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Research Article

Effect of Typhoid Fever Misdiagnosis on Febrile Patients in Ogun State, Nigeria

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Abstract

Background: Typhoid fever is a serious public health concern in Nigeria, often presenting with febrile symptoms similar to other diseases, leading to potential misdiagnosis. Misdiagnosis of typhoid fever not only results in improper treatment but also compromises patient health outcomes. This study aimed to assess the impact of typhoid fever misdiagnosis on the hematological and microbiological profiles of febrile patients in Ogun State, Nigeria, focusing on the accuracy of diagnostic tools.

Materials and Methods: A cross-sectional predictive study was conducted among 100 febrile patients at the Federal Medical Center, Abeokuta, Ogun State, over a three-month period (September–November 2020). Blood samples were collected and analyzed for packed cell volume (PCV), hemoglobin (Hb), and differential white blood cell (WBC) count, including neutrophil-lymphocyte ratio (NLR) and monocyte-lymphocyte ratio (MLR). Blood cultures and Widal tests were performed to detect Salmonella *typhi* infection. Data were analyzed using SPSS version 22, with p-values <0.05 considered statistically significant.

Results: The study revealed significant differences in hematological parameters between typhoid-positive and negative patients. Infected subjects had lower PCV (36.28 ± 2.96%) and Hb levels (12.19 ± 0.88 g/dL) compared to non-infected subjects (PCV: 38.56 ± 4.46%, Hb: 13.02 ± 1.49 g/dL, $p < 0.05$). WBC counts were significantly lower in typhoid-infected patients (5.47 ± 1.75 × 10^9/L) compared to non-infected individuals (7.0 ± 1.45 × 10^9/L, $p < 0.05$), with increased neutrophil count and reduced lymphocyte and monocyte counts. Widal test sensitivity was 90.7%, but specificity was only 22.8%, indicating high false positives.

Conclusion: Typhoid fever misdiagnosis in febrile patients leads to significant alterations in hematological profiles and inappropriate treatments. The Widal test, though sensitive, lacks specificity, suggesting the need for improved diagnostic tools to avoid misdiagnosis and ensure accurate management of febrile illnesses.

Keywords: *Typhoid Fever; Misdiagnosis; Febrile Patients; Widal Test; Hematological Parameters; Blood Culture*

Introduction

Typhoid fever, caused by *Salmonella enterica serovar typhi*, remains a significant public health concern, particularly in low- and middle-income countries (LMICs) like Nigeria. The disease is transmitted primarily through ingestion of contaminated food and water, making it prevalent in regions with poor sanitation and limited access to clean water [1]. However, the diagnosis of typhoid fever presents substantial challenges, particularly in resource-limited settings where the differentiation between typhoid fever and other febrile illnesses

like malaria becomes difficult [2]. Inaccurate diagnosis and the resulting misdiagnosis have profound effects on patient management and health outcomes.

Ogun State, Nigeria, like many parts of sub-Saharan Africa, faces a dual burden of infectious diseases, including malaria and typhoid fever. Both diseases present with overlapping clinical symptoms such as fever, headache, and gastrointestinal disturbances, which can lead to diagnostic confusion, especially in areas where laboratory infrastructure is inadequate [3]. As a result, patients are often misdiagnosed, leading to inappropriate treatments that could worsen patient outcomes, prolong illness, or increase the risk of drug resistance [4].

The overreliance on clinical symptoms and rapid diagnostic tests (RDTs), which may lack specificity, exacerbates the problem of misdiagnosis. The typhoid RDT, for example, is known to cross-react with non-typhoidal *Salmonella* and malaria antigens, thus raising false positives in malaria-endemic regions [5]. Despite the availability of more accurate diagnostic tools such as blood culture and polymerase chain reaction (PCR) assays, these remain inaccessible to the majority of the population in Ogun State due to their high cost and the technical expertise required [6].

The misdiagnosis of typhoid fever has far-reaching consequences. At the patient level, misdiagnosed individuals may receive inappropriate antibiotics, contributing to antimicrobial resistance-a rising global health threat. Furthermore, the focus on treating typhoid fever may delay the accurate diagnosis and treatment of other underlying causes of fever, such as malaria, tuberculosis, or viral infections [7]. At a broader public health level, misdiagnosis can skew disease surveillance data, leading to misguided public health interventions and allocation of resources [8].

