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ORIGINAL RESEARCH

Hospitalization rate and outcomes in patients with left ventricular dysfunction receiving hemodialysis

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Introduction: Left ventricular dysfunction (LVD) is characterized as left ventricular ejection fraction (EF) below half of the systolic capacity of the left ventricle. Patients on hemodialysis have higher risk of developing LVD than the general population. Our aim was to assess hospitalization rate and outcomes in hemodialysis patients with LVD.

Patients and methods: All patients ≥18 years old, who started hemodialysis therapy at King Abdulaziz University Hospital between January 2011 and December 2011, were identified using medical records of hemodialysis unit. Patients were then divided into three groups, according to their EF results prior to the initiation of hemodialysis, as patients with EF <40%, EF between 40% and 49%, and EF ≥50%. Patients were then followed for 5 years by reviewing their hospital records to assess their outcomes, hospital admissions, and length of hospital stay.

Results: Analysis included 333 patients. Patients with EF <40% were 40, 36 patients with EF 40%–49%, and 257 patients had an EF >50%. Patients with EF <50% were significantly older than patients with EF >50% (P=0.002). Diabetes mellitus and hypertension were more prevalent in patients with EF <40% and EF 40%–49% when compared with patients with EF >50% (P<0.001, P=0.002). The average length of stay between the three groups was significantly different (P=0.007). Intensive care unit admissions were significantly different when comparing the three groups (P=0.013) and was found to be an independent risk factor for mortality in our patients. Half of the patients with EF <40% and 44% of patients with EF of 40%–49% died compared with only 27% of patients with EF >50% (P=0.002). However, Kaplan–Meier analysis showed no significant difference in the survival time among the three groups (P=0.845).

Conclusion: Mortality and morbidity increased in patients with LVD on hemodialysis compared with patients with normal EF.

Keywords: LVD, hemodialysis, mortality, hospitalization

Introduction

Left ventricular dysfunction (LVD) is characterized as a left ventricular ejection fraction (EF) below one-half of the systolic capacity of the left ventricle. Patients on hemodialysis have 10–30 times the risk of LVD than that of the general population.[1–3] Recent literature has shown a correlation between cardiovascular disease (CVD) and chronic kidney disease (CKD), and how often they coexist.[2] In patients with CKD, 74% have left ventricular hypertrophy at the beginning of dialysis, and it is considered to be the most common cardiac finding in those patients.[4]

Previous studies have shown that CVD contributes to most of the morbidity and mortality in patients receiving hemodialysis. Patients with CVD receiving hemodialy-

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sis have up to 20 times higher mortality risk than the rest of the population.[5–8] In patients with CKD, the morbidity and mortality of CVD are abnormally high in all stages of CKD, with a predominance of 80%.[6,9] Patients with LVD are more prone to comorbidities, such as high blood pressure, diabetes mellitus (DM), anemia, and a low body mass index.[1–3] In dialysis patients, there are multiple risk factors that lead to CVD and contribute to the prognosis. Some of these risk factors include advanced age, systemic hypertension (HTN), DM, proteinuria, obesity, cigarette smoking, and the risk factors associated with renal impairment. DM and cigarette smoking have worsening effects on dialysis patients, with DM being shown to decrease the survival rate and increase the hospitalization rate among those patients.[1–3,6,9]

When comparing heart failure (HF) and low EF (<40%) patients, those who were on dialysis were less likely to receive guideline-directed therapy when compared with those with no renal impairment.[10] In LVD patients receiving hemodialysis, it is important to determine the impact of these risk factors on the prognosis, clinical outcome, survival rate, and prevalence of morbidity and mortality associated with this disease. Future guidelines and protocols dealing with this group of patients must be designed to improve the outcome and survival among those patients. For this research, our aim was to assess the clinical characteristics, comorbidities, hospitalization rate, and outcomes among hemodialysis patients with LVD compared with normal EF patients in the King Abdulaziz University Hospital (KAUH) Hemodialysis Unit in Jeddah, Saudi Arabia.

Patients and methods

Study design and participants

We conducted this hospital-based retrospective cohort study at the Department of Medicine in the KAUH Hemodialysis Unit between November 2016 and September 2017 using the electronic-based patient records.

