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Research Article

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Comparison of clinical characteristics and outcomes of acute kidney injury in the elderly and younger hospitalized patients

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Abstract. *Data regarding the epidemiology, causes, and outcomes of acute kidney injury (AKI) are limited, especially in the elderly population. We aimed to investigate the clinical characteristics and early outcomes of AKI and to compare them between elderly and young patients hospitalized in an internal medicine clinic.*

Methods. This single-center retrospective study included patients with AKI who were hospitalized in a tertiary hospital. AKI was identified according to the Kidney Disease Improving Global Outcomes criteria. Sociodemographic, clinical, and laboratory data were recorded. Renal recovery, need for dialysis, and in-hospital mortality were compared between the elderly (>60 years) and younger (≤60 years) patients.

Results. A total of 454 patients (327 elderly and 127 younger) were included in the study. The frequency of AKI in hospitalized patients was 12%. The most common cause of AKI was prerenal (61%). Prerenal AKI due to absolute intravascular volume reduction was the most important cause in both groups. Compared with the elderly patients, younger patients exhibited an increased rate of renal AKI (23% vs. 39%, p=0.001) and an increased need for dialysis during hospitalization (21% vs. 31.5% p=0.027). The incidence of vasculitis and glomerulonephritis was higher in younger patients with renal AKI than in the elderly patients (12% vs. 1.3% for vasculitis and 24% vs. 4% for glomerulonephritis p=0.001). Twenty-four percent of patients required dialysis during hospital stay and 10% required dialysis at discharge. The overall in-hospital mortality was 6,4%. Considering the AKI pathophysiology, the highest mortality rate was observed in AKI patients with renal origin (3.5%). There were no significant differences between elderly and younger patients based on renal recovery (complete recovery, 41% vs. 50%; progression 59% vs. 50%, p=0,073), hospital mortality (5.5% vs. 6.7%, p=0.634), and the need for dialysis at discharge (14% vs. 8.8%, p=0.082).

Conclusions. In our study, we concluded that there was no significant difference between elderly and younger hospitalized patients according to the early outcomes of AKI. However, the younger patients had a higher rate of renal AKI with a more severe course.

Keywords: *acute kidney injury, dialysis, elderly, in-hospital mortality, renal recovery.*

Conflict of interest. The authors declare no conflict of interest.

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Порівняння клінічних характеристик та наслідків гострого пошкодження нирок у пацієнтів похилого та молодого віку

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Резюме. *Дані щодо епідеміології, причин та наслідків гострого пошкодження нирок (ГПН) обмежені, особливо у людей похилого віку. Метою цієї роботи було дослідити клінічні характеристики та ранні результати лікування ГПН і порівняти їх між літніми та молодшими пацієнтами, госпіталізованими в клініку внутрішньої медицини.*

Методи. Це одноцентрове ретроспективне дослідження включало пацієнтів з ГПН, які були госпіталізовані до лікарні третього рівня. ГПН ідентифікували відповідно до критеріїв KDIGO. Аналізували соціально-демографічні, клінічні та лабораторні дані. Відновлення функції нирок, потребу в діалізі та госпітальну смертність порівнювали між літніми (>60 років) і молодшими (≤60 років) пацієнтами.

Результати. До дослідження включено 454 пацієнти (327 літніх і 127 молодших). Частота ГПН у госпіталізованих пацієнтів становила 12%. Найпоширенішою причиною ГПН була преренальна (61%). Найважливішою причиною в обох групах було преренальне ГПН через абсолютне зменшення внутрішньосудинного об'єму. Порівняно з пацієнтами похилого віку, молодші пацієнти продемонстрували підвищену частоту ГПН (23% проти 39%, p=0,001) і підвищену потребу в діалізі під час госпіталізації (21% проти 31,5% p=0,027). Захворюваність васкулітом і гломерулонефритом з формуванням ГПН була вищою у молодших пацієнтів, ніж у пацієнтів літнього віку (12% проти 1,3% для васкуліту та 24% проти 4% для гломерулонефриту p=0,001). Двадцять чотири відсотки пацієнтів потребували діалізу під час перебування в лікарні та 10% потребували діалізу при виписці. Загальна госпітальна смертність склала 6,4%. З огляду на патофізіологію ГПН найвищий рівень смертності спостерігався у хворих на ГПН ниркового походження (3,5%). Частота відновлення функції нирок не мала суттєвих відмінностей між літніми та молодшими пацієнтами (повне відновлення, 41% проти 50%; прогресування 59% проти 50%, p=0,073), госпітальна смертність (5,5% проти 6,7%, p=0,634), також потреба в діалізі на момент виписки (14% проти 8,8%, p=0,082).