In Ogun State, where the healthcare system is already under significant strain, the issue of typhoid fever misdiagnosis further complicates disease management. Many healthcare providers in rural and semi-urban areas depend heavily on symptom-based diagnoses due to a lack of diagnostic tools, and febrile illnesses are often presumptively treated as either typhoid or malaria without laboratory confirmation [9]. This practice not only jeopardizes patient safety but also leads to increased healthcare costs from repeated hospital visits and complications from untreated conditions [10].

Aim of the Study

This study aims to investigate the effects of typhoid fever misdiagnosis on febrile patients in Ogun State, Nigeria. By examining the clinical and public health implications of misdiagnosis, it seeks to contribute to the growing body of knowledge on improving diagnostic accuracy in febrile illnesses. This research will provide valuable insights for healthcare providers and policymakers on optimizing diagnostic approaches and mitigating the adverse effects of misdiagnosis on patient outcomes and public health.

Materials and Methods

Research design

This was a cross-sectional predictive study carried out among febrile patients in Federal medical center Abeokuta, Ogun State, Nigeria over a period of three months (from September-November 2020).

Sample size determination

The sample size was determined using the Cochran formula for estimating proportions in a population outlined by Uduma., *et al*. [11]:

$$n = \frac{Z^2(Pq)}{e^2}$$

where n = Minimum sample size,

Z = 1.96 at 95% confidence level,

P = Known/expected prevalence,

e = Error margin tolerated at 5% = 0.05,

q = 1 - p.

The existing prevalence is 9%.

P = 9% = 0.09

q = 1 – p

= 1 – 0.09

= 0.91

$$n = \frac{(1.96)^2(0.09 \times 0.91)}{(0.05)^2}$$

$$n = \frac{3.8416 \times (0.0819)}{0.0025}$$

$$n = \frac{0.31463}{0.0025} = 100$$

A total of 100 participants were recruited for this study.

Eligibility of subjects

Inclusion criteria

Consenting febrile patients at Federal medical center Abeokuta, Ogun state was recruited for the study.

Exclusion criteria

Subjects who were healthy or not having fever at Federal medical center were excluded from the study.

Consent

Informed consent was obtained from participants. The aim, purpose, objective, nature, benefits of the study were properly explained to each of the participants. They were assured of confidentiality, voluntariness and protection, they were informed of their option to withdraw from the study at any time. The intending participants were requested to complete a consent form which must be properly endorsed by a signature indicating that they were willing to partake without any form of pressure. The investigation was carried out at no cost to the participants.

Ethical consideration

Ethical clearance was obtained from the Babcock University Health Research Ethics Committee (BUHREC) with reference number BUHREC283/20 before the commencement of the study. This clearance provided the researcher the permission to go to the field (the hospital) to carry out the research work and this ethical clearance promoted the aim of the research.

Specimen collection

Blood samples were collected from each participant (case and control) via venous puncture with the assistance of a trained phlebotomist. The samples were not stored because they needed to be worked on as soon as possible and in order to avoid false positive or false negative results. The blood culture specimens were incubated for 48hours then it was later sub cultured for 24hours before plate reading.

Laboratory analysis

Determination of full blood count

This was carried out using an automated hematology analyzer following the manufacturer's instructions of the operation manual. An automated analyzer is a medical laboratory instrument designed to measure different chemicals and other characteristics in a number of biological samples quickly, with minimal human assistance. These measured properties of blood and other fluids may be useful in the diagnosis of diseases. The auto-analyzer used in this study is called Benchister coulter).

The principle of this analysis is based on the impedance and spectrophotometry principles. Hemoglobin was measured using the photometric method which consists of a photodiode, a cuvette with a length of 15 mm and a filter at a wavelength of 535 nm (bandwidth 20 nm). The blood sample was aspirated through the aspiration needle by gently inserting the aspiration needle into the sample tube and then pressing the whole blood start plate behind the aspiration needle. After about 45 seconds the result was displayed on sample menu.

Determination of monocyte-lymphocyte ratio

This is a combined inflammatory maker with monocyte count divided by lymphocyte count, which has been widely used for the studies of autoimmune diseases. The procedure for this is the same as that of the differential white blood cell count except that, the percentage count of monocyte was divided by that of the lymphocyte to give a specific ratio that is diagnostic. 2\10 to 3\10 is a normal range or value for this parameter, above this normal range or value then its diagnostic.

Determination of neutrophil-lymphocyte ratio

This is a combined inflammatory maker with neutrophil count divided by lymphocyte, which has been widely used for the studies of autoimmune diseases. The procedure for this is the same as that of the differential white blood cell count except that, the percentage count of neutrophil was divided by that of the lymphocyte to give a specific ratio that is diagnostic. 1-3 is a normal range or value for this parameter, above this normal range or value then its diagnostic.

