Higher mortality in patients hospitalized for acute aortic rupture or dissection during weekends

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Background: **The management of acute aortic aneurysm rupture or dissection (AARD) requires specific medical expertise, diagnostic techniques, and therapeutic options, not always available in all hospitals through the entire week. The aim of our study was to evaluate whether an association exists between weekday (WD) or weekend (WE) admission and mortality for patients with ARRD.**

Methods: **Based on the database of routinely collected hospital admissions of the region of Emilia Romagna (RER) of Italy, we examined the discharge sheets of all patients with AARD (January 1999 to December 2009). The risk of in-hospital death was calculated for admissions on the WE compared with the admissions during a WD.**

Results: **The analysis considered 4559 events in 4461 patients. AARD admissions were most frequent on Monday (14.7%) and Friday (14.8%) and less frequent on Saturday (12.6%). The percentage of events admitted on Sunday/holiday was 15.0%, whereas the distribution of death rate with respect to day of admission was significantly different ($\chi^2 = 23.472$; $P < .001$) with the highest frequency peak on Sunday/holiday (17.4%) and the lowest on Tuesday (12.9%). WE admissions were associated with significantly higher in-hospital mortality (43.4%) than WD admissions (36.9%, $P < .001$). Multivariate regression analysis showed that WE admission was an independent risk factor for increased in-hospital mortality odds ratio 1.318; 95% confidence interval, 1.144-1.517; $P < .001$).**

Conclusions: **Our findings show that hospitalization for AARD on WE is associated with a significantly higher mortality rate than hospitalization on WD. Further studies are needed to investigate whether ensuring optimal diagnostic and therapeutic approaches during the entire week might improve the overall survival of patients with ARRD. (J Vasc Surg 2012;55:1247-54.)**

Acute aortic aneurysm rupture or dissection (AARD) represent life-threatening conditions, ranking as the third most common cause of out-of-hospital sudden death referred to an emergency department.[1] Moreover, after arriving at the hospital, the condition is associated with high mortality even in centers with advanced technology and considerable expertise in AARD.[2,3] Several studies have shown that in patients hospitalized due to an acute cardiovascular event, a significantly higher mortality rate is present in the case of admission on weekends (WE), compared with that during weekdays (WD).[4-7] Other studies observed that although all-cause mortality was similar in patients admitted during WD or WE, admissions on WE were followed by a higher mortality within the first 48 hours.[8] Hospital admission during WE is associated with an increased mortality in some but not all acute medical conditions.[6,7,9] For example, acute conditions requiring urgent diagnosis and treatment (acute myocardial infarction [AMI], stroke, pulmonary embolism, rupture of abdominal aortic aneurysm, and intensive care unit [ICU] admission), seem to be associated with increased in-hospital or short-term mortality during the WE compared with a WD.[4,5,10-12] Also, medical patients admitted or discharged from the ICU early in the WE seem to have an increased mortality risk and readmission risk to the ICU.[13,14]

The aim of this study was to determine whether the mortality rate for patients hospitalized for AARD during the WE is different from that of patients admitted during a WD.

METHODS

Patient selection and eligibility. The study was conducted with the approval of the local institutional committees for human research. The analysis included all emergency hospital admissions for AARD between January 1, 1999 and December 31, 2009, recorded in the Region Emilia Romagna (RER) (Italy) database, obtained from the Center for Health Statistics. Starting from 1999, the RER created an electronic database, tracking all discharge hospital sheets of patients admitted to hospitals. The discharge hospital sheet lists name and surname, gender, date of birth, date and hour of hospital admission and discharge, department of admission and discharge, vital status at discharge, length of stay, primary and up to 15 secondary discharge diagnoses, and the most important diagnostic procedures based on the International Classification of

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Diseases, ninth Revision, Clinical Modification (ICD-9-CM). To respect the national dispositions-by-law in terms of privacy, the RER health authorities removed patient name, exact address, and other potential identifiers from the database provided for this study. A consecutive identification number for each patient was the only identification data allowed for analysis to categorize the admissions by age group and to analyze the database for potential rehospitalization with the same diagnosis.

