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Unseen Threefold Mortality After the First Ten Days in Hemodialysis Patients Following Joint Arthroplasty: A Nationwide Retrospective Cohort Study of 1,287 Arthroplasty Patients on Hemodialysis

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Background: The study addresses the growing number of hemodialysis (HD) patients undergoing joint arthroplasty, who are at higher risk of complications and mortality. Previous research has often overlooked deaths after discharge. This study aimed to examine early outcomes in a large nationwide cohort of patients who underwent arthroplasty for elective and fracture-related reasons.
Methods: Between 2016 and 2022, a study was conducted using the e-Nabız database of the Türkiye Ministry of Health, focusing on patients aged 18 years and above who underwent elective or fracture-related arthroplasty. This study included 1,287 patients reliant on dialysis who underwent total hip arthroplasty, total knee arthroplasty, or hemiarthroplasty (HA), with 7.7% of them receiving dialysis for the first time. Propensity score matching was used to create an equally sized group of non-dialysis-dependent patients, ensuring demographic balance in terms of age, sex, a comorbidity index, and surgery type. The primary objective was to compare mortality rates 10, 30, and 90 days after arthroplasty.
Results: The first-time dialysis patients who underwent HA had significantly higher 30- and 90-day mortality rates compared to the chronic dialysis group ($P = .040$ and $P < .001$, respectively). Also, the HD patients consistently exhibited higher 90-day mortality rates across all surgery types. With total knee arthroplasty, HD patients had a mortality rate of 8.7%, in stark contrast to 0% among non-HD patients ($P < .001$). Similarly, with total hip arthroplasty, HD patients had a 12% mortality rate, while non-HD patients had a markedly lower rate of 2.7% ($P = .008$). In the case of HA, HD patients had a significantly elevated 90-day mortality rate of 31.9%, in contrast to 17.1% among non-HD patients ($P < .001$).
Conclusions: Joint arthroplasty has higher rates of mortality and complications among HD patients. Surgical decisions must be based on patients' overall health, necessitating collaboration among specialists. These patients should be closely monitored.

Projections estimate that the number of individuals worldwide suffering from end-stage renal disease and requiring chronic dialysis is anticipated to double to 5.4 million by the year 2030 [1]. It is known that roughly more than half of the patients undergoing hemodialysis (HD) are aged 65 years or above. In the United States, there are approximately more than half a million individuals living

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who have end-stage renal disease, and among these patients, about 70% are receiving dialysis treatment [2,3]. Consequently, a growing number of older chronic dialysis patients who have multiple morbidities will be undergoing elective or postfracture joint arthroplasty surgery in the near future. In this patient group, metabolites causing chondral damage and severe osteoporosis are prominent factors driving the necessity for arthroplasty surgery [4–6].

Mortality is a rare but important complication following primary total joint arthroplasty (TJA), observed during early follow-up. Systematic reviews have reported that both in-hospital mortality and 90-day mortality are less than 1% after TJA [7–9]. However, it is important to highlight that in some large series of patients who underwent hemiarthroplasty (HA) for hip fractures, the reported 90-day mortality rates ranged from 14 to 30% [8,10]. Hemodialysis increases the risk of mortality and perioperative complications in arthroplasty patients through various mechanisms [11–14]. After knee and hip arthroplasty in dialysis patients, the 30-day mortality rate has been reported to range between 1 and 2.3%, while after hip fractures, the mortality rate is reported at 8% [11,15]. Among these complications, myocardial infarction, stroke, pneumonia, surgical site infection, and increased transfusion requirements can be mentioned [16]. Therefore, it is of marked importance to not only anticipate potential perioperative complications but also provide comprehensive information to patients in the preoperative phase.

Research on this topic has been conducted using patient cohorts from specialized referral centers where chronic HD patients are managed [11,17–20]. However, a large portion of patients undergo surgery outside of these centers. Therefore, studies may not accurately reflect the true numbers. Additionally, it is widely acknowledged that a considerable proportion of mortality occurs outside the hospital, which may affect the reported mortality rates depending on follow-up rates and follow-up periods [21]. Hence, it is possible that some deceased patients may be overlooked or not captured in the process of data collection.

