Original article

Weekend and holiday admissions for decompensated heart failure and in-hospital mortality. A cumulative effect of "nonworking" days?

Javier Elola,[a,*] Cristina Fernández-Pérez,[a,b,c] Náyade del Prado,[a] José Luis Bernal,[a,d] Nicolás Rosillo,[a,e] Marian Bas,[f] Antonio Fernández-Ortiz,[f] Raquel Barba,[g] Juana Carretero-Gómez,[h] and Julián Pérez-Villacastín[i]

[a] *Fundación Instituto para la Mejora de la Asistencia Sanitaria, Madrid, Spain*
[b] *Servicio de Medicina Preventiva, Área Sanitaria de Santiago de Compostela y Barbanza, Santiago de Compostela, A Coruña, Spain*
[c] *Instituto de Investigación de Santiago, Santiago de Compostela, A Coruña, Spain*
[d] *Servicio de Información y control de gestión, Hospital Universitario 12 de Octubre, Madrid, Spain*
[e] *Servicio de Medicina Preventiva y Salud Pública, Hospital Universitario 12 de Octubre, Madrid, Spain*
[f] *Instituto Cardiovascular, Hospital Clínico Universitario San Carlos, Madrid, Spain*
[g] *Servicio de Medicina Interna, Hospital Rey Juan Carlos, Móstoles, Madrid, Spain*
[h] *Servicio de Medicina Interna, Hospital Universitario de Badajoz, Badajoz, Spain*
[i] *Servicio de Cardiología, Hospital Clínico Universitario San Carlos, Madrid, Spain*

A B S T R A C T

Introduction and objectives: The aim of this study was to analyze whether nonelective admissions in patients with heart failure (HF) on nonworking days (NWD) are associated with higher in-hospital mortality.

Methods: We conducted a retrospective (2018-2019) observational study of episodes of nonelective admissions in patients aged 18 years and older discharged with a principal diagnosis of HF in acute general hospitals of the Spanish National Health System. NWD at admission were defined as Fridays after 14:00 hours, Saturdays, Sundays, and national and regional holidays. In-hospital mortality was analyzed with logistic regression models. The length of NWD was considered as an independent continuous variable. Propensity score matching was used as a sensitivity analysis.

Results: We selected 235 281 episodes of nonelective HF admissions. When the NWD periods were included in the in-hospital mortality model, the increases in in-hospital mortality compared with weekday admission were as follows: 1 NWD day (OR, 1.11; 95%CI, 1.07-1.16); 2 days (OR, 1.13; 95%CI, 1.09-1.17); 3 (OR, 1.16; 95%CI, 1.05-1.27); and $\geq$ 4 days (OR, 1.20; 95%CI, 1.09-1.32). There was a statistically significant association between a linear increase in NWD and higher risk-adjusted in-hospital mortality (chi-square trend P = .0002). After propensity score matching, patients with HF admitted on NWD had higher in-hospital mortality than those admitted on weekdays (OR, 1.11; average treatment effect, 12.2% vs 11.1%; P < .001).

Conclusions: We found an association between admissions for decompensated HF on an NWD and higher in-hospital mortality. The excess mortality is likely not explained by differences in severity. In this study, the "weekend effect" tended to increase as the NWD period became longer.

© 2023 Sociedad Española de Cardiología. Published by Elsevier España, S.L.U. All rights reserved.

Ingresos en fines de semana y festivos por insuficiencia cardiaca descompensada y mortalidad intrahospitalaria. ¿Un efecto acumulativo de los «días no laborables»?

R E S U M E N

Introducción y objetivos: Analizar si los ingresos no programados de pacientes con insuficiencia cardiaca (IC) en días no laborables (DNL) se asocian con un aumento de la mortalidad intrahospitalaria.

Métodos: Estudio observacional retrospectivo (2018-2019). Pacientes mayores de 18 años dados de alta con diagnóstico principal de IC en hospitales generales de agudos del Sistema Nacional de Salud español. Se consideraron ingresos en DNL los efectuados durante los viernes a partir de las 14:00 h, sábados, domingos y festivos nacionales y autonómicos. Se desarrollaron modelos de regresión logística para

* Corresponding author:
E-mail address: fjelola@movistar.es (J. Elola).
𝕏 @FundacionImas @fundacion_fic @secardiologia @Sociedad_SEMI @jvillacastin (J. Pérez-Villacastín) @FJ_Elola (J. Elola).

analizar la mortalidad intrahospitalaria considerando la duración de los DNL como variable continua independiente. Como análisis de sensibilidad se utilizó el emparejamiento por puntuación de propensión.

Resultados: Se seleccionaron 235.281 episodios de ingresos no programados por IC. Un día de DNL aumentaba el riesgo de mortalidad intrahospitalaria respecto al ingreso en día laborable (OR = 1,11; IC95%, 1,07-1,16); 2 días (OR = 1,13; IC95%, 1,09-1,17); 3 días (OR = 1,16; IC95%, 1,05-1,27), y ≥ 4 días (OR = 1,20; IC95%, 1,09-1,32). El aumento lineal del periodo de DNL se asoció con una mayor mortalidad intrahospitalaria ajustada por riesgo (χ^2 tendencia p = 0,0002). Tras el emparejamiento por puntuaciones de propensión, los pacientes con IC ingresados en DNL presentaron una mayor mortalidad hospitalaria que los ingresados en días laborables (OR = 1,11; efecto medio del tratamiento, 12,2 frente a 11,1%; p < 0,001).