Висновки. У нашому дослідженні ми дійшли висновку, що не було суттєвої різниці між літніми та молодшими госпіталізованими пацієнтами відповідно до ранніх результатів ГПН. Однак у молодших пацієнтів частота ГПН нирок була вищою з більш важким перебігом.

Ключові слова: *гостре пошкодження нирок, діаліз, люди похилого віку, госпітальна смертність, відновлення функції нирок.*

Introduction: Acute kidney injury (AKI) is associated with various etiologies and pathophysiological processes, leading to a sudden decrease in kidney function with retention of urea and other nitrogenous waste products and impaired extracellular volume and electrolyte homeostasis.

AKI is a common clinical syndrome prevalent in 7.2% to 34% of hospitalized patients [1-5]. AKI is associated with significant risks of short- and long-term adverse health outcomes, including increased demand for renal replacement therapy, hospital readmission, progression to chronic kidney disease (CKD), and death [3, 4]. In a large multicenter randomized controlled trial (the SALTO study) was shown that severe AKI in critically ill patients was associated with a high proportion of death within the first 2 months. Moreover, a quarter of long-term survivors after AKI experienced worsening renal function and suffered from a distinguishable impairment of quality of life [6]. CKD, which is one of the important complications of AKI, is found to develop in a respectable number of patients (9.4% after 1-year follow-up and 18.3% after 4-year follow-up) even after a fully recovered non-severe AKI [7]. AKI has been shown to worsen cardiovascular outcomes in those with existing heart disease, and AKI has also been observed to increase the risk of acute cardiovascular events in the medium to long term in patients without pre-existing heart disease [8, 9]. The incidence of cardiovascular events was higher in AKI survivors who progressed to CKD after AKI [7]. It is assumed that advances in supportive care of patients at risk of AKI or patients who developed AKI, such as education, medical treatment, and renal replacement, would significantly improve health outcomes, even in elderly patients who have developed AKI. In the literature, there is limited data regarding the epidemiology, causes, and

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outcomes of AKI, especially in the Turkish elderly population. Given the ever-growing rate of elderly in our country and worldwide and the higher incidence of AKI in this age group it is important to determine the age-specific distribution of early outcomes after AKI and to identify the regional feature of AKI. However, studying AKI in the elderly population would be helpful to recognize opportunities for improvement that would positively impact outcomes.

In this study, we aimed to evaluate the clinical profile and early outcomes of patients with AKI hospitalized in an internal medicine clinic at a tertiary hospital and compare the results between elderly and younger patients.

Material and Methods. This was a retrospective, single-center observational study that included patients diagnosed with AKI who were hospitalized in a tertiary hospital in Istanbul from January to December 2019. This study was conducted following the World Medical Association Declaration of Helsinki. The study was approved by the Ethics Committee of HSU Prof. Dr. Cemil Tascioglu City Hospital (previously known as Okmeydani Training and Research Hospital) under a broad regulatory protocol allowing for the analysis of patient-level data (Approval No:1035/2019).

Patients. All patients aged ≥18 years who were admitted to the Internal Medicine Clinic of our tertiary hospital in Istanbul between January 1 and December 31, 2019, and coded with ICD-10 N17 and N19 were screened. Patients who had all available laboratory data needed for a diagnosis of AKI and fulfilled the Kidney Disease: Improving Global Outcomes (KDIGO) criteria for a diagnosis of AKI were included in the study. Patients on chronic renal replacement therapy (RRT), stage 4 and 5 CKD or kidney transplantation, pregnant and breastfeeding women, and those who did not have relevant laboratory (the absence of at least two creatinine tests during hospitalization) and clinical data were excluded from the study. For patients who had multiple hospitalizations, only the first admission was analyzed. Informed consent was obtained from each patient enrolled in the study.