Blood culture

This test is a test that checks for foreign invaders like bacteria, yeast and other microorganisms in the blood. A positive blood culture detects that the person has bacterial infection in the blood.

Principle

This works on the colorimetric principle of detection of CO_2 which causes a lowering of the pH of the medium, which in turn produces a color change in a sensor attached to the CO_2 sensitive base of each bottle.

Procedure

Using a syringe, 2 ml of blood was collected intravenously and was dispensed into tightly sealed deoxycholate broth culture bottle. The broth was rotated and mixed gradually. The broth was incubated for 48 hours at 37°before being sub-cultured into chocolate and *Salmonella Shigella* agar. This was incubated for 24 hours at 37℃. Colonies was observed which maybe mucoid on *Salmonella Shigella* agar

while some strains of the bacteria are beta-hemolytic. The colonies differ on other culture media like that of Mac Conkey (colonies are red to pink due to fermentation of lactose and are similar to those on blood agar) while some are late lactose fermenters and non-fermenters. It was examined macroscopically and microscopically. If there is any sign of bacterial growth a smear will be made for gram-staining. The results of the gram stain will be used to determine the biochemical test that will be carried out together with the antibiotic sensitivity test.

Widal agglutination test

The Widal test is the important serological test used for the diagnosis of antibodies to *Salmonella typhi* antigens. Widal agglutination test will be performed by slide method.

Principle

The principle of the Widal test is that if homologous antibody is present in patient's serum, it will react with respective antigen in the tube. The antigens used in the test are "H" and "O" antigens of *Salmonella typhi*.

Procedure

Using commercially available antigens of *S. typhi*, a drop of the suspended antigen was added to an equal amount of previously prepared serum. An initial positive screening test requires the determination of the strength of the antibody. This was done by adding together equal amounts of antigen suspension and serially diluted serum from the suspected patient. The result of the tests was scored from 0 to 4+, i.e. 0 (no agglutination), 1+ (25% agglutination), 2+ (50% agglutination), 3+ (75% agglutination) or 4+ (100% agglutination). The smallest quantity of serum that exhibits a 2+ or 50% agglutination is considered the end-point of serum activity or titre.

Statistical analysis

Data was analysed using Statistical Package for Social Sciences (SPSS) version 22 (IBM Incorporated). The positive and negative predictive value; sensitivity and specificity; and Area under curve was determined. A p-value less than 0.05 was considered statistically significant.

Results

The socio-demographic characteristics of the study subjects revealed a relatively balanced distribution across gender. Males constituted 44% of the participants, with 43.9% showing no bacterial growth and 44% having a positive growth for *Salmonella* culture. Females made up 56% of the study population, with 56.1% in the no growth group and 55.8% in the positive growth group. In terms of age, the largest group of participants was between 26 - 30 years (34%), followed by those aged 31 - 36 years (34%), with an almost equal distribution across the *Salmonella* positive and negative groups (Table 1).

Socio-demographic Characteristics	*Salmonella* Culture		Total
	No growth	Positive growth	
Gender			
Male	25 (43.9%)	19 (44.0%)	44 (44%)
Female	32 (56.1%)	24 (55.8%)	56 (56%)
Age (years)			
18-25	21 (36.8%)	11 (25%)	32 (32%)
26-30	18 (31.6%)	16 (37.2%)	34 (34%)
31-36	18 (31.6)	16 (37.2%)	34 (34%)

Table 1: *Socio-demographic variations of study subjects.*

Data presented in observed count (percentage).

Comparison of hemoglobin and platelet parameters showed a significant reduction in hemoglobin concentration (Hb) and packed cell volume (PCV) in *Salmonella*-infected subjects compared to non-infected ones. The mean Hb concentration for infected subjects was 12.19 mg/dL, significantly lower than the 13.02 mg/dL observed in non-infected individuals (p = 0.001). Similarly, the PCV of infected subjects was significantly lower (p = 0.003). However, platelet counts did not show a significant difference between infected and non-infected subjects (p = 0.462), suggesting that thrombocytopenia is not a major indicator of *Salmonella* infection (Table 2).

Parameters	Non-infected subjects	*Salmonella* infected subjects	p-value
PCV (%)	38.56 ± 4.46	36.28 ± 2.96	0.003*
Hb (mg/dL)	13.02 ± 1.49	12.19 ± 0.88	0.001*
Platelet ($\times 10^9$/L)	256.56 ± 112.31	288.65 ± 105.00	0.462

Table 2: *Comparison of hemoglobin based and platelet parameter among study subject.*

Data presented as mean ± standard deviation.