The criteria for inclusion in the statistical analysis were emergency admission and AARD as the primary diagnosis (441* ICD-9-CM code). In particular, we included patients with the following diagnostic codes:

- 441.0 Dissection of aorta
  - 441.00 Unspecified site
  - 441.01 Thoracic
  - 441.02 Abdominal
  - 441.03 Thoracoabdominal
- 441.1 Thoracic aneurysm, ruptured
- 441.3 Abdominal aneurysm, ruptured
- 441.5 Aortic aneurysm of unspecified site, ruptured
- 441.6 Thoracoabdominal aneurysm, ruptured

The analysis excluded patients with the following codes:

- 441.2 Thoracic aneurysm without mention of rupture
- 441.4 Abdominal aneurysm without mention of rupture
- 441.7 Thoracoabdominal aneurysm, without mention of rupture
- 441.9 Aortic aneurysm of unspecified site without mention of rupture

Only admissions directly related to AARD, ie, only cases in which AARD was indicated as the main discharge diagnosis, were extracted from the database.

Traumatic aortic dissection or rupture (ICD-9 codes 901.0 and 902.0) were excluded.

For patients admitted to one hospital and then transferred to another, only one admission has been considered (with the date of hospitalization referring to the first admission hospital, and the final diagnosis to the discharging hospital). All recurrent admissions secondary to a primary event or a postoperative complication related to prior surgical management have been considered as one admission only.

Admission on the WE was defined as occurred during the period from midnight of Friday to midnight of Sunday. The nine main national festive days in Italy (January 1, April 25, May 1, June 2, August 15, November 1, December 8, December 25 and 26) when occurring on a WD, were considered as Sunday/WE.

Geographic and hospital characteristics. Emilia-Romagna is a region situated in north-eastern Italy, with a surface area of 22,124 km^2, a total population of ~4,323,830 people (≈7% of the total Italian population). The region is administratively divided into nine provinces (from West to East): Piacenza, Parma, Reggio Emilia, Modena, Bologna, Ferrara, Ravenna, Forlì-Cesena, and Rimini. Since 1978, Italy has a National Health Service (NHS), based on the principle of "universal entitlement," with the Government providing free and equal access to prevention, medical care, and rehabilitation services to all residents. The NHS is largely under the control of regional governments and is administered by local health authorities (Azienda Sanitaria Locale/ASL). Thus, the RER accounts 11 local health authorities (Piacenza, Parma, Reggio Emilia, Modena, Bologna, Imola, Ferrara, Ravenna, Forlì-Cesena, and Rimini), and total hospitals available in the region are 104. Five of these are teaching hospitals (Parma, Reggio, Emiliae, Modena, Bologna, Ferrara) and one is a research orthopedic institute, with 17,061 total beds available for acute patients.[15]

Data collection. The total population was divided into subgroups by gender and presence of major cardiovascular risk factors, eg, arterial hypertension, and diabetes mellitus. To reduce the impact of age and comorbidity as influencing factors in the analysis of in-hospital prognosis, we considered the Charlson index modified for use with ICD-9-CM administrative databases and adjusted by age (CCIa).[16-18] Because the database did not provide complete clinical information, such as severity score of each case, the analysis was limited to hard outcomes: fatal (death during hospitalization) and nonfatal (patient discharged alive). We also analyzed outcomes events in relation to the different hospitals that provided the care:

- Province where the hospitals are located;
- Type of hospital, ie, teaching hospitals (usually characterized by urban location) or community hospitals (more capillary distributed around the provincial territory, characterized by a limited number of beds);
- Local availability of heart surgery, vascular surgery, and coronary intensive care unit; and
- Number of hospital beds for acute patients:
  - More than 600
  - 400-599
  - 200-399
  - Less than 200.

Aim of the study. The primary aim of our study was to see if in-hospital mortality was different for patients admitted for AARD during the WE compared with patients admitted during a WD.

The secondary aims were to analyze day of hospital admission for AARD and in-hospital mortality and to analyze whether risk factors for AARD were different in patients admitted on the WE compared with those admitted during a WD.