Data collection. Researchers collected the patients' demographic, clinical, and laboratory data from medical charts and patients' electronic records ('e-biz'). 'E-nabız' is a computerized collection of Turkish patients' health records from all national health institutions. The patients' creatinine values at least 3 months before admission to the hospital, on admission, and during hospitalization were documented to confirm the diagnosis and stage of AKI. AKI was identified according to KDIGO criteria [10]. AKI was diagnosed when serum creatinine level increased ≥ 0.3 mg/dL (≥26.5 Â µmol/L) within 48 hours or ≥1.5 fold increase in the previous seven days or a decreased urine volume of <0.5 mL/kg/hour for six hours. The data from previous diagnoses, co-morbidities, and laboratory tests were also reviewed through the 'e-nabiz' system to verify data accuracy and reliability. A nephrologist was consulted in case of ambivalence about the etiological classification or the distinction between AKI and CKD.

Once AKI was diagnosed, we categorized the severity of AKI into stages 1-3 according to the KDIGO recommendation, using the peak creatinine level after AKI onset [10].

Patients were stratified into two groups according to age: ≤60 or >60 years. We used the age cutoff for "elderly" to be 60 years in this study based on socio-cultural references since the retirement age is 58-60 in our country and studies evaluating the elderly population as over 60 years old [11].

Elderly and younger patients were divided into the following subgroups according to the underlying etiology of AKI: prerenal (caused by decreased renal perfusion), renal (renal parenchymal injury), postrenal (excretory system obstruction), and indeterminate (caused by undiagnosed etiology). We examined the main causes of prerenal AKI and classified them as absolute intravascular volume reduction (hemorrhage and volume depletion due to different causes), decrease in cardiac output (heart failure [HF]), systemic vasodilatation and hypoperfusion (cirrhosis, sepsis), and drugs that disrupt autoregulation and glomerular filtration. Renal causes were classified as vasculitis, glomerulonephritis, acute tubular necrosis (ATN), and tubulointerstitial disease (TID). ANT and TID were gathered under the common name 'ATN+TID.'

We collected data on renal outcomes, such as the need for temporary and permanent renal replacement treatment (hemodialysis or hemodiafiltration), recovery pattern of kidney function, and in-hospital mortality comparatively between the elderly and younger groups. Patients who died during hospitalization were excluded from the analysis of the renal outcomes (dialysis at discharge and recovery).

Creatinine values at discharge were obtained to determine the recovery pattern of kidney function.

i) Complete recovery, defined as a return to normal levels of creatinine or baseline creatinine levels in patients with current CKD

ii) Progression, defined as an increase in creatinine levels above baseline (progression to CKD in cases of AKI with no pre-existing CKD or progression of CKD stage in cases of current CKD).

Statistical analysis. Descriptive statistical methods were used to describe the main characteristics of the study population. We used the Student's t-test to compare continuous variables and the chi-square test to compare categorical variables. Continuous values are presented as mean and standard deviation (M± SD). Statistical significance was set at $p < 0.05$. Data were analyzed using SPSS for Windows version 20.0.

Results. A total of 3741 patients (n=1541 for (≤60 years and n=2200 aged > 60 years) were admitted to the Internal Medicine Clinic during the study period. Among them, 504 were diagnosed with AKI. Fifty patients were excluded from the analysis due to the short length of hospital stay (n=25), lack of available data

on serum creatinine on the 3rd day (n=3), misdiagnosis of AKI (progression of CKD misclassified as AKI) (n=21), or a history of prior kidney transplant (n=1) (Fig. 1).