Conclusiones: Se observó una asociación entre los ingresos por insuficiencia cardiaca descompensada en DNL y una mayor mortalidad intrahospitalaria. El exceso de mortalidad no se explica por diferencias en la gravedad del proceso. En este estudio se observó una tendencia a aumentar el «efecto fin de semana» a medida que el periodo de DNL se hacía más largo.

Abbreviations

HF: heart failure
NWD: nonworking days

INTRODUCTION

A large number of studies have analyzed the association of weekend admissions with significantly higher in-hospital mortality rates compared with weekday admissions ("weekend effect") in a wide range of patient populations, diseases, health care providers, and health systems.[1,2] Major health policy interventions have been proposed and implemented to avoid the weekend effect,[3] but these have been highly controversial. The debate about the existence of the "weekend effect" and its causes remains open. Some researchers have questioned the existence of a weekend effect,[4] while others have highlighted the uncertainty about its causes,[5] attributing the excess mortality to the greater severity of patients admitted at weekends or to structural and managerial aspects of the centers.[6] Others have proposed an extended weekend effect describing an excess of mortality also on Mondays and Fridays.[7]

The existence of a weekend effect on various aspects of health care quality, including mortality, has also been demonstrated in the Spanish National Health System (SNHS).[8,9] Heart failure (HF) is one of the main causes of hospital admissions in the SNHS, with high in-hospital mortality rates, 30-day readmissions, and prolonged hospital stays.[10] In patients with HF, excess mortality has been described in weekend admissions, attributed to the greater severity of these patients[11] or to the reduced hospital staffing at weekends.[12]

Although there are local exceptions, on weekends and holidays (nonworking days [NWD]) nursing staff are halved, consultants are only on call for emergencies, there are no ward rounds and no imaging, and pathology departments are only used for emergencies.[13] The aim of this study was to analyze whether nonelective admissions of patients with HF on NWD and the length of reduced care on admission were associated with higher in-hospital mortality. Secondary objectives were to analyze the association of NWD with length of stay and the likelihood of 30-day readmission for circulatory diseases.

METHODS

Population

Retrospective observational study of episodes of nonelective admission in patients aged 18 years and older discharged with a principal diagnosis of HF from acute general hospitals of the SNHS (table 1 of the supplementary data) from 2018 to 2019. The data source was the Minimum Data Set of the SNHS, which includes information on the demographic characteristics of admitted patients and administrative variables related to the diagnoses and procedures performed in patients during the hospitalization episode, coded according to the International Classification of Diseases, 10th Revision (ICD 10).[14]

NWD on admission were defined as Fridays after 14:00 hours, Saturdays, Sundays and national and regional holidays. If a single working day fell between 2 NWD, it was also considered a NWD. The length of NWD periods was classified into 5 mutually exclusive categories: 0 (admission on a working day); 1: admission on an NWD day; 2: admission on an NWD day accumulating 2 consecutive NWD; 3: admission on an NWD day accumulating 3 consecutive NWD; 4: admission on an NWD day accumulating 4 or more consecutive NWD.

To quantify possible differences in the outcomes of care in patients with HF in the SNHS in relation to NWD, in-hospital mortality, 30-day readmission for circulatory diseases, and length of hospital stay were compared with those of patients admitted on working days (Monday to Friday, excluding national or regional holidays).

To improve the quality and consistency of the data: *a)* the episodes of patients admitted to a hospital and transferred to another acute hospital were concatenated, attributing the data of the concatenated episode to the index episode, and *b)* episodes in patients younger than 18 years discharged to home with a stay of 1 day or less, discharges due to transfer to another hospital that could not be concatenated, voluntary discharges, and discharges to unknown destinations were excluded.[15]

Statistical analysis

Continuous variables are expressed as mean and standard deviation or median [interquartile range] and categorical variables as numbers and percentages. Comparisons between continuous variables were made using Student t test for 2 factors and analysis of variance (ANOVA) with Bonferroni correction, for 3 or more

factors, and between categorical variables using the chi-square test or Fisher exact statistic.

The adjustment variables defined by the Centers for Medicare and Medicaid Services were used to develop risk-adjusted models for HF mortality and readmissions.[15,16] Sex and age (continuous) were independent variables in these models. We fitted the variables to the Minimum Data Set structure after grouping the secondary diagnoses into annually updated Agency for Healthcare Research and Quality "Condition Categories"[17,18] (table 2 of the supplementary data). Logistic regression models were fitted including patient demographic and clinical variables and comorbidities with statistical significance and odds ratio (OR) > 1.0. Backward stepwise elimination was used to estimate the fit of the models; significance levels for factor selection and elimination were $P < .05$ and $P \geq .10$, respectively. Calibration was analyzed graphically after patients were grouped into quintiles with respect to predicted probabilities and tabulation of predicted vs observed mean probabilities. Discrimination was assessed using the area under the receiver operating characteristic curve (AUROC).[19] To investigate the possible effect of in-hospital mortality as a competing event in

readmission, we estimated the risk function of the subdistribution (Fine and Gray model, Stata stcrreg option) and compared the result with that of estimating a Cox proportional hazards model, in both cases considering NWD as an independent variable.[20] The chi-square trend was used to assess the association between the linear increases in NWD and risk-adjusted in-hospital mortality.