All patients ≥18 years old, who started hemodialysis therapy at KAUH between January 2011 and December 2011, were identified using the hospital information system and medical records of the hemodialysis unit. The patients were then divided into three groups according to their EF results prior to starting hemodialysis as patients with EF <40%, EF between 40% and 49%, and EF ≥50%. Patients were then followed for 5 years by reviewing their hospital records to assess their outcomes, hospital admissions, and length of hospital stay (LOS).

Variables and data measurements

Using a standardized and pretested data extraction sheet, we collected data from the electronic hospital records and hemodialysis unit registry. The following data were extracted: age, gender, nationality, DM history, ischemic heart disease (IHD) (one or more vessels disease on coronary angiography), dyslipidemia, body mass index, height, weight, cause of end-stage renal disease, number of hospital admissions over the study period, mean LOS per visit, intensive care unit (ICU) stay, echocardiography results before starting dialysis therapy, mortality, and time to death in months. Left ventricular EF was assessed for all patients by certified, well-trained echocardiography technicians prior to the initiation of dialysis. The procedure and results were supervised, reported, and verified by a consultant in cardiology. The primary outcomes were mortality and time from the index visit to death. Secondary outcomes include mean LOS in each visit, ICU stay, and the total number of readmissions over the study period. Important demographic variables were identified a priori for inclusion as covariates (namely, age, sex, DM history, IHD, dyslipidemia, body mass index, and cause of end-stage renal disease).

Statistical methods

We used percentages to represent the categorical data. If the numerical data were normally distributed, we used the mean and SD, but we used the median and IQR if not. A chi-squared test was used when comparing the categorical variables. The Kruskal–Wallis test was used for the numerical variables. Correlations were done to examine the relation between numerical variables. Kaplan–Meier analysis was used to assess survival in all groups. To adjust for potential confounding variables, multiple logistic regression models were constructed. IBM SPSS Statistics for Windows, version 21.0 (IBM Corporation, Armonk, NY, USA) was used, and for all the statistical tests, a *P*-value of <0.05 was defined as the level of significance.

Ethical considerations

Ethical approval was obtained from the Department of Bioethics at KAUH. The requirement to obtain written informed consent from each patient was waived because this was an observational retrospective study. All patients' information were confidential, and data were analyzed anonymously.

Results

The analysis included 333 patients who were receiving hemodialysis. Of these, 257 patients had EFs ≥50%, 36 had EFs of 40%–49%, and 40 had EFs <40%. The age was significantly higher in patients with EFs <50% when compared with those with EFs ≥50% (P=0.002). The proportion of males varies across the groups too (Table 1).

With regard to the comorbidities, 92.5% (N=37) and 86.1% (N=31) of patients with EFs <40% and EFs of 40%–49%, respectively, had one or more comorbidities when compared with only 69% (N=177) of patients with EFs ≥50% (P<0.001). DM was prevalent in 70% of patients with EFs <40% and 53% of patients with EFs of 40%–49% when compared with only 31% of those with EFs ≥50% (P<0.001). HTN was also more prevalent in patients with EFs <50%; 88% (N=35) of patients with EFs <40%, 81% of those with EFs of 40%–49%, and only 63% (N=163) of those with EFs ≥50% had HTN (P=0.002; Table 1).

When comparing the mortality, 50% (N=20) of patients with EFs <40% and 44% (N=16) with EFs of 40%–49% died when compared with 27% (N=68) of patients with EFs ≥50% (P=0.002) (Table 2). The median number of admissions in patients with EFs <40% was 2.5 (IQR =7), while in patients with EFs of 40%–49% it was 2 (IQR =6) compared with 2 (IQR =5) in patients with EFs ≥50% (P=0.409). However, the average length of the stay between the three groups was significantly different (P=0.007) (Table 2). The number of ICU admissions showed a statistically significant difference between the three groups (P=0.013) (Table 2).

When comparing echocardiographic parameters before starting hemodialysis among the three groups, left atrial size was significantly different among the three groups (P<0.001), and it shows that the lower the EF in the classification, the larger the atrial size. The same findings are also observed in the left ventricular size, which was also significantly different among the three groups (P<0.001). However, fractional shortening decreases with lower EF, and it is statistically different between the groups (P<0.001) (Table 3).

