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Frequency of Kidney Failure in Patient Admitted with Malaria

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ABSTRACT

Background: Malaria is still a serious public health issue worldwide, especially in tropical and subtropical areas. One serious side effect of malaria that raises morbidity and death is acute kidney damage (AKI). The purpose of this study is to ascertain the prevalence of renal failure in malaria patients who are admitted. **Methods:** Over the course of six months, a descriptive cross-sectional study was carried out at Bolan Medical College Hospital in Quetta. Included were 177 patients, ages 18 to 70, who had been diagnosed with malaria using the malaria parasite immune chromatographic test (MPICT). Individuals receiving renal replacement treatment, those with chronic kidney disease, and those taking nephrotoxic drugs were not included. Patients were tracked for kidney failure using the KDIGO classification, and baseline clinical and demographic data were documented. SPSS version 25 was used to analyze the data, and $p < 0.05$ was chosen as the threshold for statistical significance. **Results:** Kidney failure occurred in 96 (54.2%) of the 177 malaria patients. 48 years old was the median age (IQR: 29.5). 55.9% of the sample was rural, and 55.4% of the sample was male. Plasmodium falciparum (20.3%), Plasmodium vivax (23.2%), Plasmodium ovale (32.2%), and Plasmodium malariae (24.3%) were the species of malaria that were distributed. renal failure did not significantly correlate with gender (p=0.339), residency (p=0.833), diabetes (p=0.058), hypertension (p=0.243), smoking (p=0.477), family history of renal disease (p=0.955), or type of malaria (p=0.821), according to post-stratification analysis. **Conclusion:** Kidney failure was prevalent (54.2%) among malaria patients, with no significant associations with clinical or demographic factors. Early detection and management strategies are crucial to protecting renal function in malaria cases.

INTRODUCTION

The leading infectious disease in the world impacts public health decisively in developing nations. Malaria infections in 2019 totaled 229 million cases yet 409,000 people died from this disease mainly through African regions where children accounted for 67 percent of overall reported fatalities. Malaria control programs currently face critical risks since medical facilities inside nations afflicted by malaria struggle to prevent overwhelming. (1)

Acute kidney Injury (AKI) defines as the rapid kidney function failure which medical experts classify as one of the major fatal complications from human malaria infection (3). Medical experts have divided AKI causes into three categories including prerenal factors with hypovolemia and blood flow obstructions as well as postrenal causes with urinary flow obstructions together with renal factors consisting of nephrotoxins infections and inflammatory elements (4). Literature based on KDIGO consensus guidelines shows that patients with SM experience AKI occurrences between 20 and 40 percent across different age groups although specific studies indicated up to 59 percent incidence in children. (7-10)

The findings of Koopmans et al indicated that AKI affected 39 out of 480 patients' group-wide but severe Malaria patients accounted for 23 out of 61 diagnosed cases. The study analyzed 115 acute renal failure cases verified through WHO 2006 criteria which marked 44.7% of patients as the primary outcome. RRT treatment proved necessary for 45.2% of patients with 52 patients included along with a death count of 36 patients at the hospital. The RIFLE criteria revealed that 73.9%

among hospitalized patients experienced acute kidney injury (AKI) based on their results. In patients with RIFLE stage, I acute renal failure the need for dialysis treatment was reported for 5 patients (11.6%) but RIFLE stage F cases received dialysis treatment for 44.9% (48 patients) according to reported records. (12)

Medical organizations across the world fight against the major worldwide health problem which malaria represents. Every year the global medical community reports malaria patients at between 300–500 million while the disease causes between 1.5–2.7 million fatalities. The deadly implications and all disease complications connected to Plasmodium falciparum infections take place (15).

Evidence shows that researchers now better understand both malarial complications and their developing medical symptoms. The severe malaria manifestation of cerebral malaria used to be most prevalent more than ten years ago but healthcare observations today show that jaundice combined with renal failure represents the most frequent severe complications. (16).