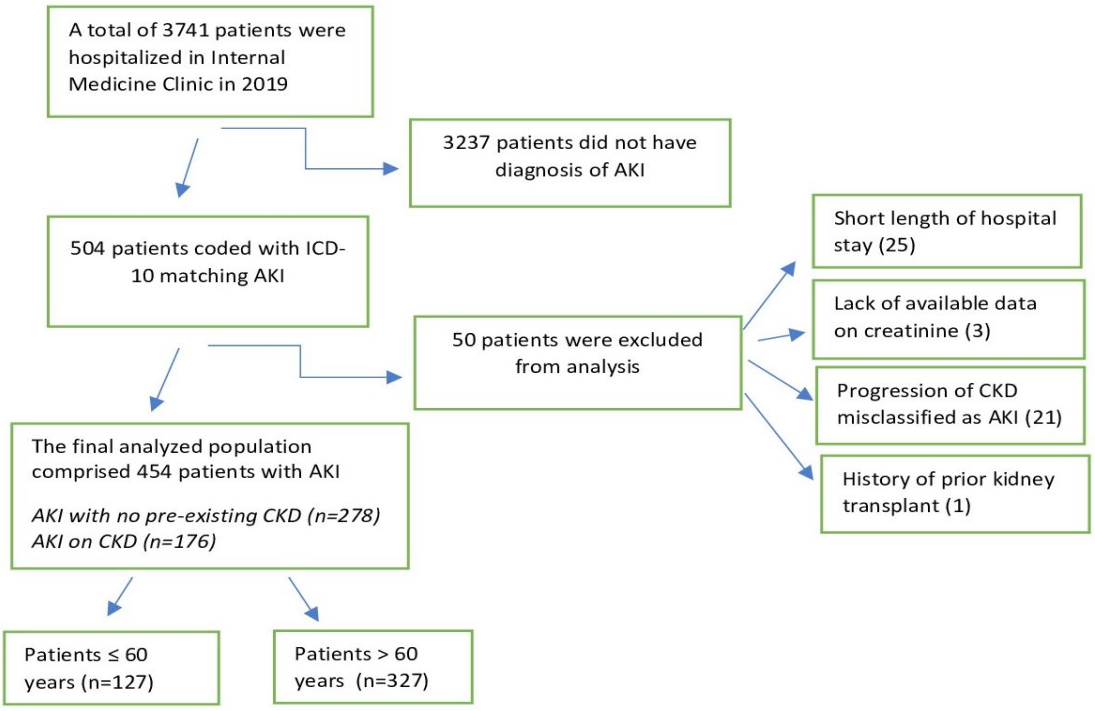

Fig. 1. Flowchart diagram of screening for patients' eligibility.

The demographic characteristics of the included patients are summarized in Table 1.

Table 1

Demographic and clinical characteristics of patients with AKI

Variables	All patients (n=454)	Patients aged ≤60 years (n=127)	Patients aged >60 years (n=327)	P-value
Age (M±SD), years	68.5±15.3	47.9±10.9	76.5±7.1	<0.001
Gender Male, n (%)	258 (57)	79 (62)	179 (55)	0.170
Education status Illiterate Primary school High school University	134 (29,7) 250 (55) 64 (14) 6 (1.3)	10 (8) 60 (47) 51 (40) 6 (5)	124 (38) 190 (58) 13 (4) 0	<0.001
DM †, n (%)	167 (37)	47 (37)	120 (37)	0.951
HT ‡, n (%)	322 (71)	58 (45)	264 (81)	<0.001
Malignancy, n (%)	87 (19)	22 (17)	65 (20)	0.156
HBV §, n (%)	9 (2)	4 (3.1)	6 (1.8)	0.447
HCV, n (%)	8 (1.7)	0 (0)	8 (8)	0.113
Basal urea, (M±SD), mg/dL	47.42±26.04	46.62±28.44	47.7±25.08	0.686
Basal creatinine, (M±SD), mg/dL	1.28±1.0	1.32±0.854	1.27±0.67	0.530
The highest urea, (M±SD), mg/dL	144.9±135.0	148.15±65.23	143.68±55.30	0.735
The highest creatinine, (M±SD), mg/dL	4.19±3.3	5.06±3.12	3.85±2.51	<0.001

Abbreviations: † DM, Diabetes mellitus; ‡ HT, Hypertension; § HBV, Hepatitis B infection; ¶ HCV, Hepatitis C infection.

The rate of AKI and characteristics of the study participants. The frequency of AKI in hospitalized patients was 12%, 8.2% in young patients, and 14.8% in elderly patients, respectively. The rate of AKI was nearly 2.5 times higher in elderly patients than in younger patients. The proportion of patients with impaired kidney function prior to the present hospitalization was similar in both age groups (younger vs. elderly, 66% vs.59 %, p=0,199). The rate of hypertension (HT) was significantly higher in the elderly (younger vs. elderly, 45% vs. 81%, p<0.001), but there was no difference in rates of diabetes mellitus (DM) and other comorbidities between the age groups. The mean serum creatinine and urea levels at hospital admission were similar between the groups (see Table 1). The proportion of patients with stage 3 AKI was higher in younger patients.

Causes of AKI and their distribution between the age groups. Although the most prevalent type of AKI in patients admitted to the internal medicine clinic was prerenal AKI, there were some differences in the distribution of the causes of AKI between the age groups. Prerenal AKI due to absolute intravascular volume reduction was the most important cause in both groups. Low cardiac output was the second most common prerenal cause and was observed at a higher rate in elderly patients than in younger patients; however, the difference was not significant. AKI due to renal causes is more common in younger patients than in elderly patients because of the higher incidence of vasculitis and glomerulonephritis (GN) (Table 2). Kidney biopsies were performed in 21 patients (19 young and two elderly).

