fluid balance. Discharge of the HF patient on a day off may potentially have multiple effects on the future of the patient. While many studies have looked at the effect of the day of the week on admission in HF patients, fewer studies have tested the effect of the day of discharge on mortality and readmission rates [2, 6].

The study aimed to determine the effect of the day of the week of discharge on 30-day and one-year mortality, on the frequency of rehospitalization, and the purchase of drugs with a proven reduction of HF mortality in the 30-day post-discharge period.

Material and methods

The data collected by the National Health Fund (NHF) were used. NHF remains the only public and obligatory health insurer in Poland. The NHF database includes data on all patient admissions and discharge dates, main diagnoses, birth and death dates, and fulfilling drug prescriptions all over the country. Inclusion criteria were patients who were hospitalized with the International Classification of Diseases Tenth Revision (ICD-10) diagnosis code of I50 (congestive heart failure) due to HF exacerbation (specific NHF codes) in the 2013 year. We excluded patients who were hospitalized with the ICD-10 code I50 in the previous year disregarding the main reason for the hospitalization as well as the patients who died during the index hospitalization.

The primary outcome variable was all-cause mortality and the secondary was the first readmission due to HF exacerbation.

Survival analysis was performed for primary and secondary outcomes according to the day of the week of the discharge adjusting for age, sex, length of stay (LOS) of the index hospitalizations, severe HF as reported to NFH (defined as need for vasopressors or dialysis), type of ward (cardiology *vs.* non-cardiology) and fulfilling (or not) prescription for at least one of the selected medications with proven influence for HF mortality including angiotensin converting enzyme inhibitor (ACEI)/angiotensin receptor blocker (ARB), mineralocorticoid receptor antagonist (MRA), beta-blocker (BB) within the period of 30 days after index hospitalization. Endpoints were censored 365 days after discharge. The data obtained from NHF were encrypted using personal identifiers before the authors had any access to them.

Statistics

Variables were compared using the Chi2 test and Kruskal-Wallis test according to the day of discharge. The analysis also included the bivariate comparison between pulled weekdays and respectively Sundays, Saturdays or both weekend days combined using the Chi2 test and Mann–Whitney U test.

Estimates of cumulative event rates were calculated using the Kaplan–Meier method with the log-rank comparison of survival curves. Cox proportional-hazards analyses were performed for primary and secondary outcomes using above-mentioned variables that present $p < 0.1$ in univariate analysis. We used the combined data regarding BB, ACEI, ARB, or MRA use.

P values of less than 0.05 were considered significant. The statistical analysis of the data was performed using R (R version 3.6.1, R-core Team, R Foundation for Statistical Computing, Vienna, Austria, 2019, https://www.r-project.org), graphs with "survminer" and 'forestmodel" R packages.

The study was not considered for review by the local ethical committee since the database was previously collected by a government agency and all data were fully anonymized, and fully encrypted before the authors had any access to them. There was no direct patient contact.

Results

The analysis included 96,219 patients (median age 77.0 yrs., 46.3% males) fulfilling the inclusion and exclusion criteria (Fig. 1). On weekend days 5.34% discharges took place. The lowest discharge rate (1.2%) occurred on Sundays, the highest (24.3%) on Fridays.

The characteristics of all patients and comparison among the distinctive days of the week is depicted in Table 1. The significant differences in the patients' characteristics between weekdays of the discharge included length of stay, severe HF according to specified criteria, fulfilling prescriptions for the drugs of interest and ward type. Of note the median of length of stay was significantly (by 1 day) shorter, the percentage of severe HF approx. 1.5 higher and the rate of fulfilling prescriptions for the drugs of interest approximately 10% lower in case of patients discharged on Sundays as compared with the pulled working days (Tab. 1).