To minimize potential selection bias in the comparison of outcomes between the 2 groups (weekday and NWD), the effect on causes of in-hospital mortality was further assessed by propensity score matching (option k-nearest neighbours matching, psmatch2, Stata), selecting among the episodes admitted on an NWD day those with a similar profile to each weekday episode, according to the variables statistically significant in the risk-adjusted models. Final matching was performed from the risk-adjusted models with a 1:1 ratio and without replacement. The probability of in-hospital mortality, the effect of differences between groups (average treatment effect), and OR with their 95% confidence intervals (95%CI), were calculated. A P-value of < .05 was considered to be statistically significant. Kernel density plots were used to graphically represent the matching process.

Table 1
Profile of patients discharged for heart failure. Weekdays vs "nonworking" days

	Total 235 281	Weekday 162 079 (68.9)	NWD days 73 202 (31.1)	SMD	P
Age, y	80.8 ± 10.6	80.6 ± 10.7	81.2 ± 10.4	−0.014	<.001
Men, %	46.6	47.2	45.7	0.027	<.001
Charlson Index > 2, %	69.7	70.1	69.2	0.017	<.001
History of PCI, %	9.4	9.4	9.3	0.003	.314
History of coronary artery bypass graft surgery, %	3	3	3.0	0.000	.591
Metastatic cancer and acute leukemia (CC 8), %	2.5	2.5	2.5	0.000	.991
Diabetes mellitus or diabetes mellitus complications (CC 17-19, 122-123), %	41.1	41	41.3	−0.006	.268
Protein-calorie malnutrition (CC 21), %	1.9	1.9	1.9	0.000	.414
Liver or biliary disease (CC 27-32), %	3.1	3.2	3.1	0.006	.196
Dementia or other specified brain disorders (CC 51-53), %	11.6	11.3	12.0	−0.021	<.001
Major psychiatric disorders (CC 57-59), %	1.0	1.0	0.9	0.010	.558
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190), %	0.4	0.4	0.4	0.000	.407
Cardiogenic shock (R57.0), %	0.4	0.4	0.4	0.000	.483
Cardiorespiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02, except (R57.0), %	30.2	29.4	31.3	−0.039	<.001
Acute myocardial infarction (CC 86), %	0.7	0.6	0.7	−0.013	<.001
Unstable angina and other acute ischemic heart disease (CC 87), %	0.8	0.8	0.8	0.000	.664
Coronary atherosclerosis or angina (CC 88-89)	23.8	23.8	23.8	0.000	.830
Valvular and rheumatic heart disease (CC 91), %	33.9	34.1	33.6	0.010	.014
Hypertension (CC 95), %	17.1	17.1	17.0	0.003	.584
Stroke (CC 99-100), %	0.2	0.3	0.2	0.018	.165
Vascular disease and complications (CC 106-108), %	7.8	7.8	7.7	0.004	.320
Chronic obstructive pulmonary disease (CC 111), %	16.4	16.4	16.3	0.003	.265
Pneumonia (CC 114-116), %	4.1	4	4.2	−0.010	.002
Renal failure (CC 135-140), %	44.4	44.1	44.8	−0.013	.003
Trauma; other injuries (CC 166-168, 170-174), %	2.7	2.7	2.8	−0.006	.020
In-hospital crude mortality rate, %	11.1	10.7	11.7	−0.031	<.001
Length of stay	7 [4:11]	7 [4:11]	6 [4-11]		<.001
Length of stay, discharged alive	7 [4-11]	7 [4-10]	6 [4-11]		<.001
Length of stay, in-hospital deaths	6 [3-12]	6 [3-12]	6 [3-12]		<.001
30-day readmissions (cardiac causes), %	10.2	10.0	10.8	−0.026	<.001

CC, condition categories[17,18]; ICD-10-CM, International Classification of Diseases, 10th Clinical Modication; NWD, nonworking days; PCI, percutaneous coronary intervention; SMD, standard mean deviation.
Unless otherwise indicated, the data are expressed as percentage, mean ± standard deviation, or median [interquartile range].

The data source was an anonymized administrative database, not requiring the approval of a Health Care Ethics Committee or informed consent from the patients.