Table 2

The causes of AKI in the study groups

Variables	All patients (n=454)	Patients aged ≤60 years (n=127;8.2%)	Patients aged >60 years (n=327;14.8%)	P- value
AKI †, n (%) AKI with no pre-existing CKD ‡ AKI on CKD	 278 (61) 176 (39)	 84 (66) 43 (34)	 194 (59) 133 (41)	**0.199**
Causes of AKI, n (%) Prerenal Renal Postrenal Undeterminate	 275 (61) 124 (27) 48 (10,5) 7 (1.5)	 59 (46.5) 50 (39) 15 (12) 3 (2.5)	 216 (66) 74 (23) 33 (10) 4 (1)	**0.001**
Prerenal causes, n (%) Absolute intravascular volume reduction Decrease in cardiac output Sistemic vasodilatation Autoregulation, glomerular filtration disruption, drugs	275 162 (59) 81 (29) 28 (10) 4 (2)	59 36 (62) 14 (23) 9 (15) 0 (0)	216 126 (58) 67 (31) 19 (9) 4 (2)	**0.271**
Renal causes, n (%) Vasculitis Primary GN § ATN ¶ + TID ¶ ¶	124 7 (6) 15 (12) 102 (82)	50 6 (12) 12 (24) 32 (64)	74 1 (1.3) 3 (4) 70 (94.7)	**0.001**
KDIGO* stages of AKI Stage 1 Stage 2 Stage 3	 172 (38%) 82 (18%) 200 (44%)	 29 (22%) 23 (18%) 75 (60%)	 143 (44%) 59 (18%) 125 (38%)	**<0.001**

*Abbreviations: †AKI, Acute Kidney Disease; ‡CKD, Chronic Kidney Disease; §GN, Glomerulonephritis; ATN, Acute Tubular Necrosis; T D, Tubulointestinal Disease; *KD GO, Kidney Disease Improving Global Outcomes.*

Outcomes. The overall in-hospital mortality was 6,4% (29 deaths). Renal recovery rate, need for dialysis at discharge, and in-hospital mortality were not significantly different between the age groups. There was also no difference in mortality rates between the age groups, regardless of pre-existing renal dysfunction (Table 3).

Table 3

The outcomes of the patients with AKI

Variable	Overall (n=454)	≤60 years (n=127)	>60 (n=327)	P-value
Dialysis at hospital stay n (%)	109 (24%)	40 (31.5%)	69 (21%)	0.027
Dialysis at discharge n (%)	46 (10%)	18 (14%)	28 (8.8%)	0.082
In-hospital mortality (n,%)	29 (6.4%)	7 (5.5%)	22 (6.7%)	0.634
In-hospital mortality in pure AKI† (n,%)	20 (7.7%)	4 (3%)	16 (4.8%)	0.302
In-hospital mortality in AKI†on CKD‡ (n,%)	9 (2)	3 (2.3)	6 (1.8)	0.690
Mortality according to AKI† causes **Prerenal** **Renal** **Postrenal**	29 (6.4%) 13 (2.8) 16 (3.5) 0	7 (5.5) 0 7 (5.5) 0	22 (6.7) 13 (4) 9 (2.7) 0	 0.002
Recovery (all surviving patients) **1. Complete recovery** **2. Progression**	425 203 (48%) 222(52%)	120 49 (41%) 71 (59%)	305 154 (50%) 151 (50%)	 0.073
Recovery in pure AKI† **1. Complete recovery** **2. Progression**	258 * 199 (77%) 59 (23%)	80 49 (61%) 31 (39%)	178 150 (84%) 28 (16%)	 <0.001
Recovery in AKI† on CKD‡ **1. Complete recovery** **2. Progression**	167* 4 (2%) 163 (98%)	40 0 40 (100%)	127 4 (3%) 123 (97%)	 0.256

Abbreviations: †AKI, Acute Kidney Disease; ‡CKD, Chronic Kidney Disease; * Recovery rates were calculated after excluding patients who died.

