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Incidence of Acute Kidney Injury During Epidemic Diarrheal Illness in Sulaimani city

Rozhan Jamal Hamaali* Dana Ahmed Shareef**

Abstract

Background and objectives: Diarrheal disorders represent a considerable worldwide health concern, sometimes necessitating hospitalization due to consequences such as dehydration and disturbances in electrolyte levels. The objective of this analysis is to ascertain the incidence of acute kidney injury among individuals with diarrheal illnesses at two healthcare facilities in Suleimani, Iraq.

Methods: a retrospective study on patients who had been admitted due to acute diarrhea in Shahid Doctor Hemin Teaching and Shar Hospitals in the city center of Suleimani governorate, covering the period of May until July 2022. Data was collected on demographics, symptoms of dehydration,vital signs, and laboratory values such as blood urea, serum creatinine, sodium, potassium, and chloride. General stool examinations were also performed for the patients.

Results: In this study, the records of 625 patients were examined. The results showed that 55% of male participants and 45% of female participants experienced acute kidney injury during their illness ($P<0.05$). The study found a higher incidence of acute kidney injury among individuals who consumed tap water (66.3%) compared to those who drank well water (21.1%) or bottled water (12.7%) ($p<0.05$). The research also revealed that people diagnosed with hypertension and diabetes were more susceptible to acute kidney injury, with prevalence rates of 19.9% and 16.5% respectively ($p<0.05$).

Conclusion: The study revealed a high occurrence of acute kidney injury in people experiencing diarrhea, especially those with specific risk factors. This underscores the importance of raising awareness and implementing preventive measures to address this complication and potentially improve outcomes.

Keywords: Acute kidney injury, Dehydration, Diarrheal illness, Water sanitation

*M.B.Ch.B, Nephrology Board Trainee at KHCMS. Email: rojanjamal20@gmail.com, Corresponding author
**M.B.Ch.B, MRCP, FRCP, professor of nephrology. Email: d_sharif@hotmail.com

Introduction

Diarrhea is a widespread medical condition that often requires hospitalization worldwide.[1,2] It poses a major public health concern, particularly in developing countries where clean water and proper sanitation facilities are limited. Diarrhea affects people worldwide, regardless of region or population. However, a disproportionate amount of diarrhea-related illness and death occurs in low-income countries, where resources and infrastructure to manage these burdens, are limited compared to high-income countries.[3] According to Troeger et al.'s systematic analysis for the global burden of diseases, in 2016 diarrhea ranked as the eighth most common cause of death across all age groups, resulting in 1,655,944 fatalities.[4] Diarrhea is classified into different types based on the duration and nature of symptoms: acute or chronic, and infectious or non-infectious. Acute diarrhea refers to episodes lasting less than two weeks, usually caused by infections, with viral infections being the most common. Typically, the condition resolves on its own. On the other hand, chronic diarrhea lasts longer than two weeks and is often non-infectious. Causes may include malabsorption, inflammatory bowel disease, and side effects from medications.[5] In this study we will only focus on the infectious types of diarrheas. The leading cause of diarrheal illness globally is acute viral gastroenteritis, affecting both men and women equally. Norovirus, the most prevalent viral culprit, is responsible for 90% of epidemic diarrheal cases worldwide and approximately half of all viral gastroenteritis cases. In the United States alone, it leads to 19 to 21 million cases of diarrheal illness each year. Additionally, Norovirus is responsible for half of all foodborne diarrheal outbreaks.[6] Hospitalization may be necessary in cases of severe diarrhea, particularly in infants, young children, elderly individuals, and those with weakened immune systems. The main reasons for hospitalization include dehydration, electrolyte imbalances, and the need for intravenous fluids and medications to control symptoms and prevent complications.[7] Despite the wide-ranging impact and severity of diarrheal disease, there is a notable lack of understanding regarding the frequency and underlying factors contributing to associated acute kidney injury (AKI). Acute kidney injury is a common medical condition that poses significant challenges to medical professionals. It refers to a sudden and rapid loss of kidney function, resulting in accumulated waste products and toxins in the body. It can be caused by a variety of factors, including infections, medications, dehydration, trauma, or underlying medical conditions.[8,9] The consequences of AKI can be severe and life-threatening. Individuals who develop AKI are at a higher risk of mortality; even mild cases of acute kidney injury (AKI) can double the risk of chronic kidney disease (CKD). Acute kidney injury also prolongs hospital stays and can lead to long-term complications, such as chronic kidney disease (CKD).[9,10] chronic kidney disease is a progressive condition that results in the loss of kidney function over time. It can lead to a range of health problems, including anemia, bone disease, and cardiovascular disease. Individuals who have experienced AKI are at a higher risk of developing CKD, particularly if they have pre-existing risk factors, such as diabetes, high blood pressure, or cardiovascular disease.[11,12] Early diagnosis and treatment of AKI are crucial to improving patient outcomes and preventing long-term complications. Medical professionals may use a variety of approaches to manage AKI, depending on the underlying cause and severity of the condition. These may include medications to support kidney function, fluid and electrolyte management, and other supportive measures.[13] The aim of this analysis is to investigate the incidence of