Mortality

The all-cause one-year mortality in all patients was 21.9%, being significantly different according to

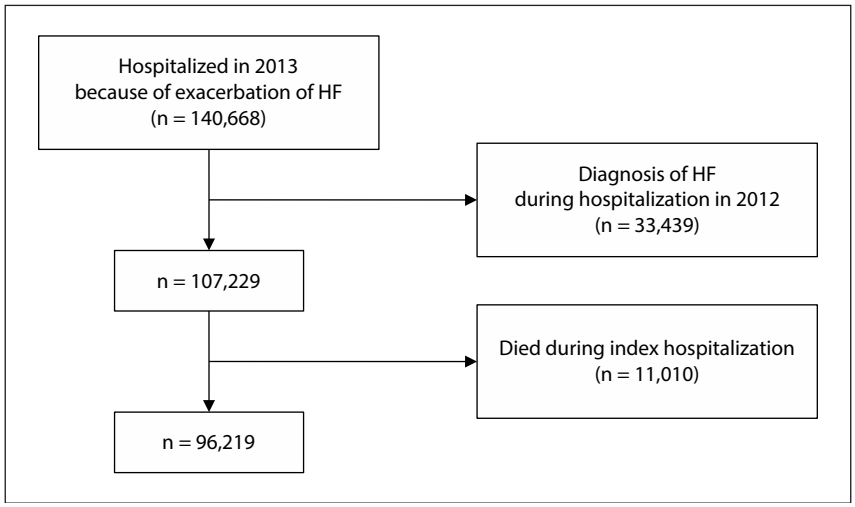

Figure 1. The flowchart of patient selection. HF — heart failure

the day of the week of the discharge in unadjusted survival analysis (log-rank $p < 0.0001$; Fig. 2). The highest one-year mortality rate was linked to the Sunday discharges compared with the other weekdays pulled (27.8% *vs.* 21.8%, $p < 0.001$). One-year mortality was not different between Saturday discharges comparing weekdays discharges pulled or between weekend days *vs.* weekdays (Tab. 1). In the Cox analysis comparing days separately, one-year mortality was significantly higher for Sunday discharges compared with the other days [hazard ratio (HR): 1.40; 95% confidence interval (CI): 1.23–1.59; $p < 0.001$, Saturday discharges presenting the lowest mortality were used as a reference].

Cox analysis with all covariates for one-year mortality is presented on Figure 3. The mortality was higher for higher LOS, **in patients {???}** and discharges from non-cardiology wards.

The respective analysis for 30-day mortality was similar, with the significant difference according to the day of the week of the discharge in unadjusted survival analysis (log-rank $p < 0.001$).

The highest 30-day mortality rate was linked to the Sunday discharges compared with the other weekdays pulled (10.8% *vs.* 5.3%, $p < 0.001$). In the Cox analysis comparing days separately, 30-day mortality was significantly higher for Sunday discharges compared with the other days (HR: 2.14; 95% CI: 1.78–2.57; $p < 0.001$). Other significant covariates in Cox analysis for 30-day mortality were similar to the one-year mortality analysis, with one exception for lower mortality after discharge from non-cardiology ward (HR: 0.93; 95% CI: 0.89–0.98; $p < 0.001$; Friday discharges (the lowest mortality) were used as a reference).

Readmissions

One-year rate of rehospitalization due to exacerbation of HF was 10.6%, 30-day rate was 4.3% in all patients. Survival analysis revealed no differences in long or short-term rehospitalization rate according to the day of the week of the discharge in unadjusted and adjusted survival analysis.

Discussion

Similarly to the other studies, the largest number of discharges (24.3%) occurred on Fridays and was the lowest on Saturdays (1.2 %). On weekend days 5.34% of discharges took place. In the OPTIMIZE-HF (Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients with Heart Failure) analysis regarding day of the discharge the respective percentages were 19.4%, 7.1%, and 18% [2]. The low weekend-day discharge rate in HF patients in Poland probably reflects national institutional specificity. As McAlister notes "Although daily discharge rates on Saturday and Sunday are lower than those for the other 5 days of the week, bed shortages and hospital overcrowding have increased interest in maximizing week-round discharge efficiency" [6].