For a realistic assessment of mortality after joint arthroplasty in HD patients, it is necessary to conduct research with comprehensive registries that include all patients undergoing surgery at all centers and ensure the complete recording of all mortality, including mortality that occurs at home. Using a nationwide database of this type, our primary goal was to examine the timing and rate of mortality in HD patients who underwent joint arthroplasty. As a secondary objective, we aimed to determine whether mortality rates differed between acute and chronic HD patients undergoing both elective and urgent arthroplasty procedures.

Methods

For this retrospective comparative database study, patient data were obtained from the e-health database (e-Nabız) maintained by the Ministry of Health of the Republic of Türkiye. This database contains information from a diverse range of public, private, secondary, and tertiary hospitals and university health care institutions across Türkiye [22]. The study was carried out in conformity with the principles outlined in the Declaration of Helsinki and ethical approval was received from the Ministry of Health. The requirement for individual informed consent for data acquisition was waived, but strict measures were taken to ensure the maximum protection of the privacy and security of patients' health information.

This study examined both chronic dialysis patients and first-time dialysis patients who underwent total hip arthroplasty (THA), total knee arthroplasty (TKA), or HA between January 1, 2016, and December 31, 2022, to identify postoperative mortality. The data were obtained from the e-Nabız system in May 2023. While determining the study population, patients who had a history of HD were initially identified using Health Services Implementation Regulation codes (SUT, via https://skrs.saglik.gov.tr, accessed May 2023). From among these patients, those who underwent THA, TKA, or HA were identified using operation-specific codes. While TKA and THA patients were operated on under elective conditions, HA was performed following hip fractures. These patients were then separated into 2 groups based on their need for preoperative HD. Patients who had a history of HD for more than 2 months before the index surgery were classified as undergoing chronic HD, while patients who did not have a history of HD until 4 days before surgery were classified as undergoing acute (first-time) HD. There is no consensus on the specific duration for characterizing patients as chronic dialysis recipients. Some authors consider 90 days of HD as indicative of chronicity, while others propose shorter durations. We define patients as chronic dialysis patients after receiving HD continuously for a period of 2 months [23–25]. Patients who were under 18 years of age, had undergone renal transplantation or simultaneous bilateral arthroplasty, had a THA or TKA following a fracture, had peritoneal dialysis, had a history of HD less than 2 months before surgery, or had a follow-up period shorter than 90 days were excluded from the study. In some dialysis centers, multiple dialysis sessions can be performed in a packaged format at once. This may lead to misconceptions about when the patient received their last dialysis. Many chronic dialysis patients receive dialysis 2 or 3 times a week [26]. In order to work with a more refined patient group, individuals who did not have a HD procedure code within the 4 days preceding surgery were also excluded. Out of 5,247 patients who underwent arthroplasty while on dialysis, 1,187 chronic HD patients who met the inclusion criteria were included in the evaluation (Figure 1). For the chronic dialysis group, a control group was created by performing propensity score matching (PSM). No control group was created for the acute dialysis group.

Patients' comorbidities were determined using the Tenth Edition of the International Classification of Diseases, and Charlson comorbidity index (CCI) scores were calculated accordingly [8]. Demographic data, institution level, length of hospital stay, and mortality in 10, 30, and 90 days were recorded for the groups.

A total of 1,287 patients undergoing THA, TKA, or HA who were on dialysis were evaluated in this study. Among them, 100 (7.7%) patients were recipients of acute dialysis. The mean age of chronic HD patients was 70 years (range, 19 to 102). The control group consisted of 1,187 individuals matched for age, sex, and CCI using PSM. The demographic characteristics of the study population and the control group were well balanced due to the use of PSM. The distributions of detailed demographic data, including age, sex, CCI, and body mass index (BMI), are presented in Table 1.

We conducted receiver operating characteristic analyses to evaluate the association between CCI scores and 90-day mortality. Statistical significance was determined at a P value less than .05. The receiver operating characteristic analysis revealed a significant correlation, with a crucial CCI score of 8 identified. The area under the curve for this threshold was 0.58, indicating moderate accuracy in predicting mortality, with a sensitivity of 61% and a specificity of 52%.