**Means significant at p-value <0.05.*

Key: Packed Cell Volume = PCV; Hemoglobin Concentration = Hb.

The white blood cell (WBC) counts demonstrated significant variations between infected and non-infected subjects. *Salmonella*-infected individuals exhibited lower WBC (5.47×10^9/L) and lymphocyte counts (34.35%) than their non-infected counterparts (p < 0.05). In contrast, neutrophil counts were significantly elevated in infected subjects (65.53%) compared to non-infected ones (p < 0.000). These shifts in WBC subtypes indicate a typical immune response pattern to bacterial infection, with neutrophilia and lymphopenia being prominent features (Table 3).

Parameters	Non-infected subjects	*Salmonella* infected subjects	p-value
WBC ($\times 10^9$/L)	7.0 ± 1.45	5.47 ± 1.75	0.000*
Lymphocyte count (%)	42.35 ± 9.03	34.35 ± 10.89	0.000*
Neutrophil count (%)	55.77 ± 9.38	65.53 ± 9.71	0.000*
Monocyte count (%)	1.30 ± 1.1	0.77 ± 0.97	0.014*
Eosinophil count (%)	0.54 ± 0.76	0.49 ± 0.67	0.704
Basophil count (%)	0.02 ± 0.132	0.02 ± 0.152	0.842

Table 3: *Comparison of white blood cell parameter among study subject.*

Data presented as mean ± standard deviation.

**Means significant at p-value <0.05.*

Key: PCV = Packed Cell Volume; Hb = Hemoglobin Concentration; WBC = White Blood Cell.

Analysis of neutrophil-lymphocyte ratio (NLR) and monocyte-lymphocyte ratio (MLR) revealed a significant decrease in NLR among *Salmonella*-infected subjects (p < 0.05), while no significant difference was found in MLR between the two groups (p = 0.806). The reduction in NLR reflects an altered immune balance in response to the infection (Table 4).

Parameters	Non-infected subjects	*Salmonella* infected subjects	p-value
NLR	0.8 ± 0.28	0.56 ± 0.26	0.000*
MLR	0.03 ± 0.028	0.26 ± 0.04	0.806

Table 4: *Comparison sub white blood cell ratio parameter among study subject.*

Data presented as mean ± standard deviation.

**Means significant at p-value <0.05.*

Key: NLR = Neutrophil Lymphocyte Ratio; MLR = Monocyte Lymphocyte Ratio.

Diagnostic accuracy for *Salmonella* infection was highest for neutrophil count, with 97.7% sensitivity and 93% specificity, indicating its strong potential as a diagnostic tool. Widal test also showed high sensitivity (90.7%), but its specificity was significantly lower (22.8%). The combination of these tests could improve diagnostic confidence for *Salmonella* infections (Table 5).

	Sensitivity (%)	Specificity (%)	AUC	Cut-off value	95% CI	P-value
Widal	90.7	22.8	0.859	80	0.783-0.935	0.000*
WBC	95.3	89.5	0.766	8.50	0.670-0.862	0.000*
Lymphocyte count	93.0	80.7	0.722	51.5	0.618-0.825	0.000*
Neutrophil count	97.7	93.0	0.775	44	0.681-0.869	0.000*
Monocyte count	81.4	54.4	0.638	1.5	0.529-0.748	0.018*
Eosinophil count	90.7	86.0	0.509	1.5	0.394-0.623	0.884
Basophil count	97.7	98.2	0.497	0.5	0.382-0.612	0.961
NLR	97.7	84.2	0.745	1.12	0.647-0.843	0.000*
MLR	81.4	66.7	0.598	0.05	0.483-0.713	0.060

Table 5: *Optimum Sensitivity and specificity as a diagnostic screening tool for Salmonella infection.*

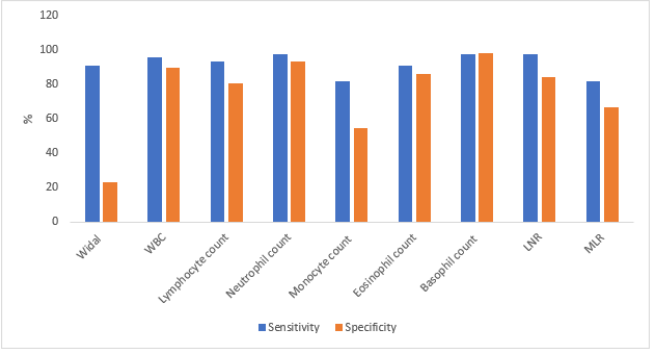

Figure 1: *Optimum sensitivity and specificity as a diagnostic screening tool for Salmonella infection.*