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AKI among individuals with diarrheal illnesses at two healthcare facilities in Suleimani, Iraq.

Patients and methods

The researchers enrolled 625 patients who had been admitted due to acute diarrhea in Shahid Doctor Hemin Teaching and Shar Hospitals in the city center of Suleimani governorate, covering the period of May until July 2022. We performed retrospective study in the abovementioned teaching hospitals using a convenience nonrandom sampling method. Any adult patient (≥18 years) who presented with acute diarrhea was included. The medical records of all patients were reviewed carefully by the researchers, and the needed data and information were extracted. Those data were already agreed on by the researchers and approved by the Kurdistan Higher Council of Medical Specialties via an organized research questionnaire. The information involved clinical history and physical examination of the patients in addition to demographic data, water source, presenting symptoms (type of diarrhea, vomiting, abdominal pain, fever, urine output, muscle cramp, etc.), duration of diarrhea before admission, and past medical history. The vital signs, which were checked for all patients, were recorded too. The degree of dehydration was categorized into three levels (none, some, and severe) based on the World Health Organization (WHO) classification. Severe dehydration criteria included Low pulse volume, cool extremities, tachycardia, significant thirst, reduced skin turgor, marked hypotension and confusion. Some dehydration was identified when a patient showed at least two of the following signs: significant thirst, Oliguria, sunken eyes, dry mucous membranes weakness, light headed, postural hypotension (>20mmHg). On the other hand, no dehydration is determined when there are no signs of severe or some dehydration.[14] Laboratory investigations of the patients were also evaluated and included in the research; these encompassed a complete blood count (CBC) at admission, blood urea, serum creatinine, sodium, potassium, and chloride, both during admission and at the time of discharge. Simultaneously, general stool examinations were also performed for the patients. We relied on KDIGO guidelines for the definition and staging of the severity of AKI. According to KDIGO, the AKI is defined by any of the following: an increase in serum creatinine level greater than or equal to 0.3 mg/dl within 48 hours; an increase in serum creatinine level greater than or equal to 1.5 times baseline over 7 days; or a decrease in urine output of less than 0.5 ml/kg/h for 6 hours.[15] The statistical package for social science (SPSS, version 28) was used to analyze the data, and the Chi-square test of association was used to compare proportions. When the expected frequency (value) was less than 5 of more than 20% of the cells in the table, Fisher's exact test was used. To compare the means of the two samples, a student's t-test of two independent samples was used. A p-value of ≤ 0.05 was considered statistically significant.

Results

We enrolled 626 cases in our study. There was a significant statistical association between AKI and gender; more than half (55%) of male participants had AKI, while less than half (45%) of female participants had AKI. There was a significant statistical association between AKI and water source; most (66.3%) of tap water drinkers had AKI, while 21.1% of well water sources caused AKI, and the least contributed was 12.7% of bottle water drinkers had AKI. There was a statistically significant association between AKI and past medical history; most (71.2%) of cases with no PMH had no AKI, while 19.9% of HTN cases went through AKI, and finally 16.5% of DM cases had AKI. The Chi square test was significant, and the p-value was < 0.05, Table (1).