Data analysis. On the basis of day of admission (time of arrival to the emergency department), each case was categorized into seven 1-day intervals for analysis, and the events were analyzed on the basis of their occurrence on WE vs WD. Data have been expressed as absolute numbers, percentage, and mean ± SD. Analysis of all variables relative to the associated diagnosis was performed using χ^2 or Student *t*-test, where appropriate. Comparisons of baseline

Table I. Total population: diagnosis codes and mean age

ICD-9-CM code	*Subgroup*	*No. patients*	*Mean age ± SD*[a]
	All cases	4559	72.6 ± 12.7
441.00	Dissection of aorta, unspecified site	302	68.5 ± 12.8
441.01	Dissection of thoracic aorta	1057	67.8 ± 14
441.02	Dissection of abdominal aorta	374	75.3 ± 12.1
441.03	Dissection of thoracoabdominal aorta	477	65.9 ± 13.6
441.1	Thoracic aneurysm, ruptured	282	72.6 ± 13.5
441.3	Abdominal aneurysm, ruptured	1842	77.1 ± 9.5
441.6	Thoracoabdominal aneurysm, ruptured	126	74.6 ± 11
441.5	Aortic aneurysm of unspecified site, ruptured	99	73.3 ± 14.1

ICD-9-CM, International Classification of Diseases, ninth Revision, Clinical Modification; *SD,* standard deviation.
[a]$F = 91.31$; $P < .001$.

characteristics between subgroups were performed using Bonferroni correction for multiple comparisons. Logistic regression models were used to evaluate the association between potential risk factors and risk of AARD. For all considered subgroups, in-hospital mortality risk was calculated with regression logistic analysis. A multivariable logistic regression was used to determine the odds of in-hospital mortality on WE vs WD admissions.

Multivariable modeling included patients' data, which may impact prognosis in acute AARD, such as sex, hypertension, Charlson comorbidity age-adjusted index (CCIa), and potential confounding factors, including teaching or community hospital, number of hospital beds, province, years/seasons of admission, and first or secondary admission for AARD. Odds ratios (ORs) and their 95% risk interval have been reported.

Survival analysis for subgroups of patients admitted on a WD or the WE was performed by using Kaplan-Meier analysis data. The analysis was limited to in-hospital mortality and restricted to 60 days from index hospitalization.

Statistical analysis has been performed using SPSS 13.0 for Windows 2004 (SPSS Inc, Chicago, Ill) for statistical analysis of demographic data.

RESULTS

During the observed period, the RER database contained records of 4559 events of AARD, 3320 in males (72.8%). Events were relative to 4461 different patients (mean age, 72.6 ± 12.7 years), 3246 males (72.8%; mean age, 71 ± 12.5 years), and 1215 females (27.2%; 76 ±12.8 years; $P < .001$). In 98 (2.2%) patients, a recurrent hospitalization due to AARD was registered. The percentage of deceased patients was slightly higher (but not statistically significant) among subjects with recurrent admission (43.9%; 43/98) compared with those at first admission (38.6%; 1720/4461) (χ^2 = .931; P = .334). Table I summarizes all considered cases and subgroups of aortic diseases. Table II reports the number of cases observed along the different years of analysis.

AARD admissions were most frequent on Monday (14.7%) and Friday (14.8%) and less frequent on Saturday (12.6%). The percentage of events admitted and Sunday/holiday was 15.0% (Table III). The observed distribution of admissions did not show any statistically significant difference compared to that expected (χ^2 = 6.106; P = .411).

However, there was a significant difference in the distribution of fatal cases on the basis of day of admission

Table II. Number of cases observed during the analyzed periods (years)

Year	*Weekdays admission number (%)*[a]	*Weekends admission number (%)*[a]	*Total number (%)*[b]
1999	230 (74.4)	79 (25.6)	309 (6.8)
2000	278 (69.7)	121 (30.3)	399 (8.8)
2001	317 (72.2)	122 (27.8)	439 (9.6)
2002	289 (72.6)	109 (27.4)	398 (8.7)
2003	299 (73.5)	108 (26.5)	407 (8.9)
2004	315 (71.9)	123 (28.1)	438 (9.6)
2005	352 (74.1)	123 (25.9)	475 (10.4)
2006	320 (75.7)	103 (24.3)	423 (9.3)
2007	317 (73.7)	113 (26.3)	430 (9.4)
2008	288 (70.2)	122 (29.8)	410 (9.0)
2009	315 (73.1)	116 (26.9)	431 (9.5)
Total	3320 (72.8)	1239 (27.2)	4559 (100)

[a]% Within the year.
[b]% Between total of observed events.