When correlating echocardiographic parameters with number of hospital admissions, EF was negatively correlated to number of admission (corr. coeff. r=–0.005, P=0.928). Left atrial size was positively correlated to number of admissions (corr. coeff. r=0.053, P=0.414). Left ventricular size

Table 1 General characteristics of patients according to their ejection fractions (EFs)

Characteristics	EF <40% (N=40)	EF =40%–49% (N=36)	EF =50%–100% (N=257)	*P*-value
Age				
Mean [SD]	61.08 [16.1]	60.9 [13.9]	53.43 [16.8]	0.002
Median [IQR]	61 [18]	63 [12]	55 [22]	
Gender				
Males	26 (65)	24 (69)	126 (49)	0.025
Females	14 (35)	11 (31)	131 (51)	
Comorbidities,[a] N (%)	37 (92.5)	31 (86.1)	177 (68.9)	<0.001
Diabetes mellitus, N (%)	28 (70)	19 (52.8)	79 (30.7)	<0.001
Hypertension, N (%)	35 (87.5)	29 (80.6)	163 (63.4)	0.002
Dyslipidemia, N (%)	5 (12.5)	1 (2.8)	13 (5.1)	0.122
Ischemic heart disease, N (%)	16 (40)	11 (30.6)	20 (7.8)	<0.001

Note: [a]Comorbidities = hypertension, diabetes, ischemic heart disease, and dyslipidemia.

Table 2 Hospitalization rates and outcomes of patients according to their ejection fractions (EFs)

Parameters	EF <40% (N=40)	EF =40%–49% (N=36)	EF = 50%–100% (N=257)	*P*-value
Number of admissions per 5 years				
Median [SD]	6.4 [12.1]	5.5 [7.5]	4.5 [8.6]	0.409
Median [IQR]	2.5 [7]	2 [6]	2 [5]	
Minimum–maximum	0–69	0–27	0–86	
Average length of stay per admission (days)				
Mean [SD]	5.05 [5.5]	13.8 [20.3]	6.8 [13.1]	0.007
Median [IQR]	4 [8]	7 [8]	5 [7]	
Minimum–maximum	0–30	0–90	0–180	
Intensive care unit admission, N (%)	23 (57.5)	19 (52.8)	94 (36.6)	0.013
Death, N (%)	20 (50.0)	16 (44.4)	68 (26.5)	0.002
Time to death in months				
Mean [SD]	45.8 [16]	44 [16.5]	46 [13]	0.852
Median [IQR]	49	51	50	

Table 3 Echocardiographic parameters before starting hemodialysis among the three groups

Parameters	EF <40% (N=40)	EF =40%–49% (N=36)	EF = 50%–100% (N=257)	*P*-value
Left atrium size				
Mean [SD]	4.5 [0.8]	4.3 [0.8]	3.9 [0.7]	<0.001
Median	5	4	4	
Left ventricle size				
Mean [SD]	4.8 [0.8]	4.0 [0.6]	3.6 [0.6]	<0.001
Median	5	4	3	
Fractional shortening				
Mean [SD]	16.7 [4.7]	25.0 [6.3]	34.2 [5.0]	<0.001
Median	16.5	23	34	

Abbreviation: EF, ejection fraction.

was also positively correlated to number of admissions (corr. coeff. *r*=0.39, *P*=0.561). Fractional shortening was positively correlated to number of admission (corr. coeff. *r*=0.015, *P*=0.821).

When correlating LOS with echocardiographic parameters, EF was negatively correlated to LOS (corr. coeff. *r*=0.09. *P*=0.141). Left atrial size was positively correlated to LOS (corr. coeff. *r*=0.182, *P*=0.004). Left ventricular size was positively correlated to LOS (corr. coeff. *r*=0.187, *P*=0.005). Fractional shortening was negatively correlated to LOS (corr. coeff. *r*=–0.094, *P*=162).