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Table (1): Association between AKI and gender, water source and past medical history.

Variable	Categories	AKI		p-value
		Normal	AKI	
Sex	Male	76 (36.5%)	230 (55%)	<0.001
	Female	132 (63.5%)	188 (45%)	
Water source	Tap water	164 (78.8%)	277 (66.3%)	0.005
	Well water	29 (13.9%)	88 (21.1%)	
	Bottle	15 (7.2%)	53 (12.7%)	
Past medical history	No PMH	148 (71.2%)	220 (52.6%)	<0.001
	DM	25 (12%)	69 (16.5%)	
	HT	16 (7.7%)	83 (19.9%)	
	IHD-HF	8 (3.8%)	14 (3.3%)	
	Malignancy	0 (0%)	11 (2.6%)	
	Others	11 (5.3%)	21 (5%)	

Table (2) shows that there was a significant statistical association between AKI and frequency of diarrhea; most (71.8%) of more than 10-day diarrhea cases had AKI, while 21.1% of 5- to 10-day diarrhea cases had AKI. There was a significant statistical association between AKI and type of diarrhea; most (78.7%) of watery-type diarrhea caused acute kidney injury, while only 17.2% of bloody-type diarrhea led to AKI. There was a significant statistical association between AKI and vomiting; the majority (91.9%) of vomiting categories had AKI, while only 8.1% of free vomiting cases experienced AKI. There was a statistically significant association between AKI and abdominal pain; most (67.2%) of patients with mild pain had AKI, whereas only 15.1% of severe pain cases had acute kidney injury. There was a statistically significant association between AKI and fever; the majority (81.8%) of free fever samples had AKI, while only 18.2% of patients with fever underwent AKI. The Chi square test was significant, and the p-value was < 0.05.

Table (2): Association between AKI and gastroenteritis.

Variable	Categories	AKI		p-value
		Normal	AKI	
Frequency of diarrhea	<5	7 (3.4%)	30 (7.2%)	<0.001
	5-10	115 (55.3%)	88 (21.1%)	
	>10	86 (41.3%)	300 (71.8%)	
Type of diarrhea	Watery	180 (86.5%)	329 (78.7%)	<0.001
	Non-bloody	24 (11.5%)	17 (4.1%)	
	Bloody	4 (1.9%)	72 (17.2%)	
Vomiting	Yes	139 (66.8%)	384 (91.9%)	<0.001
	No	69 (33.2%)	34 (8.1%)	
Abdominal pain	Mild	146 (70.2%)	281 (67.2%)	0.023
	Severe	16 (7.7%)	63 (15.1%)	
	No	46 (22.1%)	74 (17.7%)	
Fever	Yes	25 (12%)	76 (18.2%)	0.048
	No	183 (88%)	342 (81.8%)	

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Results of Table (3) reveal that there was a significant statistical association between AKI and urine output. The majority (84.7%) of decreased urine output cases developed acute kidney injury, while 14.1% of normal urine output cases had AKI, and only 1.2% of increased cases had AKI. There was a significant statistical association between AKI and muscle pain or leg cramps; 30.1% of patients with muscle pain or leg cramps had AKI, while free-pain cases were normal and free of AKI. There was a significant statistical association between AKI and dehydration assessment; most (60%) of severe dehydration caused AKI, while 36.8% of existing dehydration led to acute kidney injury, and only 3.1% of those without dehydration had AKI. There was a significant statistical association between AKI and treatment options; the majority (91.9%) of conservative treatments developed AKI, while 7.2% of renal replacement therapy (HD) caused AKI, and finally, only 1.7% of continuous renal replacement therapy (CRRT) cases reported AKI. The Chi square test was significant, and the p-value was < 0.05.

Table (3): Association between AKI and urine output, pain, dehydration and treatment.