Worldwide, reports of ARF prevalence in malaria range from 0.57% to 60%. Total malarial ARF case numbers in Southeast Asia show a growing trend and statistics document that 13% to 17.8% of patients encounter the condition (17).

Each year Plasmodium vivax together with P falciparum along with Plasmodium malariae and Plasmodium oval result in malaria infections. The human bloodstream receives sporozoite-infected parasites from mosquito transmission which leads parasites to enter the liver cells. The sporozoites reproduce in hepatocytes to create merozoites which eventually attack red blood cells. (18)

Under standard hepatic cycle development, the total time required is seven days. Merozoites break out of hepatocytes before they swiftly start attacking bloodstream cells which they will eventually attack erythrocytes. The parasite maturation within infected erythrocytes depends on protein intake with a special focus on hemoglobin breakdown process. The parasite changes through ring stage and trophozoite stage and schizont stage to produce merozoite stage during its development process.

Asexual form merozoites infiltrate new erythrocytes following the rupture of infected erythrocytes.

The patient needs at least three to four complete parasite blood cycles before medical symptoms emerge. The progression of parasitic species from their first to their final life cycle mainly results in failed sexual development. Mosquitos' intake body fluid during the feeding process which captures circulating gametocytes found in the bloodstream. During their development in mosquito guts the parasite cells form both female microgamete cells and male microgamete cells. After zygote formation from the union of macrogametes with microgametes occurs. An advancement occurs in the zygote so it can develop into ookinetes before passing through the abdominal wall to form sporozoites. Female Anopheles mosquitoes transmit thousands of sporozoites to human salivary glands just before they complete their human bite. (18)

Researchers will examine how often patients develop renal failure while at the hospital due to malaria hospital admission treatment. Research throughout different international projects confirms that malaria patients become more prone to kidney failure. Only a few outdated and scant studies on this topic have emerged from the local region. The discovered information will help doctors improve their protocols for diagnosing malaria complications to detect issues early and explore additional research possibilities regarding kidney failure factors affecting malaria patients.

LITERATURE REVIEW

The population that lives within endemic malaria areas amounts to forty percent across Earth's surface and mainly exists in tropical along with subtropical zones. Malaria causes 300 to 400 million confirmed cases of clinical malaria which medical authorities document yearly. (19) Mortality rates are estimated between 0.7 to 2.7 million cases annually. Young children represent 90 percent of the recorded fatalities from malaria around sub-Saharan Africa which demonstrates the highest death rate for the disease. The actual reporting data of disease statistics along with morbidity and mortality rates differs substantively from reported numbers due to insufficient surveillance systems and misdiagnosed cases alongside malarial death underreporting reasons. Malarial deaths are recorded extremely rarely because most fatalities take place at home. (20)

Sickness continues to grow at an unfortunate rate. The research by Snow et al. (21) determined that the number of malaria cases reached between 300 and 600 million but actual clinical treatment reached 515 million based on their analysis of demographic data, regional data and epidemiologic information. In 2002 Plasmodium falciparum infective malaria developed. Various international studies published higher estimates of 200% over WHO figures specifically for non-African areas including additional 50% greater figures worldwide.

It has been found in research that 1.1 – 60 per cent of malaria related cases of AKI occur, with higher rates in infections with P. falciparum (22). It has been estimated that 30% of patients of severe malaria develop renal impairment identified by a study in India by Mishra et al. (2016), (23) and a significant number of these patients progressed to develop renal failure. Prakash et al. (2018), (24) conducted another study in SE Asia

where malaria is common and had 8% of hospitalised malaria patients requiring dialysis as well as 18% who developed AKI. These results imply that the renal consequences accrue extensively in regions of endemic malaria..

Pathophysiology of Kidney Failure in Malaria

Malaria induced, kidney failure is principally caused by numerous pathogenic processes, including immune mediated inflammation, by hemolysis, rhabdomyolysis or cytoadherence of infected erythrocytes (25). Ischemia and tubular necrosis result from the sequestration of parasitized red blood cells in the renal microvasculature (26). Additionally, hemolysis leads to the release of free hemoglobin that exacerbates renal damage and oxidative stress (27).