The results of our study revealed that HF patients discharged on Sundays had two times higher 30-day and 40% higher 1-year mortality compared with those discharged on the other days of the week. The effect of the day of the discharge was independent of patient characteristics such as age, gender, duration of hospitalization, type of the ward, HF severity, and fulfilling the prescriptions of HF drugs with a proven influence

Table 1. Characteristics of the group and subgroups.

	ALL	1	2	3	4	5	1–5	6	7	6 + 7	p 6 *vs.* 1–5	p 7 *vs.* 1–5	p 1–5 *vs.* 6–7	p overall
N	**96219 (100)**	16833 (17.5)	17855 (18.6)	17035 (17.7)	15938 (16.6)	23417 (24.3)	**91078 (94.7)**	3996 (4.2)	1145 (1.2)	**5141 (5.3)**				
Males	**44505 (46.3)**	7725 (45.9)	8288 (46.4)	7805 (45.8)	7455 (46.8)	10832 (46.3)	**42105 (46.2)**	1849 (46.3)	551 (48.1)	**2400 (46.7)**	0.972	0.213	0.535	0.453
Age, yrs.	**77 (69–83)**	77 (69–83)	78 (69–83)	78 (69–83)	77 (69–83)	77 (69–83)	**77 (69–83)**	77 (69–83)	77 (68–83)	**77 (69–83)**	0.377	0.213	0.177	0.265
LOS, days	**7 (5–9)**	7 (5–10)	7 (5–10)	7 (5–9)	7 (4–9)	7 (4–9)	**7 (5–9)**	5 (4–8)	6 (4–9)	**5 (4–8)**	< 0.001	< 0.001	< 0.001	< 0.001
Advanced HF	**4608 (5.0)**	886 (5.3)	865 (4.8)	815 (4.8)	742 (4.7)	1033 (4.4)	**4341 (4.8)**	196 (4.9)	71 (6.2)	**267 (5.2)**	0.715	0.028	0.173	0.001
Prescription for HF	**58785 (61.1)**	10053 (59.7)	10773 (60.3)	10357 (60.8)	9792 (61.4)	14652 (62.6)	**55627 (61.1)**	2583 (64.6)	575 (50.2)	**3158 (61.4)**	< 0.001	< 0.001	0.625	< 0.001
BB	**24377 (25.3)**	4211 (25.0)	4444 (24.9)	4329 (25.4)	3973 (24.9)	6060 (25.9)	**23017 (25.3)**	1122 (28.1)	238 (20.8)	**1360 (26.5)**	< 0.001	0.001	0.060	< 0.001
ACEi	**36954 (38.4)**	6293 (37.4)	6827 (38.2)	6436 (37.8)	6172 (38.7)	9238 (39.4)	**34966 (38.4)**	1639 (41.0)	349 (30.5)	**1988 (38.7)**	0.001	< 0.001	0.701	< 0.001
ARB	**7672 (8.0)**	1303 (7.7)	1377 (7.7)	1378 (8.1)	1343 (8.4)	1862 (8.0)	**7263 (8.0)**	331 (8.3)	78 (6.8)	**409 (8.0)**	0.500	0.165	0.982	0.112
MRA	**25904 (26.9)**	4490 (26.7)	4785 (26.8)	4522 (26.5)	4257 (26.7)	6449 (27.5)	**24503 (26.9)**	1159 (29.0)	242 (21.1)	**1401 (27.3)**	0.004	< 0.001	0.595	< 0.001
Cardiology ward	**27505 (28.6)**	4948 (29.4)	5072 (28.4)	4952 (29.1)	4725 (29.6)	6387 (27.3)	**26084 (28.6)**	1108 (27.7)	313 (27.3)	**1421 (27.6)**	0.219	0.349	0.127	< 0.001
30-day readmission	**4075 (4.2)**	726 (4.3)	725 (4.1)	764 (4.5)	690 (4.3)	974 (4.2)	**3879 (4.3)**	153 (3.8)	43 (3.8)	**196 (3.8)**	0.200	0.444	0.131	0.305
30-day mortality	**5166 (5.4)**	919 (5.5)	943 (5.3)	900 (5.3)	841 (5.3)	1215 (5.2)	**4818 (5.3)**	224 (5.6)	124 (10.8)	**348 (6.8)**	0.404	< 0.001	< 0.001	< 0.001
One-year readmission	**10196 (10.6)**	1779 (10.6)	1910 (10.7)	1832 (10.8)	1685 (10.6)	2454 (10.5)	**9660 (10.6)**	419 (10.5)	117 (10.2)	**536 (10.4)**	0.829	0.707	0.700	0.976
One-year mortality	**21002 (21.8)**	3675 (21.8)	3909 (21.9)	3738 (21.9)	3384 (21.2)	5155 (22.0)	**19861 (21.8)**	823 (20.6)	318 (27.8)	**1141 (22.2)**	0.072	< 0.001	0.524	< 0.001