When comparing echocardiographic parameters before the initiation of hemodialysis and the mortality in our patients, EF before the initiation of hemodialysis was significantly lower in patients who died within the study period (*P*<0.001). Fractional shortening was also significantly lower in patients who died. However, left atrial and ventricular sizes show no significant difference (Table 4).

In the logistic regression model for death, the age was significantly associated with mortality with an OR of 1.035 (95% CI =1.004–1.068) (*P*=0.027). DM had an OR of 2.270 (95% CI =0.795–6.482) (*P*=0.126), and ICU admission was significantly associated with increased mortality with an OR of 15.983 (95% CI =6.057–42.175) (*P*<0.001; Table 5).

Kaplan–Meier survival analysis was done to examine the survival among the three groups according to their EF. However, there was no statistically significant difference in the survival time in months among the three groups (*P*=0.845) (Figure 1). Number of patients at risk over time is presented in Table 6.

The associations between the number of admissions and the other variables were examined using linear regression. The only significant factor was that of the left ventricular size, which was negatively correlated (β=–0.226) with the number of admissions (*P*=0.043; Table 7).

A linear regression was also estimated for average length of stay in each admission. The ICU admissions were posi-

Table 4 Characteristics of echocardiographic parameters before the initiation of hemodialysis according to the 5-year mortality

Parameters	Died (N=104)	Survived (N=229)	*P*-value
Ejection fraction			
Mean [SD]	50.7 [15.7]	57 [12.3]	<0.001
Median	55	60	
Left atrium size			
Mean [SD]	4 [0.7]	4 [0.7]	0.394
Median	4	4	
Left ventricle size			
Mean [SD]	3.8 [0.9]	3.6 [0.8]	0.07
Median	4	3	
Fractional shortening			
Mean [SD]	28.8 [8.3]	31 [8.2]	0.047
Median	31	32	

Table 5 Logistic regression and OR results for mortality

Variables	*P*-value	OR (95% CI)
Age (years)	0.027	1.035 (1.004–1.068)
Gender	0.401	1.461 (0.603–3.536)
Comorbidities	0.898	1.148 (0.138–9.546)
Hypertension	0.349	0.423 (0.070–2.562)
Ischemic heart disease	0.923	0.946 (0.307–2.917)
Diabetes mellitus	0.126	2.270 (0.795–6.482)
Dyslipidemia	0.322	2.290 (0.444–11.801)
Body mass index	0.485	0.978 (0.918–1.041)
Number of admissions	0.446	1.024 (0.964–1.088)
Average length of admission in days	0.231	0.971 (0.926–1.019)
Intensive care unit	<0.001	15.983 (6.057–42.175)
Left atrium size	0.797	1.089 (0.569–2.084)
Left ventricle size	0.797	0.907 (0.430–1.912)
Fractional shortening	0.228	1.073 (0.957–1.204)
Ejection fraction	0.148	0.952 (0.890–1.018)