Variable	Categories	AKI		p-value
		Normal	AKI	
Urine output	Normal	77 (37%)	59 (14.1%)	<0.001
	Decreased	131 (63%)	354 (84.7%)	
	Increased	0 (0%)	5 (1.2%)	
Muscle pain / leg cramps	Yes	36 (17.3%)	126 (30.1%)	<0.001
	No	172 (82.7%)	292 (69.9%)	
Dehydration assessment	No dehydration	19 (9.1%)	13 (3.1%)	<0.001
	Some dehydration	179 (86.1%)	154 (36.8%)	
	Severe dehydration	10 (4.8%)	251 (60%)	
Treatment options	Conservative	208 (100%)	381 (91.1%)	<0.001
	HD	0 (0%)	30 (7.2%)	
	CRRT	0 (0%)	7 (1.7%)	

CRRT: continuous renal replacement therapy, HD: hemodialysis/renal replacement therapy

Findings of Table (4) show that there was a significant statistical difference between AKI and variables: age, S. creatinine, platelets, blood urea, S. potassium, and pulse rate achieved a higher AKI mean in comparison to duration of diarrhea, hemoglobin, WBC, S. potassium, S. sodium, S. chloride, S. creatinine at discharge, S. potassium at discharge, S. sodium at discharge, SBP, DBP, and SPO2 had a higher non-AKI mean.

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Table (4): The difference between AKI and non-AKI regarding age, blood and serological measures.

Variables	AKI	N	Mean	Std. Deviation	p-value
Age	Normal	208	38.44	17.22	< 0.001
	AKI	418	52.39	17.68	
S. creatinine	Normal	208	0.82	0.19	< 0.001
	AKI	418	3.32	2.10	
Duration of diarrhea (hours)	Normal	208	60.35	40.46	0.003
	AKI	418	50.52	38.11	
Hemoglobin	Normal	208	13.68	2.073	< 0.001
	AKI	418	15.71	6.46	
WBC	Normal	208	10.15	3.98	< 0.001
	AKI	407	14.97	5.65	
Platelet	Normal	208	293.75	82.82	< 0.001
	AKI	407	326.08	111.822	
Blood urea	Normal	208	35.19	12.656	< 0.001
	AKI	415	81.42	50.484	
S. potassium	Normal	208	3.571	.7042	0.010
	AKI	416	3.878	1.6421	
S. sodium	Normal	208	140.14	3.304	< 0.001
	AKI	415	138.19	5.061	
S. chloride	Normal	208	102.14	3.643	0.002
	AKI	415	100.95	5.590	
S. creatinine at discharge	Normal	207	0.8508	.60160	< 0.001
	AKI	367	1.7588	1.65053	
S. potassium at discharge	Normal	208	3.948	.2720	< 0.001
	AKI	382	3.818	.4436	
S. sodium at discharge	Normal	208	140.17	2.746	0.017
	AKI	384	139.48	4.288	
SBP	Normal	207	118.09	12.108	< 0.001
	AKI	410	107.68	22.118	
DBP	Normal	207	71.74	7.551	< 0.001
	AKI	410	64.16	14.365	
Pulse rate	Normal	207	88.54	12.685	< 0.001
	AKI	394	100.10	19.194	
SPO2	Normal	207	96.54	4.247	0.005
	AKI	405	95.52	4.231	

Discussions

The incidence of acute kidney injury (AKI) in pandemic-related diarrheal illnesses is a crucial concern for human health. The results reveal a statistically significant correlation between gender and AKI. Among males, AKI prevalence was 55%, while among females, it was 45%. The obtained p-value of less than 0.001 indicates strong statistical significance, suggesting a potential link between gender and the risk of AKI within the studied group. In this study, we found a significant link between water sources and AKI. Acute kidney injury prevalence was 66.3% for tap water users and 21.1% for well water users, with a p-value of 0.005, demonstrating a strong statistical association. Pruss-Ustun reported in their study, that 88% of diarrhea associated deaths are attributed to unsafe water, poor hygiene and sanitation.[16] Unsafe drinking water have been attributed to chronic kidney disease which in turn increases the risk of developing AKI according to Bradshaw et al.'s findings.[2] A significant association between past medical