Propensity Score Matching

The study incorporated a PSM algorithm to adjust for potential confounding variables based on methodologies presented in previous studies [27]. This process involved constructing a logistic regression model to generate propensity scores. A one-to-one matching approach was adopted, whereby each dialysis patient

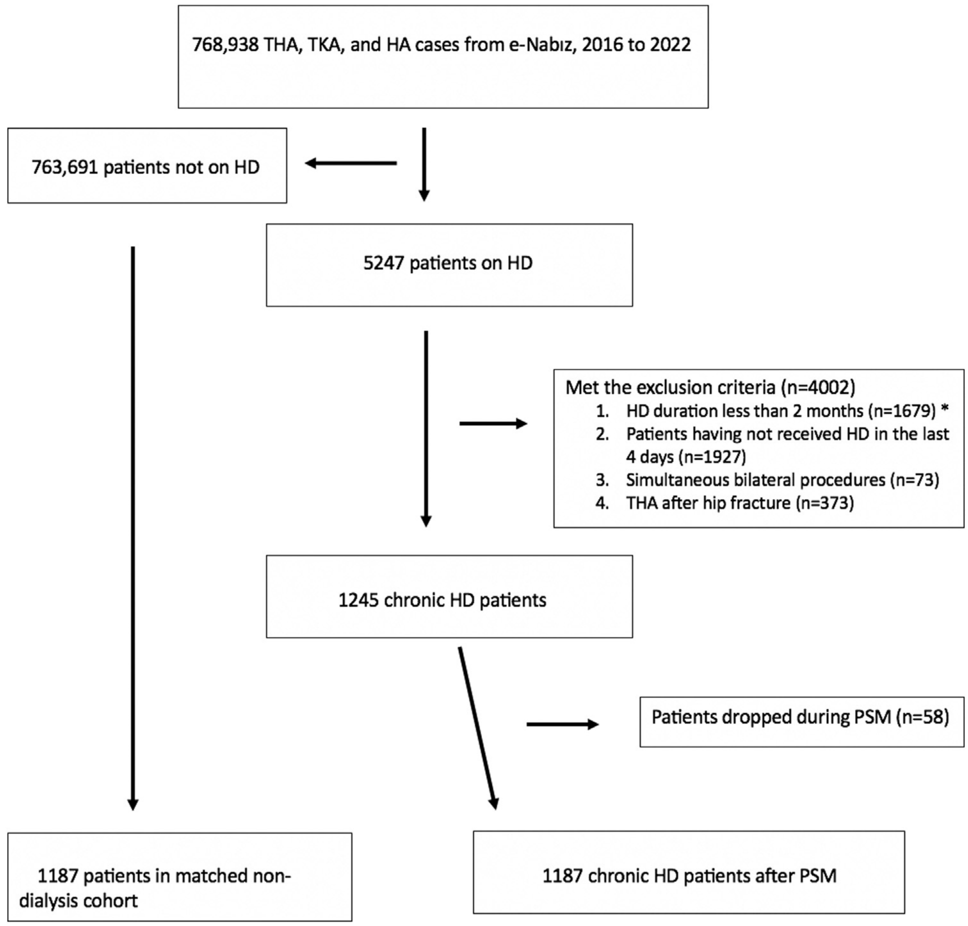

Fig. 1. Flowchart showing inclusion and exclusion criteria. THA, total hip arthroplasty; TKA, total knee arthroplasty; HA, hemiarthroplasty; HD, hemodialysis; PSM, propensity score matching * included patients who received first dialysis within 4 days before surgery (n = 100).

was coupled with a unique non-dialysis patient chosen based on the closest propensity scores. Any data points beyond the common support were eliminated from both groups to adequately balance the covariates.

The best caliper width was determined by taking 0.2 times the standard deviation of the logit of the propensity score, as outlined in earlier work. Following this procedure, a satisfactory match was achieved between the 1,187 chronic HD patients included in this study and an equal number of non-dialysis patients. The adequacy of the model was further substantiated by contrasting the significance and the mean difference of the propensity scores of the datasets before and after matching. Finally, 6 variables were effectively balanced: patient age, sex, type of arthroplasty procedure, year of surgery, and CCI score. We did not match BMI between groups because HD patients often show a higher prevalence of malnutrition and protein-energy wasting. This could lead to major variations in BMI among individuals who have similar characteristics in the same age group when compared to the group not undergoing dialysis.