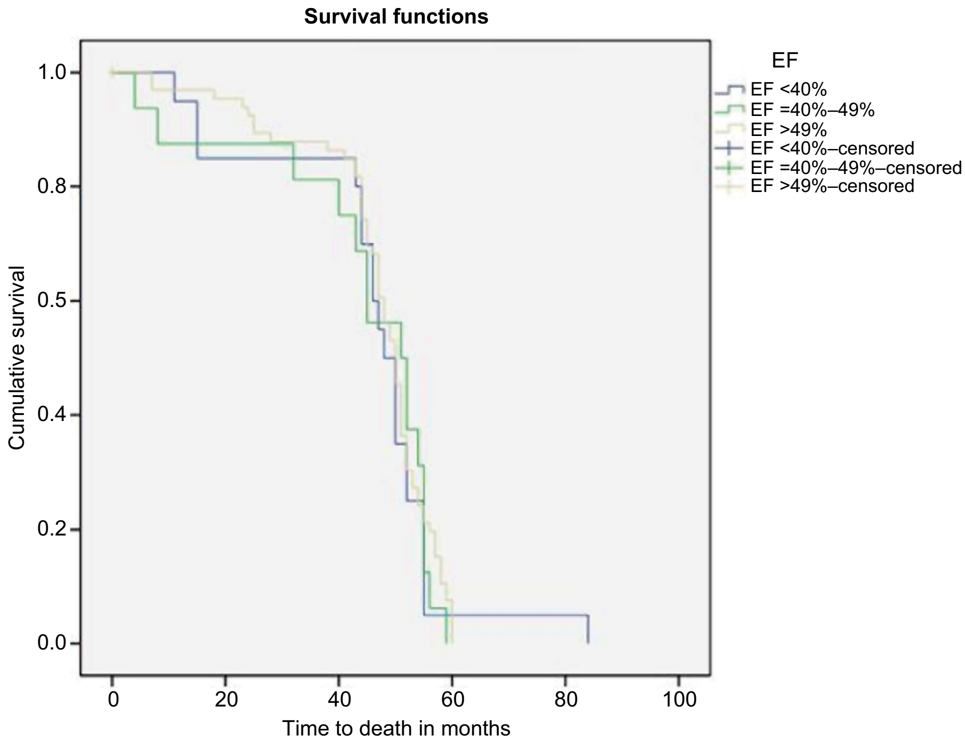

Figure 1 Kaplan–Meier survival analysis for patients according to their EF classification prior to enrolment in the study.
Abbreviation: EF, ejection fraction.

tively correlated and associated with an increased length of stay (β=0.332) ($P<0.001$). The other variables showed no significant correlations (Table 8).

Discussion

In our study, we compared the characteristics and hospitalization rates of dialysis patients based on their EFs. Those with EFs >50% were considered to be the control group, and those with EFs <40% and EFs of 40%–49% were considered to be the cases. Among the patients with EFs <40% and EFs of 40%–49%, there was an increased mortality rate when compared with the control group (50%, 44.4%, and 26.5%, respectively). Our findings are supported by numerous previous studies,[2,3] which showed that HF patients with low EFs associated with renal failure requiring dialysis had higher morbidity and mortality rates when compared with those without HF.[11] This can be explained by the notion that with the increased duration of ERSD, changes may affect the cardiovascular system, like uremic pericarditis, and the serum calcium can affect both the blood vessels and the myocardium. This may eventually lead to the development of HF or a low EF, which some studies have shown to be risk factors for increasing the mortality rate among dialysis patients.[2,12] However, the effect of EF on time to mortality in 5 years showed no significant difference between the three group, which may indicate that EF alone has minimal effect on time to mortality and other factors (demographics and comorbidities) must be taken under consideration when assessing time to mortality and improving the outcomes in those patients.

Our result also demonstrated that patients with EFs <50% do indeed have a worse prognosis than those with EFs ≥50%. Although our present study did not show any significance in the multivariate analysis, this could be explained by the small sample size.

Only advanced age was found to be an independent risk factor for mortality in dialysis patients in our study. DM, HTN, dyslipidemia, and IHD were not significantly associated with mortality. It is worth noting that the lower the patients were in the classification, the higher the prevalence of the abovementioned comorbidities, which may reflect their poor cardiovascular profile. These findings are contradictory to many studies,[3,5,8] which shows that DM and IHD, in addition to smoking and advanced age (a finding supporting one of our results), were associated with an increased mortality in those patients. The results of another previous study were consistent with ours with regard to age being a risk factor for mortality.[13] A possible explanation for this diversity may be