Table III. Day-of-week distribution of AARD hospital admissions and subgroups of subjects deceased or not during hospitalization

	All cases (n = 4559) (n, % within the group)[a]	*Deceased during hospitalization (n = 1763; 38.7%) (n, % between groups)*[b]
Monday	668 (14.7)	234 (13.3)
Tuesday	653 (14.3)	228 (12.9)
Wednesday	642 (14.1)	231 (13.1)
Thursday	665 (14.6)	258 (14.6)
Friday	673 (14.8)	265 (15.0)
Saturday	576 (12.6)	240 (13.6)
Sunday/holiday	682 (15.0)	307 (17.4)

AARD, Acute aortic aneurysm rupture or dissection.
[a]Within the group, observed compared with expected, χ^2 = 6.106; P = .411.
[b]Between groups deceased/not deceased, χ^2 = 23.472; $P < .001$.

Table IV. Characteristics of the study population in relation with WD or WE admission

	Total number (%) within the group	*Weekdays admission number (%)*	*Weekends/holiday admission number (%)*	χ^{2a}	P
Total events	4559 (100)	3297 (72.3)	1262 (27.7)	–	–
Gender					
Male	3320 (72.8)	2382 (72.2)	938 (74.3)	1.889	.169
Female	1239 (27.2)	915 (27.8)	324 (25.7)		
Discharged alive	2796 (61.3)	2082 (63.1)	714 (56.6)	16.342	< .001
Deceased during hospitalization	1763 (38.7)	1215 (36.9)	548 (43.4)		
Comorbidity Charlson index					
CCIa = 0	135 (3.0)	92 (2.8)	43 (3.5)	1.881	.818
CCIa = 1-2	1059 (23.2)	776 (23.4)	283 (22.8)		
CCIa = 3-4	2301 (50.5)	1683 (50.7)	618 (49.9)		
CCIa >4	1064 (23.3)	769 (23.2)	295 (23.8)		
Province					
Bologna	1163 (25.5)	852 (25.7)	311 (25.1)	3.761	.878
Ferrara	304 (6.7)	216 (6.5)	88 (7.1)		
Forlì-Cesena	245 (5.4)	175 (5.3)	70 (5.6)		
Modena	689 (15.1)	496 (14.9)	193 (15.6)		
Parma	577 (12.7)	418 (12.6)	159 (12.8)		
Piacenza	259 (5.7)	185 (5.6)	74 (6.0)		
Ravenna	518 (11.4)	376 (11.3)	142 (11.5)		
Reggio Emilia	462 (10.1)	351 (10.6)	111 (9.0)		
Rimini	342 (7.5)	251 (91.0)	91 (7.3)		
Type of health organization (first referral setting)					
Teaching hospitals	1759 (38.6)	1280 (38.6)	479 (38.7)	0.001	.975
Community hospitals	2800 (61.4)	2040 (61.4)	760 (61.3)		
Hospital dimensions (first referral setting)					
> 600 beds	2589 (56.8)	1878 (56.6)	711 (57.4)	1.603	.902
400-599 beds	746 (16.4)	535 (16.1)	211 (17.0)		
200-399 beds	433 (9.5)	322 (9.7)	111 (9.0)		
<200 beds	791 (17.4)	585 (17.6)	206 (16.6)		

WD, Weekday; *WE*, weekend.
[a] $\chi 2$ performed using Bonferroni correction for multiple comparisons between subgroups.

(χ^2 = 23.472; $P < .001$), with a highest frequency peak on Sunday/holiday (17.4%) and lowest on Tuesday (12.9%).