RESULTS

After exclusions (figure 1 of the supplementary data), 235 281 episodes of nonelective HF admissions were selected, with a mean age of 80.8 ± 10.6 years and 53.4% were female. Crude in-hospital mortality was 11.1%, median length of stay was 6.9 [IQR, 4.1:10.8] days, and 10.2% of the patients were readmitted for circulatory diseases within 30 days of discharge. A total of 73 202 (31.1%) episodes were admitted on NWD, 26 117 episodes (11.1%) corresponded to the 1-day group; 38 424 (16.3%) to 2 days; 4421 (1.9%) to 3 days; and 4240 (1.8%) to 4 or more days of NWD after admission. There were no clinically relevant differences in the patient profile according to the duration of NWD (table 1 and table 2),

Table 2
Profile of patients discharged with heart failure according to the duration of nonworking days in the admission period

	Total	Nonworking days					P
		0	1	2	3	≥ 4	
	235 281	162 079 (68.9)	26 117 (11.1)	38 424 (16.3)	4421 (1.9)	4240 (0.2)	
Age, y	80.8 ± 10.6	80.6 ± 10.7	81.1 ± 10.5	80.3 ± 10.4	81.3 ± 10.1	81.3 ± 10.3	< .001
Men, %	46.6	47.1	45.5	45.5	45.4	46	< .001
Charlson Index > 2, %	69.7	70.2	68.8	68.8	68.6	67.9	< .001
History of PCI, %	9.4	9.4	9.5	9.1	9	8.9	.198
History of coronary artery bypass graft surgery, %	3	3	3.2	2.9	3.1	3	.296
Metastatic cancer and acute leukemia (CC 8), %	2.5	2.6	2.5	2.5	2.6	2.1	.521
Diabetes mellitus DM or DM complications (CC 17-19, 122-123), %	41.1	41.1	41.7	40.6	42.5	41.9	.010
Protein-calorie malnutrition (CC 21), %	1.9	1.9	1.7	1.9	2	2	.067
Liver or biliary disease (CC 27-32), %	3.1	3.2	3	3	2.8	3.4	.063
Dementia or other specified brain disorders (CC 51-53), %	11.6	11.4	12.3	12	12.2	12.6	< .001
Major psychiatric disorders (CC 57-59), %	1.0	1.0	1.0	0.9	1.1	0.8	.254
Hemiplegia, paraplegia, paralysis, functional disability (CC 70-74, 103-104, 189-190), %	0.4	0.4	0.5	0.4	0.5	0.4	.289
Cardiogenic shock (R57.0), %	0.4	0.4	0.5	0.4	0.6	0.4	.091
Cardiorespiratory failure and shock (CC 84), plus ICD-10-CM codes R09.01 and R09.02, except (R57.0), %	30.2	29.7	31.9	30.8	30.8	32.5	< .001
Acute myocardial infarction (CC 86), %	0.7	0.6	0.9	0.7	0.6	0.6	< .001
Unstable angina and other acute ischemic heart disease (CC 87), %	0.8	0.8	0.9	0.8	0.8	0.6	.457
Coronary atherosclerosis or angina (CC 88-89)	23.8	23.8	24.3	23.6	23	23.1	.120
Valvular and rheumatic heart disease (CC 91), %	33.9	34.1	34.2	33.4	31.8	31.9	< .001
Hypertension (CC 95), %	17.1	17	17.3	17.1	16.7	17	.784
Stroke (CC 99-100), %	0.2	0.3	0.2	0.2	0.2	0.2	.242
Vascular disease and complications (CC 106-108), %	7.8	7.8	7.9	7.5	7.9	7.6	.192
Chronic obstructive pulmonary disease (CC 111), %	16.4	16.5	16.1	16.1	16	16.2	.188
Pneumonia (CC 114-116), %	4.1	4	4.5	4.1	4.4	4	.003
Renal failure (CC 135-140), %	44.4	44.2	44.1	45.2	44.8	45.4	.005
Trauma; other injuries (CC 166-168, 170-174), %	2.7	2.7	2.7	2.8	2.8	2.5	.613
In-hospital crude mortality rate, %	11.1	10.6	12	12.2	12.5	12.8	< .001
Length of stay	7 [4:11]	7 [4:11]	6 [4:10]	6 [4:11]	7 [5:11]	7 [5:12]	< .001
Length of stay, discharged alive	7 [4-11]	7 [4-10]	6 [4-10]	6 [5-11]	7 [5-11]	7 [5-12]	< .001
Length of stay, in-hospital deaths	6 [3-12]	6 [3-13]	5 [2-11]	6 [3-12]	6 [2-12]	6 [2-12]	< .001
30-day readmissions (cardiac causes), %	10.2	10	11	10.7	10.9	11.4	< .001

CC, condition categories[17,18]; ICD-10-CM, International Classification of Diseases, 10th Clinical Modication; IQR, interquartile range; PCI, percutaneous coronary intervention.
The data are expressed as percentage, mean ± standard deviation, or median [interquartile range].

Table 3

Logistic regression model of risk adjustment for in-hospital mortality. Length of nonworking days as independent variable

	Odds ratio	95%CI		P
1 d of NWD	1.11	1.07	1.16	< .001
2 d of NWD	1.13	1.09	1.17	< .001
3 d of NWD	1.16	1.05	1.27	.002
4 d of NWD	1.20	1.09	1.32	< .001
Age	1.05	1.05	1.05	< .001
Metastatic cancer and acute leukemia (CC 8)	2.89	2.70	3.09	< .001
Protein-calorie malnutrition (CC 21)	1.54	1.42	1.67	< .001
Liver or biliary disease (CC 27-32)	1.53	1.42	1.65	< .001
Dementia or other specified brain disorders (CC 51-53)	1.37	1.32	1.42	< .001
Hemiplegia. paraplegia. paralysis. functional disability (CC 70-74. 103-104. 189-190)	1.70	1.42	2.04	< .001
Cardiogenic shock (R57.0)	24.13	20.87	27.90	< .001
Cardiorespiratory failure and shock (CC 84) plus ICD-10-CM codes R09.01 and R09.02. except (R57.0)	1.47	1.43	1.51	< .001
Acute myocardial infarction (CC 86)	1.91	1.66	2.19	< .001
Stroke (CC 99-100)	3.37	2.78	4.08	< .001
Vascular disease and complications (CC 106-108)	1.07	1.02	1.12	< .001
Pneumonia (CC 114-116)	2.03	1.93	2.14	< .001
Renal failure (CC 135-140)	1.63	1.58	1.67	< .001
Trauma; other injuries (CC 166-168; 170-174)	1.14	1.06	1.23	< .001