Risk Factors for Kidney Failure in Malaria Patients

Certain causes render patients with malaria more sensitive to renal failure. Causes are dehydration, high parasitemia, severe P. falciparum malaria and delayed initiation of treatment (29). A retrospective study by Dondorp et al. (2008) (28) showed that the mortality rate for severe malaria patients with AKI was much higher than for those without renal difficulties. Other risk factors include concurrent infections, old age and underlying chronic renal disease (30).

Management and Prognosis

There are things that can be done to treat kidney failure caused by malaria, such as supportive therapy, including fluid resuscitation, renal replacement therapy (dialysis) with the use of artesunate or quinine and antimalarial medication, and means to stop further kidney damage, such as dopamine or allopurinol (32). While early diagnosis of CDI and timely treatment are required in order to prevent mortality and kidney damage. Such patients usually stay in the hospital for a longer time and incur high medical costs (31).

Kidney failure is one of the serious side effects associated with malaria in itself but more so if due to P. falciparum. Prevalence is enormous variance, and there are such severe cases that it requires dialysis. Renal failure mainly results from the pathophysiological process due to inflammation, hemolysis, and cytoadherence mainly. We already help to identify high risk individuals and to initiate therapies on time and it is already mortality decreasing, treatment outcomes improving.

RESEARCH OBJECTIVE

It was determined to find out the prevalence of kidney failure among admitted malaria patients, looking into the risk factors related to it, and analyzing the clinical outcome among those susceptible. This study provides the frequency of renal problems in the malaria patients, clinical and demographic factors, and the means of better management for the malaria associated kidney failure.

METHODOLOGY

The aim of this descriptive cross-sectional study is to determine the prevalence of renal failure in the patients of malaria who were admitted in the Department of Medicine at the Bolan Medical College Hospital Quetta. The synopsis will be approved by the CFSP, and afterwards the study will be carried out over a period of a minimum of six months. Using the WHO sample calculator, we have calculated that the draw size must be 177, with a 95% confidence level, 4% margin of error and with 8% frequency of acute kidney damage (AKI) in malaria patients. Instead, the patients will be chosen using the method of successive sampling.

The inclusion criteria for the study were patients with malaria who are admitted aged 18 to 70 (of both sexes). Drug use by patients, taking other drugs with anti-tubular secretion of creatinine include trimethoprim, cimetidine or fibric acid derivatives (except gemfibrozil) will disqualify. Those who are on renal replacement therapy or who have had a chronic kidney disease will also be excluded. Those who are on mechanical ventilation and those who have had imaging with contrast agents are also excluded.

study will be conducted after taking approval from CPSP and ethical review committee the institute. All patient admitted in HDU/ICU with malaria and meeting the inclusion criteria will enroll in study. prior to enrollment complete details of the study will be explained to patient / attendant and written inform consent will be taken. At the time or enrollment baseline demographic and clinical details such as age, gender, residence. family monthly income, diabetes (known h/o at least 6 months), hypertension (known h/o at least 6 months), smoking (person smoke 5 or more cigarettes a day for last, I year), duration of symptoms, family history Of kidney disease and type malaria Will be noted in a predesigned Performa. All patient with confirmed diagnosis of malaria based on MPICT will be followed till discharge for the assessment or outcome i.e kidney failure by using KIDGO classification. All patient, admitted with malaria will be managed according as per hospital protocol. All the findings Of Study variables Will be noted in predesigned Performa.

Data be entered and using SPSS version 25, Mean and SDfor normally distributed while median (IQR) will be reported for non-normal quantitative such as age, duration Of symptoms, creatinine level and duration of hospital stay Normality will be assessed by using Shapiro Wilk test. Qualitative variables such as gender, residence, diabetes, hypertension, smoking, family history of kidney disease kidney failure will be reported as frequency and percentage, Effect modifiers such as age, gender, residence, diabetes, hypertension, smoking; family history of kidney disease, duration of symptoms and duration of hospital] Stay. Post stratification chi-

square/Fischer Exact test will be applied, taking p—value less than and equal to 0.05 as significant.