Table 6 Kaplan–Meier survival data

EF		Time	Status estimate	Cumulative proportion surviving at the time		No of cumulative events	No of remaining cases
				Estimate	Standard error		
EF <40%	1	11	Died	0.950	0.049	1	19
	2	15	Died	0.0	0.0	2	18
	3	15	Died	0.850	0.080	3	17
	4	43	Died	0.800	0.089	4	16
	5	44	Died	0.0	0.0	5	15
	6	44	Died	0.700	0.102	6	14
	7	46	Died	0.0	0.0	7	13
	8	46	Died	0.600	0.110	8	12
	9	47	Died	0.550	0.111	9	11
	10	48	Died	0.500	0.112	10	10
	11	50	Died	0.0	0.0	11	9
	12	50	Died	0.0	0.0	12	8
	13	50	Died	0.350	0.107	13	7
	14	52	Died	0.0	0.0	14	6
	15	52	Died	0.250	0.097	15	5
	16	55	Died	0.0	0.0	16	4
	17	55	Died	0.0	0.0	17	3
	18	55	Died	0.0	0.0	18	2
	19	55	Died	0.050	0.049	19	1
	20	84	Died	0.000	0.000	20	0
EF =40%–49%	1	4	Died	0.938	0.061	1	15
	2	8	Died	0.875	0.083	2	14
	3	32	Died	0.813	0.098	3	13
	4	40	Died	0.750	0.108	4	12
	5	43	Died	0.688	0.116	5	11
	6	45	Died	0.0	0.0	6	10
	7	45	Died	0.563	0.124	7	9
	8	51	Died	0.500	0.125	8	8
	9	52	Died	0.0	0.0	9	7
	10	52	Died	0.375	0.121	10	6
	11	54	Died	0.313	0.116	11	5
	12	55	Died	0.0	0.0	12	4
	13	55	Died	0.0	0.0	13	3
	14	55	Died	0.125	0.083	14	2
	15	56	Died	0.063	0.061	15	1
	16	59	Died	0.000	0.000	16	0
EF >49%	1	0	0.00	0.0	0.0	0	66
	2	7	Died	0.0	0.0	1	65
	3	7	Died	0.970	0.021	2	64
	4	18	Died	0.955	0.026	3	63
	5	23	Died	0.939	0.029	4	62
	6	24	Died	0.924	0.033	5	61
	7	25	Died	0.0	0.0	6	60
	8	25	Died	0.894	0.038	7	59
	9	28	Died	0.879	0.040	8	58
	10	38	Died	0.864	0.042	9	57
	11	41	Died	0.848	0.044	10	56
	12	43	Died	0.0	0.0	11	55
	13	43	Died	0.818	0.047	12	54
	14	44	Died	0.0	0.0	13	53
	15	44	Died	0.0	0.0	14	52
	16	44	Died	0.0	0.0	15	51
	17	44	Died	0.0	0.0	16	50
	18	44	Died	0.742	0.054	17	49

(*Continued*)

Table 6 (*Continued*)

EF		Time	Status estimate	Cumulative proportion surviving at the time		No of cumulative events	No of remaining cases
				Estimate	Standard error		
	20	45	Died	0.0	0.0	19	47
	21	45	Died	0.697	0.057	20	46
	22	46	Died	0.682	0.057	21	45
	23	47	Died	0.0	0.0	22	44
	24	47	Died	0.0	0.0	23	43
	25	47	Died	0.0	0.0	24	42
	26	47	Died	0.0	0.0	25	41
	27	47	Died	0.606	0.060	26	40
	28	48	Died	0.0	0.0	27	39
	29	48	Died	0.0	0.0	28	38
	30	48	Died	0.561	0.061	29	37
	31	49	Died	0.0	0.0	30	36
	32	49	Died	0.530	0.061	31	35
	33	50	Died	0.0	0.0	32	34
	34	50	Died	0.0	0.0	33	33
	35	50	Died	0.0	0.0	34	32
	36	50	Died	0.0	0.0	35	31
	37	50	Died	0.455	0.061	36	30
	38	51	Died	0.0	0.0	37	29
	39	51	Died	0.0	0.0	38	28
	40	51	Died	0.0	0.0	39	27
	41	51	Died	0.0	0.0	40	26
	42	51	Died	0.0	0.0	41	25
	43	51	Died	0.364	0.059	42	24
	44	52	Died	0.0	0.0	43	23
	45	52	Died	0.0	0.0	44	22
	46	52	Died	0.0	0.0	45	21
	47	52	Died	0.303	0.057	46	20
	48	53	Died	0.0	0.0	47	19
	49	53	Died	0.273	0.055	48	18
	50	54	Died	0.0	0.0	49	17
	51	54	Died	0.242	0.053	50	16
	52	55	Died	0.0	0.0	51	15
	53	55	Died	0.212	0.050	52	14
	54	56	Died	0.197	0.049	53	13
	55	57	Died	0.0	0.0	54	12
	56	57	Died	0.0	0.0	55	11
	57	57	Died	0.152	0.044	56	10
	58	58	Died	0.0	0.0	57	9
	59	58	Died	0.0	0.0	58	8
	60	58	Died	0.106	0.038	59	7
	61	59	Died	0.0	0.0	60	6
	62	59	Died	0.076	0.033	61	5
	63	60	Died	0.0	0.0	62	4
	64	60	Died	0.0	0.0	63	3
	65	60	Died	0.0	0.0	64	2
	66	60	Died	0.0	0.0	65	1
	67	60	Died	0.000	0.000	66	0