Outcomes

The outcome analysis delved into the dynamics of mortality across postoperative intervals (10, 30, and 90 days) for patients receiving HD compared with non-HD patients, stratified by surgical type (THA, HA, and TKA). Additionally, it involved a comparative assessment of mortality rates between chronic HD and acute (first-time) HD groups, considering surgical types separately. Lastly, we aimed to identify risk factors contributing to 90-day postoperative

Table 1
Demographics of Patients After Propensity Score Matching.

Demographic Parameters	TKA			THA			HA		
	HD (n = 126)	Non-HD (n = 126)	*P*	HD (n = 108)	Non-HD (n = 108)	*P*	HD (n = 953)	Non-HD (n = 953)	*P*
Age (mean, years)	66	66	1	59	59	.883	72	72	1
Women (%)	91 (72)	91 (72)	1	59 (55)	59 (55)	1	484 (50.8)	484 (50.8)	1
CCI	7.5	7	.256	6.5	5.8	.085	8.9	8.7	.052
BMI	29.5	32.3	**.010**	26	31.4	**.000**	25.6	28.6	**.000**

Bold indicates statistical significance ($P < .05$).
TKA, total knee arthroplasty; THA, total hip arthroplasty; HA, hemiarthroplasty; CCI, Charlson comorbidity index; HD, hemodialysis; Non-HD, non-hemodialysis; BMI, body mass index.

mortality, providing a comprehensive understanding of mortality patterns and associated factors in our study cohort.

The acute dialysis patients were stratified into 2 groups based on their postoperative continuous dialysis requirements, and the 90-day mortality rates following surgery between these distinct groups were also compared.

Data Analyses

The data were analyzed using IBM SPSS Statistics 25.0 (IBM Corp., Armonk, New York). To assess the normality of the data distribution, skewness and kurtosis values were utilized as statistical measures. Categorical variables were compared using Pearson *Chi*-square tests, while independent sample *t*-tests were employed to compare parametric variables. We utilized the Pearson correlation test to evaluate the relationships between variables. Quantitative variables were presented as mean ± standard deviation, and qualitative variables were expressed as numbers (n), frequencies, or ratios. Statistical significance was accepted for *P* values of less than .05.

A Cox proportional hazard regression model was employed to ascertain the variables influencing the likelihood of mortality within a 90-day time frame. To identify factors influencing mortality over the course of 90 days, we initially performed univariate analysis using Cox proportional hazard regression. Subsequently, multivariate Cox proportional hazard regression analysis was conducted, incorporating the factors that exhibited statistical significance in the univariate analysis.

Results

The 10-, 30-, and 90-day mortality rates were, respectively, 9.2, 16.1, and 29.7% among HD patients undergoing joint arthroplasty compared to respective rates of 2.5, 6.1, and 14% in the control group.

Subgroup analysis was conducted within the dialysis group based on the type of surgical procedure performed. Blood transfusion rates were assessed separately for patients who underwent THA, TKA, and HA. These results were compared to the respective subgroups in the control group. Additionally, mortality rates at different time intervals after surgery were assessed in both groups. Notably, at the 10-day mark, the HD group exhibited a higher mortality rate among TKA patients (1.6 versus 0%), although this difference was not statistically significant. In contrast, the 30-day mortality rate was significantly higher in the HD group for TKA (3.2 versus 0%, $P = .041$) and HA (4.6 versus 0.9%, $P = .091$). Most notably, the 90-day mortality rate was significantly elevated in the DD group across all arthroplasty types (TKA: 8.7 versus 0%, THA: 12 versus 2.7%, HA: 31.9 versus 17.1%; $P < .001$ for all). Additionally, blood transfusion rates within the first 10 days were significantly higher in the DD group for all arthroplasty types ($P < .001$) (Table 2).