LOS — length of hospitalization; BB — beta-blocker; ACEI — angiotensin converting enzyme inhibitor; ARB — angiotensin receptor blocker; MRA — aldosterone receptor antagonists; 1–7 — Mondays to Saturdays. Data is presented as numbers (percentages) or medians (IQRs)

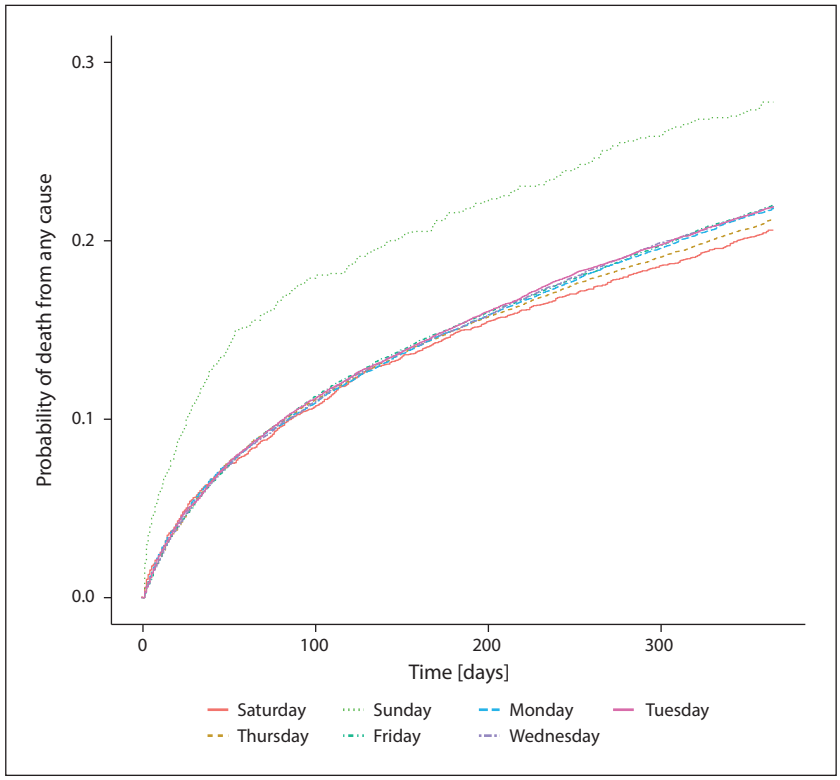

Figure 2. The primary endpoint in all patients

Variable		N	Hazard ratio	p
DOW	Saturday	3996	Reference	
	Thursday	15938	1.01 (0.94, 1.09)	0.7
	Sunday	1145	1.40 (1.23, 1.59)	<0.001
	Friday	23417	1.05 (0.98, 1.13)	0.2
	Monday	16833	1.02 (0.94, 1.10)	0.7
	Wednesday	17035	1.02 (0.95, 1.10)	0.6
	Tuesday	17855	1.01 (0.94, 1.09)	0.7
Hospital_stay		96219	1.04 (1.04, 1.04)	<0.001
Advanced_HF	No	91611	Reference	
	Yes	4608	1.72 (1.62, 1.84)	<0.001
Optimal_tx	No	37434	Reference	
	Yes	58785	0.82 (0.79, 0.84)	<0.001
Ward_type	Cardiology	27505	Reference	
	Non cardiology	68714	1.49 (1.43, 1.54)	<0.001

Figure 3. Cox analysis for primary endpoints in all patients. HF — heart failure

on HF mortality in the Cox analysis. No similar effect was observed for the Saturday discharges. In contrast to some previous studies, we tested the influence of the weekend days separately [6].