As for recurrent events, the peak of highest frequency was on Wednesday (20.4%), and the lowest on Saturday 10.2% (Monday, 12.2%, Tuesday, 17.3%, Thursday, 13.3%, Friday, 14.3%, Sunday/holiday, 12.2%), with no difference in respect to first events (χ^2 = 4.798; P = .547).

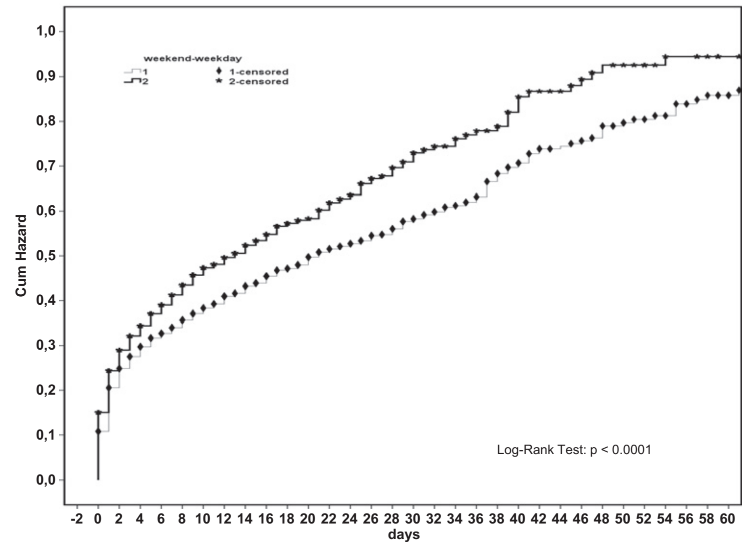
Among recurrent events, the distribution along the day-of-week of survived patients (Monday, eight [14.5%]; Tuesday, 10 [18.2%]; Wednesday, 14 [25.5%]; Thursday, seven [12.7%]; Friday, six [10.9%]; Saturday, five [9.1%]; and Sunday/holiday, five [9.1%]) did not result to be statistically different compared with deceased patients (Monday, four [9.3%]; Tuesday, seven [16.3%]; Wednesday, six [14.0%]; Thursday, six [14.0%]; Friday, eight [18.6%]; Saturday, five [11.6%]; and Sunday/holiday, seven [16.3%]) (χ^2 = 4.355; P = .629).

The mean length-of-stay (LOS) of patients admitted on a WD vs the WE was 14.5 ± 47 and 12.8 ± 20.6 days, respectively (t = .363; P = .716). In particular, LOS of patients discharged alive was 19.1 ± 58 days for those admitted on a WD and 19.6 ± 23.5 days for those admitted on a WD (t = .223; P = .823). As for deceased patients, LOS was 6.5 ± 12 days for admissions on a WD and 6.7 ± 12.8 days for those on the WE (t = .312; P = .755).

The frequency of death rate in respect to day of admission was not statistically different between first events or recurrences (χ^2 = 1.478; P = .961).

Table IV summarizes the different characteristics of the study population, according to WD or WE admission. Mortality was significantly higher in subjects admitted on the WE (43.4%) compared to a WD (36.9%) (χ^2 = 16.342; $P < .001$), whereas no difference between WE/WD was found among subgroups considering CCIa, provinces, type of health organization, or hospital dimensions (first referral setting). The percentage of patients with AARD dying within 24 hours from admission was higher (although not statistically significant) among patients admitted on WE compared with those admitted on a WD (271/308; 88%, vs 607/714; 85%, vs χ^2 = 1.335; P = .248).

Survival analysis showed a significantly increased cumulative risk of death during hospitalization for patients admitted on the WE compared with those admitted on a WD (Fig). The preliminary analysis of risk factors associated for in-hospital death is summarized in Table V. An increased risk of death during hospitalization was related to female gender, summer, increasing CCIa score, admission on WE, presence of hypertension, and admission to hospital with <200 beds.