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history and AKI was found in our study. No prior medical history had a 52.6% AKI rate, while comorbidities like diabetes (16.5%) and hypertension (19.9%) demonstrated higher AKI rates, with p<0.001. This finding is in accordance with Bradshaw et al.'s study, in which hypertension and diabetes were associated with development of AKI.[2] Statistically significant associations exist between diarrhea frequency and AKI, as indicated by p-values below 0.001. In the "<5" age group, AKI cases with diarrhea were 7.2%, higher than non-AKI cases (3.4%). In the "5-10" category, AKI cases had 21.1% diarrhea prevalence, compared to 55.3% in non-AKI cases. For cases with a prevalence of more than 10%, 71.8% of AKI cases had diarrhea, in contrast to 41.3% in non-AKI patients. The study shows a strong link between diarrhea and AKI risk, possibly due to factors like dehydration and electrolyte imbalances. This is in accordance with Bogari et al.'s study, in which they reported that patients admitted due to diarrheal illness were at an increased risk for developing AKI.[17] Strong statistical significance is evident in the relationship between diarrhea type and AKI, with p-values below 0.001 for all categories. Both AKI and non-AKI cases show a high prevalence of watery diarrhea (78.7% and 86.5%, respectively), but the AKI incidence is slightly lower. "Non-bloody diarrhea" has a lower AKI rate (4.1%) compared to non-AKI cases (11.5%), while "bloody diarrhea" has a much higher AKI incidence (17.2%) than non-AKI cases (1.9%). Watery diarrhea is common in both AKI and non-AKI cases, while non-bloody diarrhea is infrequent in AKI instances. This could be attributed to the fact that one of the symptoms of AKI is bloody stools and therefore, the blood could be due to the kidney injury rather than from the diarrheal illness.[18]The observed correlation may indicate the extent and fundamental factors contributing to the occurrence of diarrhea in instances of gastroenteritis accompanied by AKI.[9] Bloody diarrhea is more common in AKI patients.[8] Vomiting strongly correlates with AKI, as evidenced by p-values below 0.001, with 91.9% of AKI cases showing vomiting.[10] Additionally, stomach pain is significantly associated with AKI, especially severe abdominal pain, implying a possible link to AKI development.[11] Statistical significance is observed in all three categories of abdominal discomfort, with a slightly higher p-value (0.023) for "mild abdominal pain," which still indicates significance. Severe abdominal pain is significantly more common in AKI cases (15.1%) compared to non-AKI cases (7.7%), while the incidence of mild abdominal pain is comparable between AKI and non-AKI cases. Intense abdominal pain may signify a more severe underlying condition potentially linked to AKI onset and progression.[12,13] The p-value of 0.048 indicates a statistically significant relationship between fever and AKI in both the "fever yes" and "fever no" categories. In the "Fever Yes" group, there's a slightly higher incidence of fever among AKI cases (18.2%) compared to normal cases (12%), while in the "Fever No" group, AKI cases are more prevalent (81.8%) than normal cases (88%). This suggests a correlation between fever and AKI, but further clinical investigation is needed to understand the precise mechanisms and clinical implications, considering that fever is a non-specific symptom linked to various underlying illnesses.[19] In the current study, Urine Output has p-values below 0.001, signifying a strong statistical connection with AKI. Most (84%) of the AKI cases had decreased urine outout. This highlights the importance of monitoring urine output in AKI patients for assessing renal function and overall health.[20] Both "Muscle Pain/Leg Cramps Yes" and "Muscle Pain/Leg Cramps No" have p-values below 0.001, signifying a strong statistical link with AKI, indicating

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their importance in clinical evaluations for understanding renal function and overall well-being.[21] Similarly, the p-values for the three dehydration assessment categories are below 0.001, highlighting their vital statistical significance in relation to AKI. Recognizing and managing dehydration is crucial in clinical practice, as it can both predispose patients to and result from AKI.[22,23] The p-values for the three treatment categories are below 0.001, signifying a strong relationship between therapy type and AKI occurrence. Patients with AKI are more likely to undergo renal replacement therapy, such as HD or CRRT, compared to those with normal kidney function.[24]

Conclusion:

The present investigation revealed a notable prevalence of acute renal damage among individuals admitted to healthcare facilities due to diarrheal sickness in Sulaymaniyah, Iraq. Several demographic characteristics and clinical manifestations were identified as possible risk factors.

Disclosure:

The authors assert that they have no conflicts of interest.

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