The 30-day and 1-year readmission rate due to exacerbation of HF was unaffected by the day of the week of the discharge in contrast to the mortality which may result from the fact that we calculated the readmission for the exacerbation of HF only. The true number of readmissions for HF may be higher since the common practice in Poland is to avoid coding readmission with the same code if readmission appears early after the index hospitalization to increase reimbursement.

The large OPTIMIZE-HF registry, which included 48,612 HF patients from 259 US hospitals, did not reveal differences in 60- and 90-day death or rehospitalization rates after discharge regardless of day of the week [2]. However the analysis included a probably non-representative sample of selected registry patients and has not been adjusted on some important factors such as urgency of admission (elective/non-elective) or intensive care use. Moreover the follow up was limited to a prespecified patient subgroup (10%) provided by selected 90 hospitals.

A more recent analysis of 12.216 patients discharged from teaching hospitals and 12,157 patients from nonteaching hospitals in Alberta, Canada showed that 84% of discharges occurred on weekdays. Compared with weekend discharge from a nonteaching hospital, 30-day death/readmission rates were lower for weekday discharge from a nonteaching hospital, weekend discharge from a teaching hospital, and weekday discharge from a teaching hospital [6]. Similarly to our analysis, the authors used administrative data, which precludes fully adjusting for the severity of HF or functional class. In contrast to our analysis, prescribing data was unavailable.

The mean age and comorbidities may influence the results. We had no data regarding concomitant diseases but in the pulled analysis of hospitalized patients from two Polish cohorts of European registries (ESC-HF Pilot and ESC-HF-LT) of HF patients, hypertension was diagnosed in 68.9%, coronary artery disease (CAD) in 43.6%, atrial fibrillation (AF) in 43.6% pts, diabetes in 35.1%, chronic kidney disease (CKD) 20.9%, chronic obstructive pulmonary disease (COPD) 18.8% of patients. In the above-mentioned study the mean age and one-year mortality were lower than in our cohort [7]. Given the high rate of hypertension in patients hospitalized for heart failure exacerbation, in many patients the causes of heart failure exacerbation are related to suboptimal blood pressure control, years of under-treated hypertension, left ventricular hypertrophy, and diastolic dysfunction. In our cohort, the main diagnosis was heart failure, not coronary artery disease, which is more favorably financed. Therefore, it can be speculated that most patients were hospitalized for reasons other than coronary artery disease for heart failure exacerbation.

Our cohort represents real-life data including all hospitalizations due to exacerbation of HF in the index year all over the country in contrast to earlier studies that also included stable and outpatient HF patients and were conducted mostly by the tertiary level centers, probably selecting patients with smaller number of concomitant diseases, with better compliance and better care.

Our study group probably included more patients with *de novo* heart failure, since hospitalization with the diagnosis of HF during the previous year was an exclusion criterion.

Reduced healthcare staffing at weekends may result in some drawbacks including discharge by the doctor on-duty instead of by the doctor in charge, limited comments on life-style change recommendations and possible errors in drug prescriptions. One may speculate that providing the instructions to the patients may be suboptimal on Sundays. Patients discharged on days off may have potentially worse or delayed access to a family doctor, specialist clinics, and may not purchase drugs on the day of discharge (and on subsequent ones). On weekends a greater proportion of the patients may be discharged on their own demand, before the diagnostic and therapeutic process was completed.

Our results indicate that the two weekend days (Saturdays and Sundays) should not be pulled together and should be analyzed separately. While staffing appears to be similar on Saturdays and Sundays other factors linked rather to the patient characteristics should be taken into consideration, to explain the higher mortality following the Saturday discharges.