Abbreviation: EF, ejection fraction.

the sample size differences between our study and others, as their studies were larger. Additionally, we cannot exclude the potential variability present between different ethnicities and countries.[14] These differences may shed some light on how different ethnicities have different risk factors, which may become an interesting topic to explore in the future.

One interesting finding in one study was that HTN was associated with lower mortality among patients on dialysis

Table 7 Linear regression for number of admissions

Coefficients							
Model	**Unstandardized coefficients**		**Standardized coefficients**	**t**	***P*-value**	**95% CI for *B***	
	B	**Standard error**	**β**			**Lower bound**	**Upper bound**
Ejection fraction	−0.025	0.087	−0.047	−0.281	0.779	−0.0197	0.148
Age	−0.019	0.035	−0.048	−0.534	0.594	−0.088	0.051
Gender	−1.137	1.067	−0.082	−1.066	0.288	−3.244	0.969
Comorbidities	−1.022	2.606	−0.055	−0.392	0.695	−6.166	4.121
Hypertension	0.347	2.313	0.021	0.150	0.881	−4.218	4.912
Ischemic heart disease	1.107	1.484	0.064	0.746	0.457	−1.821	4.035
Diabetes mellitus	1.822	1.302	0.130	1.400	0.163	−0.747	4.392
Dyslipidemia	3.671	2.234	0.124	1.643	0.102	−0.739	8.08
Body mass index	−0.081	0.076	−0.081	−1.058	0.291	−0.231	0.070
Average length of admission in days	0.018	0.069	0.020	0.257	0.798	−0.118	0.154
Intensive care unit	1.754	1.147	0.125	1.529	0.128	−0.510	4.018
Left atrium size	1.106	0.782	0.118	1.413	0.159	−0.438	2.650
Left ventricle size	−1.909	0.937	−0.226	−2.037	0.043	−3.759	−0.059
Fractional shortening	0.003	0.146	0.003	0.020	0.984	−0.285	0.291

Table 8 Linear regression for the average length of stay

Coefficients							
Model	**Unstandardized coefficients**		**Standardized coefficients**	**t**	***P*-value**	**95% CI for *B***	
	B	**Standard error**	**β**			**Lower bound**	**Upper bound**
Ejection fraction	0.010	0.096	0.017	0.105	0.916	−0.178	0.199
Age	0.013	0.039	0.029	0.333	0.740	−0.063	0.089
Gender	0.944	1.167	0.062	0.809	0.420	−1.359	3.248
Comorbidities	−0.947	2.847	−0.046	−0.333	0.740	−6.565	4.671
Hypertension	1.870	2.523	0.099	0.741	0.460	−3.109	6.848
Ischemic heart disease	2.706	1.610	0.140	1.680	0.095	−0.472	5.883
Diabetes mellitus	−0.697	1.429	−0.045	−0.488	0.626	−3.517	2.123
Dyslipidemia	0.562	2.458	0.017	0.229	0.819	−4.290	5.414
Body mass index	−0.054	0.083	−0.048	−0.646	0.519	−0.219	0.111
Intensive care unit	5.003	1.204	0.321	4.157	0.000	2.628	7.379
Left atrium size	0.782	0.857	0.075	0.912	0.363	−0.910	2.474
Left ventricle size	0.435	1.035	0.046	0.420	0.675	−1.608	2.478
Fractional shortening	0.169	0.159	0.177	1.066	0.288	−0.144	0.483
Number of admissions	0.021	0.082	0.019	0.257	0.798	−0.141	0.184