CC, condition categories[17,18]; ICD-10-CM, International Classification of Diseases, 10th Clinical Modication; NWD, nonworking days.

although NWD patients were slightly older (81.2 ± 10.4 vs 80.5 ± 10.7; P < .001), more likely to be women (54.3% vs 52.8%; P < .001), and with a slightly higher presence of cognitive decline (12% vs 11.3%; P < .001), cardiorespiratory failure (excluding cardiogenic shock) (31.3% vs 29.4%; P < .001), acute myocardial infarction (0.7% vs 0.6%; P < .001), and renal failure (44.8% vs 44.1%; P = .003). The crude mortality rate was 10.7% for patients admitted on weekdays and 11.7% for patients admitted on NWD (P < .001). The crude mortality rates for 1, 2, 3 or more NWD on admission were 12%, 12.2%, 12.5%, and 12.8%, respectively (P < .001).

The prognostic variables included in the risk adjustment model for in-hospital mortality are shown in table 3 of the supplementary data. The adjustment model had an AUROC of 0.69 (95%CI, 0.69-0.70) and fair calibration (figure 2 of the supplementary data). When NWD periods were included in the in-hospital mortality model, compared with a weekday admission, 1 day of NWD increased an 11% the odds of in-hospital death (OR, 1.11; 95%CI, 1.07-1.16); 2 days by 13% (OR, 1.13; 95%CI, 1.09-1.17); 3 days by 16% (OR, 1.16; 95%CI, 1.05-1.27); and ≥ 4 days by 20% (OR, 1.20; 95%CI, 1.09-1.32) (table 3). Although the differences between the NWD groups were not statistically significant, there was a statistically significant association between a linear increase in NWD and higher risk-adjusted in-hospital mortality (chi-square trend P = .0002).

The crude rate of 30-day cardiovascular readmission increased with the duration of NWD, from 10% when admission occurred on a weekday to 11.4% when the period of NWD exceeded ≥ 4 days. The prognostic variables included in the risk adjustment model for 30-day cardiovascular readmissions are shown in table 4 of the supplementary data. The adjustment model had poor discrimination (AUROC, 0.58) and good calibration (figure 3 of the supplementary data). When the NWD period was incorporated into the model for 30-day in-hospital readmissions, compared with a weekday admission, 1 day of NWD increased the risk of 30-day readmission by 11% (OR, 1.10; 95%CI, 1.05-1.16); 2 days by 7% (OR,

1.07; 95%CI, 1. 03-1.11); 3 days by 9% (OR, 1.09; 95%CI, 0.98-1.22); and 4 or more days by 16% (OR, 1.16; 95%CI, 1.04-1.3) (P < .001), although the differences between the NWD groups were not statistically significant. There was no competing effect of mortality on readmissions.

After propensity score matching, patients with HF admitted on an NWD had higher in-hospital mortality than patients with HF admitted on weekdays (OR, 1.11; average treatment effect, 12.2% vs 11.1%; P < .001).
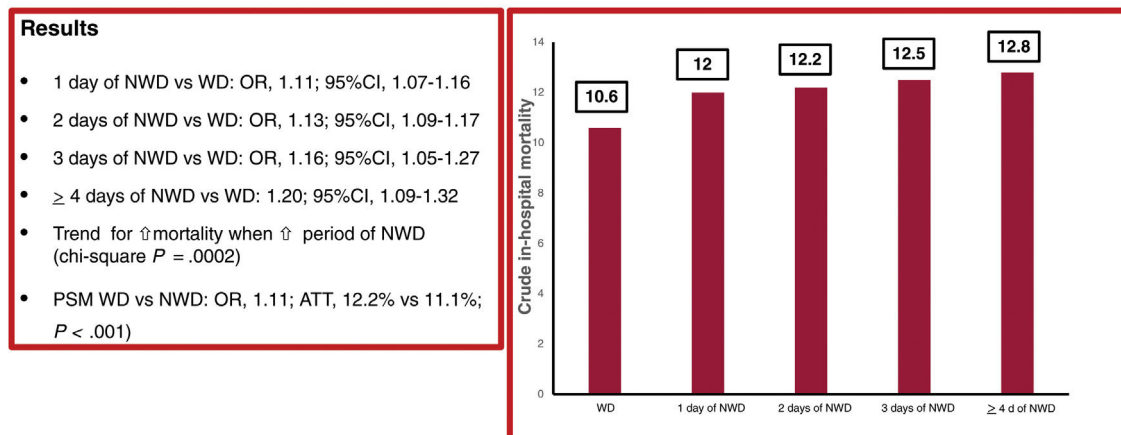
The length of stay of patients with 1 or more NWD was shorter than that of patients admitted on working days (6; IQR, 3:12 vs 7; IQR, 4:11; P < .001).