WE	N. of dead patients	271	71	40	31	29	13	11	11	11	4	6	6	7	3	5	4	1	3	1	4	4	0	1	2	1	0	0	1	0	0	0
	N.of remaining patients	1262	954	850	769	685	559	461	397	359	309	278	249	220	182	164	150	132	120	109	104	88	81	79	72	63	60	58	53	51	48	44
WD	N. of dead patients	607	173	94	48	55	32	30	25	25	9	19	7	6	6	11	5	5	3	11	7	6	2	2	2	4	2	1	3	1	1	1
	N.of remaining patients	3297	2583	2331	2140	1884	1547	1311	1121	917	793	691	570	491	436	394	347	308	275	254	228	205	185	170	164	151	139	127	118	110	103	93

Fig. Mortality among patients admitted on weekday (*WD*) and weekend (*WE*). Cumulative hazard risk of death for patients with acute aortic aneurysm rupture or dissection (*AARD*) who were admitted on WE and on WD. The cumulative 60-day risk of death was significantly higher for patients admitted on WE than for patients admitted on WD.

Table V. Risk analysis of in-hospital death

		95% CI		
	OR	*Lower bound*	*Upper bound*	P
Female gender	1.259	1.103	1.438	<.001
Seasons				
Winter	1.000		Reference	
Spring	1.090	.926	1.284	.300
Summer	1.219	1.024	1.452	.026
Autumn	1.112	.944	1.309	.203
Admission on weekend	1.331	1.165	1.519	<.001
Associated comorbidity				
Hypertension	2.856	2.457	3.320	<.001
CCIa = 0	1.000		Reference	
CCIa = 1-2	2.190	1.292	3.712	.004
CCIa = 3-4	5.586	3.337	9.349	<.001
CCIa >4	5.409	3.207	9.122	<.001
Type of health organization (first referral setting)				
Teaching hospitals	1.000		Reference	
Community hospitals	.935	.827	1.057	.282
Hospital dimensions and presence of specific operative units (the first referral setting)				
>600 beds	1.000		Reference	
400-599 beds	.801	.679	.945	.008
200-399 beds	.776	.632	.952	.015
<200 beds	1.531	1.289	1.819	<.001
Heart surgery units	1.276	1.081	1.278	<.001
Vascular surgery units	1.029	0.948	1.118	.510
No coronary intensive care units	1.126	1.105	1.775	.005

CCIa, Charlson comorbidity index age adjusted; *CI*, confidence interval; *OR*, odds ratio.

The subgroup analysis showed that the risk of death was higher in patients hospitalized during the WE, both for aortic dissection (OR, 1.401; 95% confidence interval [CI], 1.138-1.725; $P = .002$) and aortic rupture (OR, 1.201; 95% CI, 1.005-1.435; $P = .046$), but no difference was found among subgroups for anatomical site of dissection or rupture (Table VI). Finally, in-hospital mortality risk was calculated with logistic regression analysis, including in the

Table VI. Analysis of death risk related to WE-WD admission for different AARD subgroups

			WD	
ICD-9-CM code	*Subgroup*	*No. patients*	*Discharged alive, n (%)*	*Deceased, n (%)*
All cases		4559	2082 (63.1)	1215 (36.9)
Aortic dissection (all cases)		2210	1224 (74.9)	411 (25.1)
441.00	Dissection of aorta, unspecified site	302	152 (70.7)	63 (29.3)
441.01	Dissection of thoracic aorta	1057	601 (75.8)	192 (24.2)
441.02	Dissection of abdominal aorta	374	209 (77.1)	62 (22.9)
441.03	Dissection of thoracoabdominal aorta	477	262 (73.6)	94 (26.4)
Aortic aneurysm rupture (all cases)		2349	858 (51.6)	804 (48.4)
441.1	Thoracic aneurysm, ruptured	282	92 (46.2)	107 (53.8)
441.3	Abdominal aneurysm, ruptured	1842	692 (52.9)	616 (47.1)
441.6	Thoracoabdominal aneurysm, ruptured	126	40 (48.2)	43 (51.8)
441.5	Aortic aneurysm of unspecified site, ruptured	99	34 (47.3)	38 (52.7)

AARD, Acute aortic aneurysm rupture or dissection; *ICD-9-CM*, International Classification of Diseases, ninth Revision, Clinical Modification; *WD*, weekday; *WE*, weekend.

model: WD/WE admission, gender, age subgroups, CCIa, hypertension, first or successive admission for AARD, year and month of admission, season, province, type and size of hospital, availability of heart surgery, vascular surgery, and coronary intensive care unit. WE admission was confirmed to be an independent risk factor for increased in-hospital mortality (B = 0.256; standard error, 0.72; Wald, 14.695; OR, 1.318, 95% CI 1.144-1.517; $P < .001$).