Within the dialysis group, a second subgroup analysis was performed to compare chronic dialysis patients and acute dialysis patients. Within each group, the postoperative mortality rate and the need for blood transfusions were analyzed independently. There were no statistically significant differences in 10-day and 30-day mortality rates between chronic HD patients and those experiencing dialysis for the first time across all 3 arthroplasty types. However, for the 90-day mortality rate, a significant difference was observed in the HA group, where chronic HD patients had a notably higher mortality rate compared to those receiving first-time dialysis (57 versus 31.9%, $P < .001$). This suggests that the impact of dialysis timing on mortality rates may vary depending on the type of arthroplasty procedure. These findings were also compared between the chronic and acute dialysis groups (Table 3). For HA, there was a significant difference in 30-day mortality between chronic dialysis patients (18.2%) and first-time dialysis patients (26.8%, $P = .040$). Additionally, at 90 days after surgery, a substantial difference was observed between these 2 groups for HA, with chronic dialysis patients having a mortality rate of 31.9% and first-time dialysis patients having a rate of 57% ($P < .001$).

Moreover, in the acute HD cohort, 44 of 93 (47%) HA patients continued dialysis postoperatively. Of this group, 23 patients died within 90 days after surgery, resulting in a mortality rate of 52%. Conversely, among the 49 patients who did not require ongoing dialysis in the 90-day postoperative period, the mortality rate was 61% (30 of 49) ($P = .384$) (Table 4).

The Cox regression model used to examine factors influencing 90-day mortality demonstrated that men (hazard ratio [HR] = 1.20; 95% confidence interval [CI] = 1.01 to 1.41; $P = .034$), increased age, CCI score >8 (HR = 1.34; 95% CI = 1.13 to 1.61; $P < .001$), and receiving HD before surgery (HR = 2.40; 95% CI = 2.00 to 2.88; $P < .001$) were associated with higher mortality rates (Table 5).

Discussion

This study has demonstrated that 10- and 90-day mortality and blood transfusion rates were higher in the group of chronic HD patients who underwent THA, TKA, and HA. A notable finding was the substantial increase in mortality during the 90-day postoperative follow-up period for all 3 surgical procedures. Furthermore, within the cohort of HA patients, those who had begun dialysis just before the surgical procedure, receiving first-time acute dialysis, had higher rates of 10- and 90-day mortality, as well as an increased overall incidence of complications compared to patients receiving chronic HD.

The high mortality rate after TKA and THA among HD patients is a significant concern. Several studies have revealed that in-hospital mortality rates for HD patients undergoing THA and TKA are notably higher at 0.9 and 1.9%, respectively, compared to those not on dialysis, with respective rates of 0.1 and 0.13% [20,21]. In the early 2000s, due to increased complication rates in patients who have HD, arthroplasty recommendations were deemed questionable [28]. Nevertheless, it is important to emphasize that TJA can still provide major benefits in reducing pain and improving functional outcomes for HD patients. A study involving more than 3,000 patients who underwent TKA and THA while on dialysis found that

Table 2
Postoperative Mortality Rates.

Covariate	TKA			THA			HA		
	HD (n = 126)	Non-HD (n = 126)	*P*	HD (n = 108)	Non-HD (n = 108)	*P*	HD (n = 953)	Non-HD (n = 953)	*P*
Mortality in 10 d (%)	2 (1.6)	0 (0)	.156	1 (0.9)	0 (0)	.316	100 (10.5)	32 (3.1)	**<.001**
Mortality in 30 d (%)	4 (3.2)	0 (0)	**.044**[a]	5 (4.6)	1 (0.9)	.098	173 (18.2)	74 (7.8)	**<.001**
Mortality in 90 d (%)	11 (8.7)	0 (0)	**<.001**[a]	13 (12)	3 (2.7)	**.009**[a]	304 (31.9)	158 (16.6)	**<.001**

Bold indicates statistical significance ($P < .05$).
TKA, total knee arthroplasty; THA, total hip arthroplasty; HA, hemiarthroplasty; HD, hemodialysis; Non-HD, nonhemodialysis
[a] *Chi*-squared statistic is significant at the 0.05 level.