Indeed clinical characteristics differed between patients discharged on Sundays as compared with those discharged on weekdays, but these factors were included in the Cox analysis and the differences in mortality appeared independent of included covariants. Some of the differences were subtle, e.g., LOS or severe HF and although statistically significant do not explain well the clinically important differences in mortality between above-mentioned groups. Interestingly the rate of fulfilling prescriptions for the drugs of interest was approximately 10% lower in patients discharged on Sundays. Some of the Saturday discharges might be planned initially on Fridays, and subsequently transferred to Saturday, e.g., because of the problems with transportation or with providing the care of the family members. One should also take into account the fact that on days

off you may get unsubscribed more frequently for various reasons.

Among potential factors that may explain the association between weekend hospital discharges, McAlister et. al. mentioned incomplete handover between professional caregivers, limited support services (such as consultation services or diagnostic imaging), and decreased availability of community services (including home care and social support services) [6].

Analysis of the data for 81,810 HF admissions at hospitals participating in Get With the Guidelines program revealed that patients with HF discharged on a weekend received less complete discharge instructions than those discharged on weekdays and were less likely to have their left ventricular ejection fraction measured [3].

The novelty of our study was the inclusion of fulfilling prescriptions in the post discharge period into the analysis. In our cohort a much lower percentage of patients filled prescriptions for HF drugs comparing treatment at discharge in the Polish cohorts of European registries [7].

The patients discharged on Sundays present the lowest rate of drug prescription fulfillment. Although the link between Sunday discharges and mortality rate in the Cox analysis was independent of drug prescription fulfilling rate, this phenomenon may indicate to poorer adherence to the recommendations essential in HF patients (e.g. low sodium diet, moderate fluid intake, assessing the weight, taking drugs systematically) who are discharged on Sundays.

As Dharmarajan and Krumholz note in their editorial, the analyses of discharge day do not usually account for the range of factors that may influence risk after hospitalization such as patients' clinical characteristics, the quality of both hospital and transitional care, and the post-hospital environments to which patients are discharged [8]. Not surprisingly, different methodological approaches have shown weekend discharge to be associated with a range of outcomes including lower [9], identical [10], and higher [6] rates of unplanned readmission and death.

Strengths of our study in contrast to many above-mentioned studies include the fact that our cohort included patients from all over the country in the year of interest and was not limited to selected regions of the country or the institutions. The data were collected systematically and prospectively by a single insurer. Moreover, we included into our analysis the real-life data regarding fulfilling prescriptions for the drugs with proven influence on mortality.

Limitations of the study

Our study presents the typical limitations of a retrospective analysis of reimbursement data.

Due to the limitations of the NHF database, we were unable to assess many other important clinical parameters such as blood pressure, ejection fraction, laboratory tests [B-type natriuretic peptide (BNP) or N-terminal pro-B-type natriuretic peptide (NT-proBNP), plasma creatinine, natremia, hemoglobin] and concomitant diseases.

However, we had data on the duration of hospitalization, advanced HF (requiring treatment with positive inotropes or renal replacement therapy), and post-discharge treatment.

Autopsies are rarely performed in Poland and a majority of deaths took place outside hospitals therefore we were unable to establish the cause of death.

Conclusions

In conclusion the day of the week that patients with heart failure are discharged from hospital may be related to the prognosis. Therefore, the importance of the relationship between mortality and discharge date requires further investigations. Due to the many determinants of this relationship, they require careful identification.

Data availability statement

Data is available from the authors.

Ethics statement

The study was not considered for review by the local ethical committee since the database was previously collected by a government agency and all data were fully anonymized, and fully encrypted before the authors had any access to them. There was no direct patient contact.

Author contributions

Conceptualization: B.S. and J.L.; methodology: B.S. and J.L.; formal analysis: B.S.; investigation: B.S. and J.L.; resources: A.S.; data curation: B.S., A.S.; writing — original draft preparation: B.S.; writing — review and editing: J.L.; supervision: J.L., A.S.; project administration: J.L. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Acknowledgments

None.

Conflict of interest:

Authors declare no conflict of interests.

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