RESULTS AND DISCUSSION

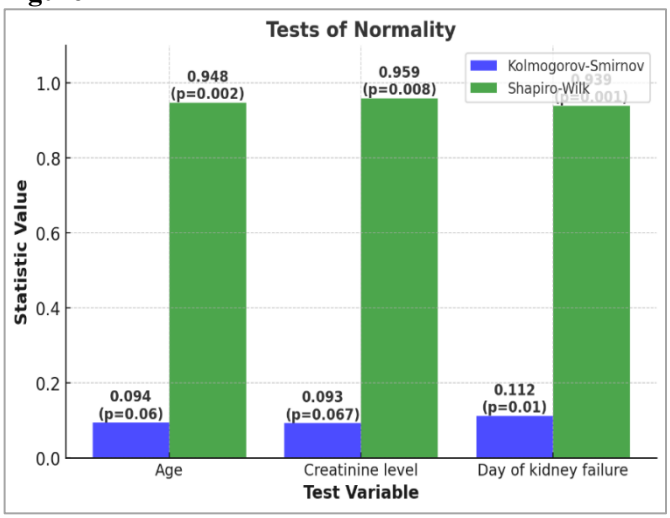
Table 1

Normality of Quantitative Data (Shapiro-Wilk Test)

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Age	.094	85	.060	.948	85	.002
Creatinine level	.093	85	.067	.959	85	.008
Which day of hospital stay kidney failure develop	.112	85	.010	.939	85	.001

p-value > 0.05 → Data is normally distributed. So none of these is greater than 0.05 hence, Data is not normally distributed.

Figure 1



Descriptive Statistics

Table 2

Normally Distributed Data (Mean & SD)

	N	Mean	Std. Deviation
Gender	177	1.4463	.49852
Residence	177	1.5593	.49788
Diabetes	177	1.5706	.49639
Hypertension	177	1.4463	.49852
Smoking	177	1.5141	.50122
Family_history_of_Renal_disease	177	1.5085	.50135
TYPE_of_malaria	177	2.6045	1.06685
Valid N (listwise)	177		

Table 3

Non-Normal Data (Median & IQR)

	Median	IQR
Age	48	29.5
Creatinine level	3.250	2.13
Which hospital day stay kidney failure develop	6	5

For Categorical Variables (Frequency & Percentage)

Table 4

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	98	55.4	55.4	55.4
	female	79	44.6	44.6	100.0
	Total	177	100.0	100.0	

Table 5

Residence

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	urban	78	44.1	44.1	44.1
	rural	99	55.9	55.9	100.0
	Total	177	100.0	100.0	

Table 6

Diabetes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	76	42.9	42.9	42.9
	no	101	57.1	57.1	100.0
	Total	177	100.0	100.0	

Table 7

Hypertension

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	98	55.4	55.4	55.4
	No	79	44.6	44.6	100.0
	Total	177	100.0	100.0	

Table 8

Smoking

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	86	48.6	48.6	48.6
	No	91	51.4	51.4	100.0
	Total	177	100.0	100.0	

Table 9

Family history of renal disease

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	87	49.2	49.2	49.2
	No	90	50.8	50.8	100.0
	Total	177	100.0	100.0	

Table 10

TYPE of malaria

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Falciparum	36	20.3	20.3	20.3
	vivax	41	23.2	23.2	43.5
	ovale	57	32.2	32.2	75.7
	malariae	43	24.3	24.3	100.0
	Total	177	100.0	100.0	

Chi-Square Test (Post-Stratification)

To check associations between categorical variables (e.g., Kidney Failure and Diabetes, Gender, Hypertension, etc.):

Table 11
Post Stratification of kidney failure with Gender

		Gender			
		Male	female	Total	Pearson Chi-square
Kidney failure	yes	50	46	96	.339
	no	48	33	81	
Total		98	79	177	