Among total sample, 2812 patients (61.7%) underwent a procedure to repair the ruptured aneurysm or dissection, whereas in 1747 (38.3%), only medical treatment was used. There was no difference of surgical treatment among patients admitted on the WE (783/1262; 62.0%) vs a WD (2029/3297, 61.5%, $\chi^2 = .078$; $P = .780$).

No WE/WD differences were found in the percentage of patients undergoing surgical procedure of repair, either for aortic dissection or rupture. In particular, among patients with aortic rupture, 75.1% (516/687) of cases admitted on the WE, 75.7% of cases admitted on a WD (1258/1662) underwent surgical repair ($\chi^2 = .073$; $P = .788$). As for patients with dissection, 46.4% (267/575) of cases admitted on the WE and 47.1% (770/1635) of those admitted on a WD underwent surgical repair ($\chi^2 = .050$; $P = .823$).

DISCUSSION

This study shows that, at least in this region of Italy, patients admitted urgently to the hospital for AARD on the WE show a highly significantly increased risk of death during hospitalization compared with patients admitted on a WD. Moreover, WE admission seems to be an independent risk factor for mortality (OR, 1.31), regardless of sex, age, province, size, and type of hospital. Our findings are consistent with several reports. Bell et al[4] analyzed all acute care admissions from emergency departments in Ontario, Canada, between 1988 and 1997 (3,789,917 admissions) and found that rupture of abdominal aortic aneurysms was associated with a significantly higher mortality in patients admitted during the WE vs patients hospitalized during a WD (42% vs 36%, respectively; adjusted OR, 1.28; 95% CI, 1.13-1.46). Aylin et al[9] evaluated in-hospital deaths regarding 4,317,866 emergency admissions to public hospitals in England from 2005 to 2006. They found that the risk of death was significantly higher in patients hospitalized during the WE than during a WD in comparison with patients admitted during a WD (42.9%; 555/573, vs 34.0%; 1453/5573; OR, 1.45; 95% CI, 1.26-1.66; $P < .001$). In that study, ruptured abdominal aortic aneurysms made up most of the cases within the aneurysm group. ICU admission during the WE was also associated with higher adjusted hospital mortality rates than during a WD. Admissions to surgical ICU (OR, 1.23; 95% CI, 1.03-1.48), but not to the medical or multispecialty ICU, were the major drivers of this observation.

Several explanations may be given for the association between WE admission and increased in-hospital mortality, particularly among the most severely ill patients. One plausible hypothesis could be that there is a reduction of available human resources on weekends. Medical activity is difficult to maintain with uniform quality of care throughout the week, and it is typically reduced during the WE. Studies confirm that fewer doctors and professional staff (including nurses)[19,20] work in hospitals on the WE than on a WD,[4,21-24] and staff on duty on the WE may also have less clinical experience.[25-29] This reduced staffing creates a scenario where admissions cannot be managed in the same way on WE as on WD. Understaffing in emergency and radiology departments,[27-29] in terms of both number and expertise, could also potentially result in delayed diagnosis and treatment, with an unfavorable impact on patient prognosis. Inadequate professional staffing and medical coverage during the WE may also delay the detection of potentially fatal early complications.[24] Finally, as for our national (and regional) healthcare organization, general practitioners operate from Monday to Friday and are not available during the WE. During holidays and WE, general practitioners are backed up by a dedicated staff of younger doctors on-call, who have less experience and may not have

Table VI. Continued.