therapy.[8] However, another study stated that HTN increased the mortality in dialysis patients.[15] This disparity in the findings can be attributed to the differences in the populations studied, both in terms of the characteristics and number of centers included in other studies. According to the Hemodialysis (HEMO) Study, the most common cause of death in dialysis patients was of cardiac origin, amounting to 39.4% of the all-cause death in the population under study.[6] Another interesting finding in this study was the effect of using high flux dialyzer (the membrane is larger, to allow for the filtration of larger molecules) on decreasing cardiac cause of death. Another interesting finding regarded the effects of using a high-flux dialyzer (the membrane is larger to allow for the filtration of larger molecules) on decreasing the cardiac cause of death.[16] In addition, it was found that with the use of high-flux dialyzer, there was a decrease in incidence of cardiac hospitalization. Unfortunately, in our study, the only type of dialyzer in our hospital is the low-flux type. As such, a comparison could not be made. This could shed some light on the importance of the type of dialyzer used in patients with LVD.

The number of ICU admissions was significantly higher in patients with EFs <40% and EFs of 40%–49% than in the control group (57.5%, 52.8%, and 36.6%, respectively). This can be explained by the fact that patients with low EFs are less likely to tolerate stressors, like fluid overload, uremic pericarditis, and electrolyte imbalances. The number of ICU admissions was also found to be an independent risk factor increasing both the mortality and the length of stay in our patients. This finding is supported by multiple studies,[17,18] one of which shows that ERSD patients have a relative risk of death over the long term of 2.23 after admission to the ICU when compared with those ERSD patients without ICU admissions. In addition, that study found that age, HF, and DM were risk factors for the 90-day mortality.[18] One point that should be mentioned is that patients requiring dialysis may be more likely to be admitted to the ICU, either due to their vulnerability to infections[19] or vascular access-associated complications.[20] Thus, their condition may worsen, necessitating an admission to the ICU. An interesting finding was that the patients with EFs of 40%–49% had longer LOS in each admission when compared with those with EFs <40%, which is contradictory to the results of other studies.[21–23] However, in the multivariate regression, the EF level did not show a significant association with the LOS. Further studies with larger sample sizes are needed to confirm the outcomes in this understudied group of hemodialysis patients.

The duration and frequency of dialysis treatments per week are highly associated with both the morbidity and mortality risks in those patients, as shown by previous research. Daily home dialysis and in-center dialysis have similar hospitalization risks, with the distinction that daily home hemodialysis has a lower risk of cardiovascular-related admissions in contrast to in-center dialysis. However, there is a higher risk of infection-related admissions.[24] A systemic review and meta-analysis of randomized controlled trials was conducted revealing that every year between 10% and 20% of all dialysis patients die, with ~45% of these deaths being due to underlying cardiovascular causes.[25] One study conducted in 2001 showed that HF exhibited a higher increase in the risk of hospitalization in Caucasian patients by 16% when compared with African-American patients in which it was only 8%.[14]

This study did have some limitations; for example, it was conducted in only one center. In addition, it had a relatively small sample size when compared with other studies, and we lacked the specific causes of mortality in our patients. It may be interesting if the patients receiving hemodialysis were compared with those receiving peritoneal dialysis in terms of the EF under the same classification. Moreover, a study that encompasses most major centers in the region would exhibit a better representation of this population. However, our study is one of the first study to assess the mortality and outcomes in patients with LVD on hemodialysis in the region and in this specific population, which might further help in improving the guidelines and practice recommendations in patients with LVD on hemodialysis.

Our study demonstrated that a low EF can affect both the mortality and morbidity rates in patients receiving hemodialysis. In addition, advanced age and ICU admission were found to be independent risk factors for mortality in these hemodialysis patients.

Conclusion

Patients with LVD receiving hemodialysis have increased risks of mortality and morbidity when compared with those with normal EFs. The hospitalization rate showed no difference in those patients receiving hemodialysis with low and normal EFs. However, the LOS increased with a low EF. Advanced age and ICU admission were found to be independent risk factors for increased mortality and morbidity in these dialysis patients. A future prospective study with larger sample size is recommended to further study this group of patients and develop future guidelines and practices to improve the outcomes of patients with LVD and low EF.

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Disclosure

The authors report no conflicts of interest in this work.

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