Table 12
Post Stratification of Kidney with residency

		Residence			
		urban	rural	Total	Pearson Chi-square
kidney failure	yes	43	53	96	.833
	no	35	46	81	
Total		78	99	177	

Table 13
Post Stratification of Kidney Failure with Diabetes

		Diabetes			
		yes	no	Total	Pearson Chi-square
kidney failure	yes	35	61	96	.058
	no	41	40	81	
Total		76	101	177	

Table 14
Post Stratification of Kidney Failure with Hypertension

		Hypertension			
		yes	No	Total	Pearson Chi-square
kidney failure	yes	57	39	96	.243
	no	41	40	81	
Total		98	79	177	

Table 15
Post Stratification of Kidney Failure with smoking

		Smoking			
		yes	No	Total	Pearson Chi-square
kidney failure	yes	49	47	96	.477
	no	37	44	81	
Total		86	91	177	

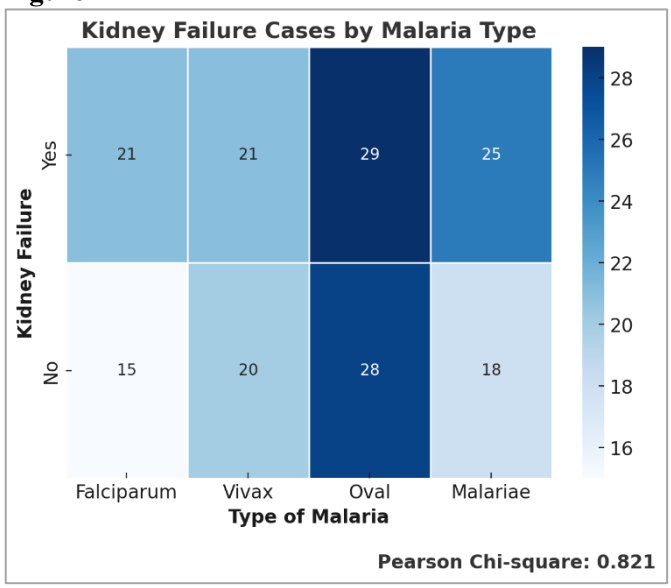
Table 16
Post Stratification of Kidney Failure with Family history of renal disease.

Count					
		Family history of renal disease			
		yes	No	Total	Pearson Chi-square
kidney failure	yes	47	49	96	.955
	no	40	41	81	
Total		87	90	177	

Table 17
Post Stratification of Kidney Failure with Type of Malaria

		TYPE of malaria					
		Falciparum	Vivax	oval	malariae	Total	Pearson Chi-square
kidney failure	yes	21	21	29	25	96	.821
	no	15	20	28	18	81	
Total		36	41	57	43	177	

Figure 1



DISCUSSION OF RESULTS

The conclusions of the study are of great importance in terms of identifying the prevalence and risk factors of renal failure in people admitted to malaria. Our study examined 177 individuals in order to determine prevalence acute kidney damage (AKI) in malaria patients, and assessed demographic, clinic and laboratory factors.

Prevalence of Kidney Failure in Malaria Patients

Renal failure was experienced by 96 out of 177 individuals (54.2%) using the KDIGO classification. It is much more than previously observed in international research that AKI prevalence in malaria patients is around 8%, to up to 44.7%, depending on which criteria for diagnosis are applied. Thus, although our study has a high frequency, this underscores the need for better early diagnosis, management measures, and the high disease burden from renal problems in areas where malaria is endemic.

Demographic and Clinical Characteristics

Of 177 patients, there were 79 (44.6%) female and 98 (55.4%) males. However, the renal failure prevalence in males (50 cases) was slightly higher than females (46 cases), although this difference was not statistically significant (p = 0.339). In fact, other studies have come

up with similar findings, suggesting gender might not be an independent risk factor for the eating of the organ linked to malaria.