DISCUSSION

The main findings of this study were as follows: a) there was an association between patients with HF admitted to SNHS hospitals during periods of NWD with an increased risk of in-hospital mortality and 30-day readmission for circulatory diseases; and b) the increased risk of in-hospital mortality tended to be greater as the period of NWD became longer (figure 1).

Previous studies have reported an association of admission on weekend days with excess in-hospital mortality in patients admitted for decompensated HF.[11,12,21–23] To our knowledge, this study is the first to analyze the association between the duration of NWD on admission and outcomes (in-hospital mortality, 30-day readmissions) in decompensated patients with HF. Despite the described association between weekend admission and greater patient severity,[11] our study found slight clinical, but statistically significant differences in the profile of patients according to the duration of NWD groups, with patients with HF admitted on NWD being slightly more severe. However, the differences in in-hospital mortality between the 2 groups remained after risk adjustment (logistic regression model and propensity score matching).

In-hospital mortality
MBDS nonelective heart failure discharges (2018-2019) SNHS
162 079 admissionson WD vs 73 202 on NWD
Logistic regression lineal and PSM (73 202 pairs)

Results

- 1 day of NWD vs WD: OR, 1.11; 95%CI, 1.07-1.16

- 2 days of NWD vs WD: OR, 1.13; 95%CI, 1.09-1.17

- 3 days of NWD vs WD: OR, 1.16; 95%CI, 1.05-1.27

- ≥ 4 days of NWD vs WD: 1.20; 95%CI, 1.09-1.32

- Trend for ⇧mortality when ⇧ period of NWD (chi-square P = .0002)

- PSM WD vs NWD: OR, 1.11; ATT, 12.2% vs 11.1%; P < .001)

Figure 1. Central illustration. Cumulative effect of 'nonworking' days. Methodology and results. 95%CI, 95% confidence interval; ATT, average treatment effect; MBDS, Minimum Basic Data Set; NWD, nonworking days; OR, odds ratio; PSM, propensity score matching; SNHS, Spanish National Health System; WD, working days.

A plausible explanation for the findings of this study is the potential gap in care that may be associated with reduced staffing on weekends and holidays.[1] Aldridge et al.[24] found no association between specialist intensity and admission mortality in acute hospital trusts in England, but reduced nursing staffing on weekends may be associated with mortality. Zapatero et al.[13] reported an association between higher ratios of patients per registered nurse and risk-standardized in-hospital mortality for selected causes, although these authors did not find this association specifically for in-hospital mortality due to HF. Amigo et al.[25] also found an association between weekend admissions and short-term mortality from selected causes in Spanish hospitals (Catalonia), with a stronger effect for HF admissions. The ratio of patients to registered nurses is high in acute general hospitals of the SNHS (9.9 ± 0.7, weekday morning shift in internal medicine wards),[13] and higher mortality rates and lower quality of care have been described when nursing workload increases.[26] Walker et al.[27] found no association between excess mortality rates during weekend admissions and hospital workload, but these authors used a proxy for workload due to lack of information on staffing information. Continuity of care during weekends in hospitals of the SNHS is generally addressed by on-duty teams, which are called when a nurse detects worsening in the clinical situation; weekend rounds are infrequent, and the implementation of early warning systems is low.[13,28] In-hospital avoidable deaths have been described when patient deterioration goes undetected or communication between staff is inadequate.[6,29] Clinical management may also be related to the weekend effect in hospitals of the SNHS, and it has been reported that adherence to clinical practice guidelines may vary throughout the day.[30]

Although there were no statistically significant differences in risk-adjusted mortality between the NWD groups, we found a statistically significant trend for in-hospital risk-adjusted mortality in patients with HF to increase with the length of NWD. Excess mortality was 20% for NWD of 4 or more days and 11% for NWD of 1 day. A cumulative negative effect of the "weekend effect" can be expected if the contributing weekend conditions remain unchanged, as is the case in the hospitals of the SNHS in relation to reduced staffing, low implementation of early warning systems, and multidisciplinary round wards.

The association between the reported NWD effect of weekends and holidays on patients with HF in the SNHS hospitals indicates the need for research into other diseases with specific risk adjustment models and analysis of the underlying probable causes: staffing and hospital workload, adherence to clinical practice guidelines, and other organizational causes such as the functioning of the primary health care level on weekends and holidays.

Limitations

Our study has several limitations. Due to its observational and retrospective design, based on an administrative database, we cannot exclude the possibility of selection bias and the possible effect of unmeasured confounders. In addition, given the data source used, there may also be bias to the extent that the Minimum Data Set does not collect information on some relevant clinical or analytical variables.[27] On the other hand, it is a strength that the use of administrative databases to study health outcomes has been validated by comparison with data extracted from medical records.[31,32]

This study used a specific risk-adjusted model for HF mortality and readmissions. Although the models used in this study are comparable to other published models in terms of their discriminatory power,[15,16] it should be remembered that there are confounding factors in the adjustment models that cannot be taken into account and that may have a significant impact.