WE			*95% CI*		
Discharged alive, n (%)	*Deceased, n (%)*	*OR*	*Lower bound*	*Upper bound*	P
714 (56.6)	548 (43.4)	1.315	1.153	1.501	< .001
391 (68.0)	184 (32.0)	1.401	1.138	1.725	.002
55 (63.2)	32 (36.8)	1.404	.830	2.374	.220
184 (69.7)	80 (30.3)	1.361	.999	1.853	.052
72 (69.9)	31 (30.1)	1.451	.874	2.411	.180
80 (66.1)	41 (33.9)	1.428	.916	2.227	.129
323 (47.0)	364 (53.0)	1.201	1.005	1.435	.046
37 (44.6)	46 (55.4)	1.069	.639	1.789	.880
264 (49.4)	270 (50.6)	1.149	.939	1.405	.181
14 (32.6)	29 (67.4)	1.927	.893	4.160	.136
8 (29.6)	19 (70.4)	2.063	.799	5.326	.171

the same know-how about patients compared with senior physicians. Another possibility is that the severity of cases reaching the hospital during the WE may be higher than that during WD.[30] For example, a single-center study conducted in Michigan, showed that acute coronary syndromes arriving to the hospital during night-time and the WE were predominantly represented by ST elevation myocardial infarction, whereas daytime and WD were characterized mainly by non-ST elevation myocardial infarction events.[31]

Limitations. This study has a number of limitations, which deserve comment. This is a retrospective study based on ICD-9 coding. Patients have been identified by using ICD-9-CM codes, and patient eligibility may therefore be subject to selection biases due to hospital coding procedures.[32-34] We cannot exclude potential variation in the sensitivity of coding across study centers (misclassification bias). Second, although we used several techniques to adjust for severity of illness, it is possible that the observed difference in mortality between WE and WD admissions may be due to unmeasured, residual confounding. Since we used only an established general comorbidity score, it is possible that patients admitted on the WE had more severe diseases and inherently worse prognoses than those admitted on a WD. We tried to reduce this potential bias by limiting our analysis to the cohort of emergency admissions, but an influencing factor by an unadjusted condition(s) is still possible. Again, it is possible that our measurement of the influence of WE admission on patient mortality underestimates the adverse effect of WE care because patients admitted on the WE may "crossover" to receive WD care and vice versa. Finally, it is possible that patients admitted on the WE have more severe disease than those admitted on a WD, but this information cannot be drawn by an ICD-9-CM database.

Despite these limitations, however, the study has also several strengths:

(1) The large number of consecutive patients hospitalized for a primary diagnosis of ARRD and the long period analysis (11 years); and
(2) The study on possible influence due to the difference of province or type (teaching/nonteaching) and size (number of beds per hospital site) of hospital.

We believe the results are well representative of the real-life clinical management of patients hospitalized for acute ARRD.

CONCLUSIONS

In the last decade, a growing body of evidence has shown that, just like other acute cardiovascular events, such as AMI and stroke, AARD exhibits a temporal pattern of onset as well, characterized by preferred peaks during morning hours and winter months.[35-38] These patterns coincide with the temporal variation in the pathophysiologic mechanisms that trigger cardiovascular events and physiologic changes in body rhythms.[39] Similar to AMI and stroke,[40,41] Monday seems to be the preferred day of onset for AARD.[42] The present study gives further confirmation that patients with AARD arrive at the hospital especially on Monday, but they die more often when arriving on the WE. Moreover, the significantly higher in-hospital mortality rate on the WE compared with a WD is maintained even after adjustment for potentially confounding patient and hospital characteristics. We do not know whether this is due to insufficient coverage throughout the week, availability of either human resources and technologies, or to different clinical characteristics, such as scores of severity, of patients urgently arriving to the hospitals on the WE. Future research should address more in-depth the underlying reasons of this difference in mortality for WE and WD and whether this higher mortality may be explained by differences in severity of disease upon arrival, or uniformity of care that is needed on weekends.

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AUTHOR CONTRIBUTIONS

Conception and design: MG, DI, RM
Analysis and interpretation: MG, DI, EB, KE, RM
Data collection: MG, DI, RM
Writing the article: MG, DI, RM
Critical revision of the article: EB, KE
Final approval of the article: MG, DI, EB, KE, RM
Statistical analysis: MG, RM
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Overall responsibility: MG

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