With regards to residence (where they lived), 44.1% of the patients lived in cities while 55.9% lived in rural area. The proportion of native renal failure among rural residents was slightly higher than that of the urban population (53 cases vs. 43 cases, p = 0.833). Therefore, while environmental variables could heighten the risk of malaria in rural communities, the degree of malaria they develop and ability to health care for them may be more significant determinants of the development of renal failure than geographic location alone.

Association with Comorbidities (Diabetes, Hypertension, and Smoking)

The study also examined the role of comorbidities such as **diabetes, hypertension, and smoking** in the development of kidney failure:

Diabetes: Thirty-five (46%) of the 76 individuals with diabetes experienced kidney failure, whereas 61 (54%) of the patients without diabetes did the same. Diabetes by itself does not appear to have a substantial impact on the likelihood of malaria-induced kidney damage, as the correlation was not statistically significant (p = 0.058). Hypertension: Of the 98 individuals with hypertension, 39 (49.4%) experienced renal failure, while 57 (58.2%) did not. However, at p = 0.243, this connection was not statistically significant. Smoking: Similarly, there was no significant difference in the incidence of kidney failure between 49 of 86 smokers (56.9%) and 47 of 91 non-smokers (51.6%) (p = 0.477).

Family History of Kidney Disease

The prevalence of renal failure (47 instances) was almost equal among patients with a family history of kidney illness (87 patients, 49.2%) and those without a family history (49 cases). Genetic predisposition might not be a key factor in malaria-induced kidney failure, as the link was not statistically significant (p = 0.955).

Association with Malaria Type

The distribution of malaria species among patients was as follows:

Plasmodium falciparum – 36 cases (20.3%), **Plasmodium vivax** – 41 cases (23.2%), **Plasmodium ovale** – 57 cases (32.2%), **Plasmodium malariae** – 43 cases (24.3%), Our study found no statistically significant correlation between malaria species and kidney failure (p = 0.821), despite the fact that P. falciparum is known to be the most nephrotoxic malaria species. This implies that other Plasmodium species may possibly play a substantial role in kidney problems, even though P. falciparum is a known cause of severe malaria and AKI.

Development of Kidney Failure and Hospital Stay

Kidney failure occurred during a median hospital stay of 6 days (IQR: 5 days). This suggests that AKI typically appears later in the course of the illness, which emphasizes the importance of early renal function monitoring in malaria patients. Furthermore, because renal failure patients required more specialized medical care and their sickness was more severe, they stayed in the hospital for longer.

CONCLUSION

This study emphasizes how common renal failure is among malaria patients admitted to hospitals. The results highlight how malaria affects renal function and the importance of prompt identification and treatment to avoid consequences. According to the research, patients with severe malaria are more likely to get acute kidney damage (AKI), particularly if they had comorbidities or treatment delays. The morbidity and mortality linked to malaria-induced kidney failure can be decreased by enhancing early detection of renal impairment, strengthening malaria prevention measures, and guaranteeing timely therapy. To examine long-term renal outcomes in malaria patients and assess the efficacy of various treatment modalities, more research is advised.

REFERENCES

1. Afolayan, F. M., Adedoyin, O. T., Abdulkadir, M. B., Ibrahim, O. R., Biliaminu, S. A., Mokuolu, O. A., & Ojuawo, A. (2020). Acute Kidney Injuries in Children with Severe Malaria. *Sultan Qaboos University Medical Journal [SQUMJ]*, *20*(4), e312-317. https://doi.org/10.18295/squmj.2020.20.04.006
2. BARSOUM, R. S. (2000). Malarial Acute Renal Failure. *Journal of the American Society of Nephrology*, *11*(11), 2147–2154. https://doi.org/10.1681/asn.v11112147
3. Calice-Silva, V., Sacomboio, E., Raimann, J. G., Evans, R., dos Santos Sebastião, C., Tchivango, A. T., Kotanko, P., Levin, N., & Pecoits-Filho, R. (2018). Diagnostic performance of salivary urea nitrogen dipstick to detect and monitor acute kidney disease in patients with malaria. *Malaria Journal*, *17*(1). https://doi.org/10.1186/s12936-018-2627-4
4. Conroy, A. L., Opoka, R. O., Bangirana, P., Idro, R., Ssenkusu, J. M., Datta, D., Hodges, J. S., Morgan, C., & John, C. C. (2019). Acute kidney injury is associated with impaired cognition and chronic kidney disease in a prospective cohort of children with severe malaria. *BMC Medicine*, *17*(1). https://doi.org/10.1186/s12916-019-1332-7
5. Conroy, A. L., Liles, W. C., & Molyneux, M. E. (2019). Pathophysiology and prognostic