Table 3
Postoperative Mortality and Transfusion Rates in Terms of Dialysis Timing.

Covariate	TKA			THA			HA		
	Chronic Dialysis (n = 126)	First-Time Dialysis (n = 4)	*P*	Chronic Dialysis (n = 108)	First-Time Dialysis (n = 3)	*P*	Chronic Dialysis (n = 953)	First-Time Dialysis (n = 93)	*P* Total (n = 1,287)
Mortality in 10 d (%)	2 (1.6)	0 (0)	.800	1 (0.9)	0 (0)	.867	100 (10.5)	15 (16)	.097
Mortality in 30 d (%)	4 (3.2)	0 (0)	.717	5 (4.6)	(0)	.703	173 (18.2)	25 (26.8)	**.040**
Mortality in 90 d (%)	11 (8.7)	0 (0)	.537	13 (12)	1 (33.3)	.273	304 (31.9)	53 (57)	**<.001**
Blood transfusion (%)[a]	107 (85)	4 (100)	.401	93 (86)	3 (100)	.488	867 (91)	88 (94)	.233

Bold indicates statistical significance ($P < .05$).
TKA, total knee arthroplasty; THA, total hip arthroplasty; HA, hemiarthroplasty.
[a] Blood transfusion in first 10 postoperative days.

there was a higher occurrence of in-hospital mortality among the patients who depended on dialysis. In that study, among patients on dialysis who underwent TKA and THA, it was found that the in-hospital mortality rate was notably higher in the HD group for both TKA (0.9 versus 0.1%) and THA (1.9 versus 0.1%) [21]. Patterson et al. reported that among approximately 300 dialysis patients who underwent THA, there was a higher incidence of 30-day mortality, adverse events, and intensive care unit admissions compared to the non-HD group [11]. Upon examining our data, we also observed a higher incidence of in-hospital mortality among patients undergoing elective TJA, a consistent finding in line with the literature to date.

The combination of advanced age, multiple comorbidities, and trauma-related surgery (HA) in this group of patients contributes to even higher complication and mortality rates in our cohort. A study by Lee et al. reported the mortality outcomes of patients undergoing HA and showed that the 30-day mortality rate was twice as high in the group receiving dialysis (7.3%) compared to the group not receiving dialysis (3.6%) [29]. Hickson et al. conducted a study involving dialysis patients who have hip fractures and revealed higher mortality rates in this group (14.3 versus 5.7%). It is worth noting that the cohort of that study included cases involving both arthroplasty and internal fixation procedures [30]. It was also reported that the 30-day mortality rates among dialysis patients who have hip fractures varied between 16 and 20% [31]. Nevertheless, in our cohort, the 30-day mortality rate was observed to be about 19% among patients who underwent HA while receiving dialysis.

The majority of patients in this study were receiving chronic HD. These patients regularly undergo HD multiple times per week. However, in certain cases, HD may be required under acute conditions, such as in cases of the development of acute kidney injury following trauma or the exacerbation of pre-existing renal conditions as a result of trauma. It is also revealed that a significant proportion of nonpregnant adults who have chronic kidney disease grade 3 or 4, categorized by 5-year estimated risks for kidney failure, remain unaware of their condition [32]. Rantalaiho et al. observed acute kidney injury in 8.5% of patients following low-energy hip fractures and reported a 90-day mortality rate of 35% in that group. However, they did not specifically address the requirements for HD [33]. In our cohort of patients who underwent HA and received HD, we noted that 8% of patients received their first HD treatment within 4 days before the surgery. In this particular group, the 90-day mortality rate was significantly higher compared to that of chronic HD patients (57 versus 31.9%, respectively; $P < .001$). In our cohort, another noteworthy concern arises: nearly half of the acute HD patients (47%) persist in receiving HD beyond the postoperative period. Despite the elevated mortality rates observed in both groups, those who receive postoperative HD and those who do not, no significant difference has been identified in terms of 90-day mortality between these 2 cohorts (52 versus 61%, respectively; $P = .384$). To our knowledge, this is the first study investigating the effects of acute preoperative HD and chronic HD on mortality in patients undergoing HA. Based on these findings, it is anticipated that mortality rates will be significantly elevated in patients experiencing the onset of acute dialysis requirements. Consequently, meticulous monitoring and treatment strategies should be promptly devised and implemented.