Considering the AKI pathophysiology, the highest mortality rate was observed in AKI patients with renal origin (see Table 3). No younger patients with prerenal AKI have died during hospitalization whereas in-hospital mortality in the elderly group occurred mainly in patients with prerenal AKI. Although the frequency of dialysis during the hospital stay due to AKI was significantly higher in young patients, there was no difference in the need for dialysis at discharge. Complete renal recovery was observed in 50 % of the elderly patients and 41 % of the young patients. In addition, almost all patients with CKD in various stages improved after AKI, with progression of the CKD stage. However, in the absence of pre-existing renal dysfunction, the rate of complete recovery was significantly higher in the elderly (see Table 3).

Discussion. In this study, we aimed to determine the demographic characteristics and clinical outcomes of patients with AKI hospitalized in the internal medicine department of a tertiary hospital and to compare these results between elderly and younger patients. We observed that the etiology and severity of AKI were different between younger and elderly hospitalized patients; however, there was no difference in AKI outcomes, except for the frequency of dialysis during their hospital stay.

The frequency of AKI among hospitalized patients varies from 11-34% [**3, 5, 10**]. In a meta-analysis that included 154 studies and >3.5 million patients, mostly from intensive care units, the incidence of AKI according to the KDIGO definition was detected as 22% [**5**]. In our study, the frequency of AKI was observed to be 12.1 %, which is similar to current literature data.

Data on the clinical/etiological characteristics of AKI are inconsistent and should be interpreted with caution. The heterogeneity among study findings probably originates from differences in patients' site of admissions (clinic, intensive care unit, etc.) and study designs. For example, some studies have classified AKI according to its underlying disease, while others have classified AKI according to its pathophysiology [**3, 5, 7, 12-14**]. Furthermore, since the prerenal and renal causes of AKI could be observed simultaneously in one patient, the etiology of AKI has not always been clearly differentiated from each other. Consequently, while in some studies, renal causes were found to be responsible for most AKI types in hospitalized patients, especially in patients admitted to the intensive care unit or after cardiac surgery, prerenal causes were identified as the most common type of AKI in other studies [**12-15**].

We found that prerenal etiologies were the most important causes of AKI in all our patients, particularly in elderly patients. In a study by Nash et al. including hospitalized patients aged 20-80 years, the most common cause of renal failure was prerenal failure due to decreased renal perfusion, which is similar to our results [14]. However, the etiologies of AKI were not evaluated separately according to the age groups of the patients in this study. Studies investigating the causes of AKI in the elderly have shown that prerenal AKI is the most common cause in this age group [13, 14]. Susceptibility to prerenal AKI in the elderly has been explained by typical age-associated structural and functional changes in the kidneys [16]. Intravascular volume depletion (especially due to dehydration caused by different conditions) and a decrease in cardiac output were the major causes of prerenal AKI in elderly patients in our study. These results highlight the importance of precise volume management, especially in elderly patients with reduced cardiac function.

The renal causes of AKI were found in 27% of all patients. Renal AKI, including vasculitis and primary GN, was significantly higher in the younger group than in elderly patients. Our younger patients had more severe AKI at advanced KDIGO stages, and the frequency of dialysis during hospitalization was higher than that in elderly patients. Dialysis requirements during hospital stay were found to be similar between age groups in some studies, whereas in other studies, younger patients received dialysis more frequently during their hospital stay [17, 18]. The AKI stage, pre-existing renal dysfunction, and burden of comorbidity have been implicated as determining factors for dialysis [18]. In our study, the creatinine level at hospital admission and the frequency of pre-existing renal dysfunction and comorbidities, except for HT, were similar in each group. Therefore, we concluded that an important factor determining the frequency of dialysis in hospitalized patients was the etiology of AKI, regardless of age.

The postrenal causes (10.5%) were at a lower rate compared with renal and prerenal causes of

AKI but in line with the literature data [19]. Although elderly patients were expected to have an increased rate of postrenal AKI owing to numerous urological problems, there was no age-related difference in the rate of postrenal AKI between the groups. The causes of postrenal renal failure are roughly divided into two subgroups: mass compression due to malignancy, and pure urological obstruction. We believe that the presence of similar malignancy rates in both age groups was associated with a similar rate of postrenal AKI among all age groups. In addition, the evaluated data reflected the internal medicine clinic profile of patients who were not hospitalized for pure urological diseases.