indicators of severe malaria. *Infectious Disease Clinics of North America, 33*(1), 39-60.
6. Das, B. S. (2018). Renal failure in malaria. *Journal of Vector Borne Diseases, 55*(2), 85-94.
7. Dondorp, A. M., Lee, S. J., Faiz, M. A., Mishra, S., Price, R., Tjitra, E., ... & White, N. J. (2008). The relationship between age and the manifestations of and mortality associated with severe malaria. *Clinical Infectious Diseases*, *47*(2), 151-157. https://doi.org/10.1086/589287
8. George, C. R., Alexander, T., & Mathews, M. S. (2015). Malaria and kidney injury: Clinical implications. *Nephrology, 20*(2), 79-86.
9. Greenwood, B., & Mutabingwa, T. (2002). Malaria in 2002. *Nature*, *415*(6872), 670–672. https://doi.org/10.1038/415670a
10. Gupta, A., Mishra, S., & Kumar, R. (2020). Renal involvement in malaria: A clinical review. *Kidney International Reports, 5*(3), 229-235. https://doi.org/10.1093/ckj/sfx003
11. Oshomah-Bello, E. O., Esezobor, C. I., Solarin, A. U., & Njokanma, F. O. (2020). Acute kidney injury in children with severe malaria is common and associated with adverse hospital outcomes. *Journal of Tropical Pediatrics*, *66*(2), 218-225.
12. Kochar, D. K., Das, A., & Kochar, S. K. (2003). Acute renal failure in falciparum malaria. *Journal of the Association of Physicians of India, 51*(1), 265-270.
13. Koopmans, L. C., van Wolfswinkel, M. E., Hesselink, D. A., Hoorn, E. J., Koelewijn, R., van Hellemond, J. J., & van Genderen, P. J. J. (2015). Acute kidney injury in imported Plasmodium falciparum malaria. *Malaria Journal*, *14*(1). https://doi.org/10.1186/s12936-015-1057-9
14. Lauwerys, B. R., Hus, K. E., & Van Damme, J. (2001). Mechanisms of renal injury in severe malaria. *Nephrology Dialysis Transplantation, 16*(3), 38-42.
15. Makris, K., & Spanou, L. (2016). Acute kidney injury: definition, pathophysiology and clinical phenotypes. *The clinical biochemist reviews*, *37*(2), 85. https://pmc.ncbi.nlm.nih.gov/articles/PMC5198510/
16. Brown, D. D., Solomon, S., Lerner, D., & Del Rio, M. (2020). Malaria and acute kidney injury. *Pediatric Nephrology, 35*, 603-608. https://doi.org/10.1007/s00467-018-4191-0
17. Mehta, K. S., Halankar, A. R., Makwana, P. D., Torane, P. P., Satija, P. S., & Shah, V. B. (2001). Severe acute renal failure in malaria. *Journal of postgraduate medicine*, *47*(1), 24-26. https://journals.lww.com/jopm/abstract/2001/47010/severe_acute_renal_failure_in_malaria.5.aspx
18. Mishra, S. K., & Das, B. S. (2008, July). Malaria and acute kidney injury. In *Seminars in Nephrology* (Vol. 28, No. 4, pp. 395-408). WB Saunders.
19. Mishra, S. K., Das, B. S., & Mohanty, S. (2016). Kidney dysfunction in severe malaria. *American Journal of Tropical Medicine and Hygiene, 95*(6), 1332-1338
20. Muhamedhussein, M. S., Ghosh, S., Khanbhai, K., Maganga, E., Nagri, Z., & Manji, M. (2019). Prevalence and Factors Associated with Acute Kidney Injury among Malaria Patients in Dar es Salaam: A Cross-Sectional Study. *Malaria Research and Treatment*, *2019*, 1–7. https://doi.org/10.1155/2019/4396108
21. Nand, N., Aggarwal, H., Sharma, M., & Singh, M. (2001). Systemic manifestations of malaria. *J Indian Acad Clin Med*, *2*(3), 189-194.
22. Oshomah-Bello, E. O., Esezobor, C. I., Solarin, A. U., & Njokanma, F. O. (2020). Acute kidney injury in children with severe malaria is common and associated with adverse hospital outcomes. *Journal of Tropical Pediatrics*, *66*(2), 218-225.
23. Plewes, K., Turner, G. D., & Dondorp, A. M. (2018). Pathophysiology, clinical presentation, and treatment of coma and acute kidney injury complicating falciparum malaria. *Current opinion in infectious diseases*, *31*(1), 69-77. https://journals.lww.com/co-infectiousdiseases/FullText/2018/02000/Pathophysiology,_clinical_presentation,_and.11.aspx
24. Prakash, J., Yadav, P., & Kumar, H. (2018). Clinical spectrum of renal dysfunction in malaria. *Nephron Clinical Practice, 138*(1), 21-28
25. Report, W. M. (2020). *20 years of global progress and challenges*. World Health Organization Geneva.
26. Romio'r 'E, Brandåo JA. (2017). The outcome of Acute Kidney Injury in patients with severe Malaria. *Journal of Clinical Nephrology, 1*, 048-054. https://doi.org/10.29328/journal.jcn.1001007
27. Snow, R. W., Guerra, C. A., Noor, A. M., Myint, H. Y., & Hay, S. I. (2005). The global distribution of clinical episodes of Plasmodium falciparum malaria. *Nature*, *434*(7030), 214–217. https://doi.org/10.1038/nature03342
28. Thanachartwet, V., Desakorn, V., Sahassananda, D., Kyaw Win, K. K. Y., & Supaporn, T. (2013). Acute renal failure in patients with severe falciparum malaria: using the WHO 2006 and