Mortality rates in various postoperative periods among HD arthroplasty patients have been previously presented [12,17,19–21,34]. However, as far as we know, no study has reported both 10-day and 30- to 90-day mortality rates. In our cohort, we observed a significant increase in mortality between postoperative days 10 and 90 in all 3 surgical groups (TKA, THA, and HA), with respective increases of approximately 5-, 12-, and 3-fold. Considering that the majority of deaths within the first 10 days occur as in-hospital mortality, it is important to highlight that these patients have significantly higher mortality rates in the early postdischarge period. It is crucial to monitor these patients closely, even after discharge, and provide them with detailed information regarding potential complications. They require closer attention compared to the general population due to their elevated risk of mortality.

Examining studies with large numbers of patients, short-term mortality rates (including follow-up periods of up to 90 days) have been reported to range between 0.02 and 14% [11,20,21,29,30,34–39] (Table 6). However, these studies are commonly derived from insurance company data; thus, they do not encompass all segments of society or all health care facilities. Ibarra Melogno et al. conducted a nationwide study in Uruguay involving

Table 4
Comparison of 90-Day Postoperative Mortality Rates in Acute Dialysis Patients.

	HA			THA			TKA		
	Postop HD Requirement + (n = 44)	Postop HD Requirement − (n = 49)	*P*	Postop HD Requirement + (n = 1)	Postop HD Requirement − (n = 2)	*P*	Postop HD Requirement + (n = 1)	Postop HD Requirement − (n = 3)	*P*
Mortality in 90 d, n (%)	23 (52.2)	30 (61.2)	.384	0 (0)	1 (50)	.4	0 (0)	0 (0)	NA

Chi-squared statistic is significant at the 0.05 level.
TKA, total knee arthroplasty; THA, total hip arthroplasty; HA, hemiarthroplasty; HD, hemodialysis.

Table 5
Cox Proportional Hazard Regression for Defining Predictors of 90-Day Mortality in Patients Who Underwent Joint Arthroplasty.

Variable	Hazard Ratio	95% Confidence Interval		*P*
		Lower	Upper	
Type of surgery				
TKA	1 (Reference)			
THA	1.80	0.83	3.91	.133
HA	4.80	2.62	8.77	**<.001**
Sex				
Women	1 (Reference)			
Men	1.20	1.02	1.41	**.036**
Age				
<45	1 (Reference)			
45-64	1.75	0.64	4.80	.278
65-74	1.78	0.65	4.90	.260
74-85	2.52	0.92	6.93	.072
>85	3.98	1.43	11.05	**.008**
Blood transfusion	0.94	0.72	1.24	.681
CCI				
0-8	1 (Reference)			
>8	1.40	1.15	1.70	**<.001**
Dialysis	2.31	1.90	2.80	**<.001**

Significance was set in bold ($P < .05$).
TKA, total knee arthroplasty; THA, total hip arthroplasty; HA, hemiarthroplasty; CCI, Charlson comorbidity index.

141 dialysis patients who underwent hip arthroplasty and reported a 30-day mortality rate of 2.4% for elective arthroplasty cases, while it was 7.1% among fracture patients. Moreover, the 6-month mortality rate was 7.1% for elective cases and 18.2% for fracture cases [35]. In our study, the mortality rates were found to be higher than those previously reported in the literature, but the combination of data on both in-home and in-hospital deaths via a shared reporting system enhanced the reliability and accuracy of the overall results.