The high number of episodes in this study is a strength but also provides an overpowered sample for statistical contrasts. A correct interpretation of the results depends on the clinical significance of the changes; we have therefore included the standard mean deviation in the comparisons between groups.

CONCLUSIONS

We found an association between nonelective hospital admissions for decompensated HF on an NWD day and higher in-hospital

mortality and a higher likelihood of 30-day readmission for circulatory diseases in acute general hospitals of the SNHS. The excess of mortality is likely not explained by differences in severity. In this study, the "weekend effect" tended to increase with more prolonged NWDs.

WHAT IS KNOWN ABOUT THE TOPIC?

- -The "weekend effect" (the association between hospital admission on weekend days and mortality) is controversial. The debate about the existence of a "weekend effect" and its causes remains open.
- -The weekend effect has been described in Spain for some conditions and hospitals.
- -Some authors have found a "weekend effect" in patients admitted for decompensated heart failure.

WHAT DOES THIS STUDY ADD?

- This study evaluated the cumulative effect of weekends and nonworking days (NWD) using a specific risk adjustment model for heart failure.
- In-hospital mortality in decompensated heart failure tended to increase with the length of NWD; 1 NWD increased mortality by 13.2% and 4 days or more by 20.8%.
- The odds ratio for in-hospital death increased from 1.11 for 1 day to 1.29 for 4 or more NWD. This trend was statistically significant.
- Differences in outcomes between patients with decompensated heart failure admitted to hospital on NWD and working days were not explained by differences in severity.

FUNDING

ETHICAL CONSIDERATIONS

This study was based on anonymized administrative data and did not require the approval of an ethics committee or informed consent.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence was not used in this study.

AUTHORS' CONTRIBUTIONS

All authors meet the characteristics defined by the International Committee of Medical Journal Editors.

CONFLICTS OF INTEREST

The authors have no relevant relationships to disclose that could affect the content of this article.

ACKNOWLEDGEMENTS

APPENDIX A. SUPPLEMENTARY DATA

Supplementary data associated with this article can be found in the online version available at https://doi.org/10.1016/j.rec.2023.10.003.

REFERENCES

1. Bell CM, Redelmeier DA. Mortality among patients admitted to hospitals on weekends as compared with weekdays. *N Engl J Med.* 2001;345:663–668.
2. Bray BD, Steventon A. What have we learnt after 15 years of research into the 'weekend effect'? *BMJ Qual Saf.* 2017;26:607–610.
3. Academy of Medical Royal Colleges. Seven Day Consultant Present Care. 2012. Available at: https://www.aomrc.org.uk/wp-content/uploads/2016/05/Seven_Day_Consultant_Present_Care_1212.pdf. Accessed 10 Oct 2023.
4. McKee M. The weekend effect: now you see it, now you don't. *BMJ.* 2016;353:i2750.
5. Lilford RJ, Chen Y-F. The ubiquitous weekend effect: moving past proving it exists to clarifying what causes it. *BMJ Qual Saf.* 2015;24:480–482.
6. Black N. Is hospital mortality higher at weekends? If so, why? *Lancet.* 2016;388:108–111.
7. Freemantle N, Ray D, McNulty D, et al. Increased mortality associated with weekend hospital admission: a case for expanded 7 day services? *BMJ.* 2015;351:h4596.
8. Barba R, Losa JE, Velasco M, Guijarro C, García de Casasola G, Zapatero A. Mortality among adult patients admitted to the hospital on weekends. *Eur J Intern Med.* 2006;17:322–324.
9. Fernández-Ortiz A, Bas Villalobos MC, García-Márquez M, et al. The effect of weekends and public holidays on the care of acute coronary syndrome in the Spanish National Health System. *Rev Esp Cardiol.* 2022;75:757–763.
10. Bonilla-Palomas JL, Anguita-Sánchez MP, Elola-Somoza FJ, et al. Thirteen-year trends in hospitalization and outcomes of patients with heart failure in Spain. *Eur J Clin Invest.* 2021;51:e13606.
11. Shah M, Patnaik S, Patel B, et al. The day of the week and acute heart failure admissions: Relationship with acute myocardial infarction, 30-day readmission rate and in-hospital mortality. *Int J Cardiol.* 2017;249:292–300.
12. Mounsey L, Chang P, Sueta C, Matsushita K, Russell S, Caughey M. In-hospital and post-discharge mortality among patients with acute decompensated heart failure hospitalizations ending on the weekend vs weekday: the ARIC Study Community Surveillance. *J Am Heart Assoc.* 2019;8:e011631.
13. Zapatero-Gaviria A, Javier Elola-Somoza F, Casariego-Vales E, et al. RECALMIN: The association between management of Spanish National Health Service Internal Medical Units and health outcomes. *Int J Qual Health Care.* 2017;29:507–511.
14. Ministerio de Sanidad. Registro de Atención sanitaria especializada RAE-CMBD. Manual de definiciones y glosario de términos. Portal Estadístico. 2023. Available at: https://pestadistico.inteligenciadegestion.sanidad.gob.es/publicoSNS/D/rae-cmbd/rae-cmbd/manual-de-usuario/manual-de-usuario-rae. Accessed 11 Oct 2023.
15. Centers for Medicare & Medicaid Services (CMS) (cms.gov). 2019 Condition-Specific Measures Updates and Specifications Report Hospital-Level 30-Day Risk-Standardized Mortality Measures. Acute Myocardial Infarction – Version 13.0. Chronic Obstructive Pulmonary Disease – Version 8.0. Heart Failure – Version 13.0. Pneumonia – Version 13.0. Stroke – Version 8.0. Submitted By: Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation (YNHHSC/CORE). 2019. Available at: Mortality Measures Resources. Available at: https://qualitynet.cms.gov/inpatient/measures/mortality/methodology. Accessed 18 Oct 2023.
16. Centers for Medicare & Medicaid Services (CMS) (cms.gov). 2019 Condition-Specific Readmission Measures Updates and Specifications Report. Acute Myocardial Infarction – Version 12.0. Chronic Obstructive Pulmonary Disease – Version 8.0. Heart Failure – Version 12.0. Pneumonia – Version 12.0. Submitted By: Yale New Haven Health Services Corporation – Center for Outcomes Research and Evaluation (YNHHSC/CORE). March 2019. Available at: Readmission Measures Overview (cms.gov). Available at: https://qualitynet.cms.gov/inpatient/measures/readmission/methodology. Accessed 18 Oct 2023.
17. Pope GC, Ellis RP, Ash AS, et al. Principal inpatient diagnostic cost group model for Medicare risk adjustment. *Health Care Financ Rev.* 2000;21:93–118.
18. Health Care Financing AdministrationPope GC, Ellis RP, Ash AS, et al. Diagnostic Cost Group Hierarchical Condition Category Models for Medicare Risk Adjustment. *Final Report.* 2000. Available at: https://www.cms.gov/research-statistics-data-