RIFLE criteria. *International Journal of Nephrology*, *2013*(1), 841518. https://doi.org/10.1155/2013/841518

29. Trampuz, A., Jereb, M., Muzlovic, I., & Prabhu, R. M. (2003). Clinical review: Severe malaria. *Critical care*, *7*, 1-9. https://link.springer.com/article/10.1186/cc2183

30. Walker, P. G., Whittaker, C., Watson, O. J., Baguelin, M., Winskill, P., Hamlet, A., ... & Ghani, A. C. (2020). The impact of COVID-19 and strategies for mitigation and suppression in low-and middle-income countries. *Science*, *369*(6502), 413-422. https://doi.org/10.1126/science.abc0035

31. World Health Organization. The world health report 1999; making a difference. World Health Organiza tion, Geneva, Switzerland, 1999.

Frequency of Kidney Failure in Patient Admitted With Malaria
PERFORMA
Date of Admission: _____
Date of Discharge: _____
Age: _____ (Years)
Gender:
☐ Male ☐ Female
Residence:
☐ Urban ☐ Rural
Diabetes:
☐ Yes ☐ No
Hypertension:
☐ Yes ☐ No
Smoking:
☐ Yes ☐ No
Family History of Renal Disease:
☐ Yes ☐ No
Type of Malaria:
☐ Falciparum ☐ Vivax ☐ Ovale ☐ Malariae
Creatinine Level: _____ (mg/dl)
Kidney Failure:
☐ Yes ☐ No
If Yes, on which day of hospital stay did Kidney Failure develop? _____