Although this national database study has presented one of the largest series of patients on HD undergoing TKA, TKA, or HA together with a matched control group, it has several potential limitations. The usage of an existing database confined our research to the variables accessible in the formats supplied. Complications that arise during surgery can be influenced not only by the patient's condition but also by variations across different hospitals and their physical or structural conditions. The experience levels of surgeons and differences in institutional protocols may result in heterogeneity. However, this may be accepted as a strength of the study in terms of representing the preferences of Turkish orthopedic surgeons regarding the management of HD patients. Comorbidities, complications, and interventions were reviewed based on codes in the electronic system. Due to the large number of patients, the errors that may occur while entering such codes could be diluted. Furthermore, while conducting mortality analysis, the exact cause of mortality may not have been known. Since patients underwent surgery at different centers, indications for initiating HD, especially in acute dialysis cases, and the continuation of this therapy in the postoperative period may vary. Due to the availability of our 90-day follow-up data, we are not certain whether patients who did not continue postoperative dialysis will require dialysis in the later stages. Additionally, we performed a comprehensive analysis, but this approach may nevertheless be insufficient for assessing deep periprosthetic joint infection and prosthesis issues due to the short follow-up of the patients. For future research, it is advisable to compare a control group of patients undergoing HD who do not have arthroplasty with those undergoing arthroplasty while on HD.

Conclusions

This study has demonstrated that the rates of mortality and complications are significantly higher in patients receiving HD compared to non-HD patients among individuals undergoing joint arthroplasty. The mortality rates are even higher among patients who have received their first dialysis treatment just before surgery. These patients should

Table 6
Fundamental Characteristics of the Reviewed Studies.

Study	Source of Data	Number of Patients on Dialysis	Etiology	Type of Surgery	Assessment	Mortality Rates (%)
Lee et al. [29]	ACP-NSQIP	233	Fracture	HA	30-d mortality	7.3
Hickson et al. [30]	ACP-NSQIP	377	Fracture	HA, THA, IF	In-hospital, 30 d	7.7, 14.3
Ponnusamy et al. [21]	NIS	1,251/1,683	Elective	THA, TKA	In-hospital	1.88, 0.92
Browne et al. [36]	Medicare	572/531	Elective	THA, TKA	In-hospital mortality within 1 y	6.47, 5.27
Patterson et al. [11]	ACP-NSQIP	306/339	Elective	THA, TKA	30-d mortality	2.3, 0.9
Venishetty et al. [37]	NIS	418	Elective	TKA	In-hospital	0.2
Ottesen et al. [20]	ACP-NSQIP	250	Elective	TKA	30-d mortality	1.2
Ibarra Melogno et al. [35]	National Registry of Uruguay	141	Elective and fracture	THA	30-d, 180-d mortality	5.7, 14.9
Erkocak et al. [38]	Rothman Institute	50	Elective	THA	In-hospital	8
Cavanaugh et al. [34]	NIS	1747	Elective	THA, TKA	In-hospital	3.9, 2.6
Hoggard et al. [39]	NIS	1137	Elective	THA	In-hospital mortality within 1 y	4.1

TKA, total knee arthroplasty; THA, total hip arthroplasty; HA, hemiarthroplasty; IF, internal fixation; ACP-NSQIP, American College of Surgeons National Surgical Quality Improvement Program; NIS, National (Nationwide) Inpatient Sample.

be operated on in comprehensive health care facilities and closely monitored during the postoperative period. Furthermore, the risks and benefits must be properly balanced before proceeding with surgery and should also be discussed with the patient. To provide the best perioperative care and minimize complications, orthopedic surgeons, nephrologists, and anesthesiologists must work together. Furthermore, particularly in elective cases, ideal timing or surgery is paramount. Meticulous team effort is required to optimize modifiable factors such as anemia, vitamin levels, hemoglobin A1c levels, and other relevant parameters.

CRediT authorship contribution statement

Murat Birinci: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation. **Ömer S. Hakyemez:** Writing – review & editing, Writing – original draft, Methodology, Data curation. **Oğuzhan Korkmaz:** Writing – review & editing, Formal analysis. **İzzet Bingöl:** Supervision, Methodology, Data curation. **Naim Ata:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Mahir M. Ülgü:** Writing – original draft, Formal analysis. **Şuayip Birinci:** Writing – review & editing, Data curation. **Mustafa O. Ayvalı:** Data curation. **Kerem Başarır:** Writing – review & editing, Writing – original draft, Methodology. **İbrahim Azboy:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Data curation.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the author(s) used ChatGPT in order to edit the language. After using this tool or service, the author(s) reviewed and edited the content as needed and took full responsibility for the content of the publication.

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