and-systems/statistics-trends-and-reports/reports/downloads/pope_2000_2.pdf. Accessed 10 Oct 2023

19. Rossello X, Dorresteijn JA, Janssen A, et al. Risk prediction tools in cardiovascular disease prevention: A report from the ESC Prevention of CVD Programme led by the European Association of Preventive Cardiology (EAPC) in collaboration with the Acute Cardiovascular Care Association (ACCA) and the Association of Cardiovascular Nursing and Allied Professions (ACNAP). *Eur J Prev Cardiol.* 2019;26:1534–1544.

20. Rossello X, González-Del-Hoyo M. Survival analyses in cardiovascular research, part II: statistical methods in challenging situations. *Rev Esp Cardiol.* 2022;75:77–85.

21. Horwich TB, Hernandez AF, Liang L, et al. Weekend hospital admission and discharge for heart failure: association with quality of care and clinical outcomes. *Am Heart J.* 2009;158:451–458.

22. Gallerani M, Boari B, Manfredini F, Mari E, Maraldi C, Manfredini R. Weekend vs weekday hospital admissions for acute heart failure. *Int J Cardiol.* 2011;146:444–447.

23. McAlister FA, Au AG, Majumdar SR, Youngson E, Padwal RS. Postdischarge outcomes in heart failure are better for teaching hospitals and weekday discharges. *Circ Heart Fail.* 2013;6:922–929.

24. Aldridge C, Bion J, Boyal A, et al. HiSLAC Collaborative. Weekend specialist intensity and admission mortality in acute hospital trusts in England: a cross-sectional study. *Lancet.* 2016;388:178–186.

25. Amigo F, Dalmau-Bueno A, García-Altés A. Do hospitals have a higher mortality rate on weekend admissions? An observational study to analyse weekend effect on urgent admissions to hospitals in Catalonia. *BMJ Open.* 2021 Nov 29;11:e047836.

26. Aiken LH, Sloane DM, Bruyneel L, et al. Nurse staffing and education and hospital mortality in 9 European countries: a retrospective observational study. *Lancet.* 2014;383:1824–1830.

27. Walker AS, Mason A, Quan TP, et al. Mortality risks associated with emergency admissions during weekends and public holidays: an analysis of electronic health records. *Lancet.* 2017;390:62–72.

28. Díez-Manglano J, Carretero-Gómez J, Chimeno-Viñas MM, et al. *Rev Clin Esp.* 2023;223:125–133.

29. Sacks GD, Shannon EM, Dawes AJ, et al. Teamwork, communication and safety climate: a systematic review of interventions to improve surgical culture. *BMJ Qual Saf.* 2015;24:458–467.

30. Bray BD, Cloud GC, James MA, et al. Weekly variation in health care quality by day and time of admission: A nationwide, registry-based, prospective cohort study of acute stroke care. *Lancet.* 2016;388:170–177.

31. Krumholz HM, Wang Y, Mattera JA, et al. An administrative claims model suitable for profiling hospital performance based on 30 day mortality rates among patients with an acute myocardial infarction. *Circulation.* 2006;113:168392.

32. Bernal JL, Bonilla-Palomas JL, Rosillo N, Bonanad C, Elola J, Anguita M. Validity of the minimum data set for outcomes research in patients hospitalized for heart failure in Spain. *Rev Esp Cardiol.* 2023;76:938–939.