Complete renal recovery after AKI is the primary treatment strategy for this condition. A study including data from nine regional central hospitals across China showed that 40% of study patients had their creatinine levels returned to baseline [3]. Likewise, Abebe et al. showed that 53.2% of the study patients were discharged with a kidney function back to baseline. However, patients with pre-existing CKD were excluded from this study [15]. In our study, the frequency of complete recovery was evaluated separately in patients with normal kidney function and those with pre-existing CKD. We found that the frequency of complete recovery was 48% in all patients. However, when patients were classified according to the presence of underlying renal dysfunction, the rate of complete recovery was 77% in patients with previously normal renal function, whereas this rate decreased to 2% in patients with prior CKD.

In the current literature, there is still debate about whether patient age affects renal outcomes of AKI [14, 20]. While some studies have reported a low frequency of kidney function recovery after AKI in elderly patients, other studies have found no difference in renal recovery status between age groups [20]. In a systematic review and meta-analysis of 17 studies, the frequency of recovery of kidney function to baseline levels was shown to be 31.3% in elderly patients and 26% in younger patients (pooled relative risk, 1.28; 95% confidence interval, 1.06 to 1.55; $p < 0.05$) [20]. Similarly, Lee et al. showed that the recovery rate after AKI was lower in elderly patients than in younger patients [21]. These authors concluded that there was a higher frequency of recovery from AKI in younger people due to fewer comorbidities and better renal function at admission [21]. In our study, we did not observe age-related differences in the overall recovery rates. However, patients with pre-existing renal dysfunction had a higher incidence of renal deterioration in the younger group than in the older group. Since AKI due to renal causes was more common and severe in young patients, we assumed that renal function might show progression in our young patients.

Pre-existing CKD is considered an important risk factor for the development of AKI [7, 22]. Each episode of AKI may lead to the development of de novo CKD or worsening of the underlying CKD [6, 22, 23]. In our study, we demonstrated that all patients with pre-existing CKD, regardless of age, had progressive deterioration of renal function after an episode of AKI. Therefore, we deemed that it is important to prevent AKI in patients with CKD of all ages.

Mortality from AKI has been observed to vary in different studies from 6-60% [1-3, 5, 23-26]. Studies have shown that age is the most important determinant of mortality in AKI [13, 14, 17, 27]. Contrary to the expectation of higher mortality in elderly patients with AKI, we did not find an increase in in-hospital mortality. The fact that most elderly patients had prerenal AKI, less severe AKI, and comorbidity rates almost equal to those of younger patients may be the most reasonable explanation for this discrepancy with the literature. However, similar to our results, some recent studies have emphasized that patient age is not important in determining AKI mortality [11, 14, 28, 29]. Given that the in-hospital mortality rate during AKI in elderly

patients was most likely similar to that in younger patients, it might also be argued that there may be an improvement in the current medical interventions for AKI in elderly patients.

Limitations. The study was conducted at a single medical center; therefore, the results cannot be generalized. Owing to the retrospective nature of the study, urine volume records were not available for all patients, which may have caused an underestimation of AKI in patients. Since patients were selected through administrative coding, mismatching in diagnosis might also cause an underestimation of AKI. Because of the lack of long-term follow-up, there might have also been a dialysis dependence misclassification at discharge since the need for dialysis could ended during the long-term follow-up.

Conclusions. In conclusion, AKI remains an important issue in hospitalized patients of all age groups. Our study adds to the current body of evidence that despite the heterogeneity of AKI and the variability of its causes, there were similar outcomes between elderly and younger populations in terms of early outcomes. However, it is assumed that there was an improvement in the renal outcomes and mortality rates associated with AKI in elderly patients. We deemed that the most important determinant of AKI-related renal outcomes, regardless of the patient's age, is the etiology of AKI and the burden of patients' comorbidities. Thus a critical issue in reducing further progression of kidney damage in hospitalized patients with ongoing AKI is to recognize the underlying diseases in AKI. Moreover, the preventive and therapeutic interventions to facilitate recovery in the event of AKI should carried out without age-based discrimination.

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Data availability statement. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

The authors' contribution.

Aylia Yesilova: project development, manuscript writing, data collection; Ilkim Deniz Toprak and Yusuf Emre Uzun: data collection;

Hakan Yavuzer: project development and manuscript editing;

Mahir Cengiz: statistical analysis and data interpretation;

Gulay Koçak: manuscript editing and data analysis.

All authors have contributed significantly and agree with the content of the manuscript.

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