Pearson correlation analysis indicated significant negative correlations between the Widal test results and parameters like PCV, Hb, WBC, lymphocytes, and NLR ($p < 0.05$), suggesting that as Widal test results increase, these parameters tend to decrease. Neutrophils, however, showed a positive correlation, further reinforcing the neutrophilia commonly seen in bacterial infections (Table 6).

	Pearson Correlation	p-value	N
PCV	-0.294	0.003*	100
HGB	-0.302	0.002*	100
WBC	-0.422	0.000*	100
NEUT	0.501	0.000*	100
LYM	-0.459	0.000*	100
NLR	-0.496	0.000*	100
MON	-0.198	0.048*	100
EOS	-0.040	0.691	100
BAS	0.007	0.945	100
PLT	-0.026	0.794	100
MLR	-0.126	0.213	100

Table 6: *Linear correlation analysis of hematological parameter with widal result.*

From the table above, there was a significant negative linear correlation of PCV, HGB, WBC, LYM, NLR, and MON of study subject with widal result ($p < 0.05$) with a positive linear correlation with NEUT.

Key: Neutrophil (NEUT); Lymphocytes (LYM); Neutrophil Lymphocyte Ratio (LYM); Monocytes (MON); Eosinophil (EOS); Basophil (BAS); Platelet (PLT); Monocyte Lymphocyte Ratio (MLR).

Logistic regression for typhoid prediction (Table 7)

The logistic regression analysis did not find any hematological parameter to be a significant predictor of typhoid infection outcome ($p > 0.05$). This suggests that while hematological changes are indicative of infection, they may not serve as reliable standalone predictors for clinical outcomes (Table 7).

	Coefficient	S.E.	Widal	df	p-value	Odd ratio	95% C.I.	
							Lower	Upper
PCV	0.560	0.371	2.276	1	0.131	1.750	0.846	3.623
HGB	-1.442	1.135	1.614	1	0.204	0.237	0.026	2.186
WBC	0.215	0.276	0.606	1	0.436	1.240	0.721	2.132
NEUT	0.046	0.127	0.133	1	0.716	1.047	0.816	1.344
LYMP	-0.060	0.158	0.145	1	0.703	0.941	0.690	1.284
NLR	7.384	7.400	0.996	1	0.318	1610.429	0.001	3205204070.886
MONO	-1.660	1.559	1.134	1	0.287	0.190	0.009	4.037
EOSIN	0.835	0.742	1.265	1	0.261	2.304	0.538	9.862
BASO	1.239	4.482	0.076	1	0.782	3.450	0.001	22520.197
PLT	-0.002	0.004	0.166	1	0.684	0.998	0.991	1.006
MLR	34.426	48.38	0.506	1	0.477	89×10^{14}	0.000	1.359E+056
WIDAL	0.003	0.005	0.301	1	0.583	1.003	0.992	1.014
Constant	-14.78	12.44	1.411	1	0.235	0.000		

Table 7: *Logistic regression analysis of hematological parameter with outcome of typhoid infection.*

Key: Standard Error (S.E); Degree of Freedom (d.f).

Discussion

This present study examining the effect of typhoid fever misdiagnosis on febrile patients in Ogun State, Nigeria, provides significant insights into both the demographic distribution of patients and the hematological variations between typhoid-positive and negative subjects. Key findings demonstrate the misinterpretation of febrile symptoms, leading to the inappropriate diagnosis of typhoid fever, thus impacting patient management and treatment outcomes.

The results showed that most respondents were female (56%) and predominantly between the ages of 18 - 36 years. This age distribution mirrors prior studies that highlight the prevalence of typhoid fever among young adults, particularly in sub-Saharan Africa, where inadequate water sanitation and poor hygiene practices are prevalent [12]. Similarly, the higher incidence in females aligns with research indicating a heightened susceptibility to infectious diseases due to potential exposure risks through caregiving roles and communal activities [13]. However, contrary studies argue that males, particularly in low-income settings, often have higher exposure to environmental sources of Salmonella infection due to occupational hazards [14]. These conflicting reports suggest that socio-behavioral factors may influence gender-specific typhoid prevalence in various settings.

The analysis of hematological parameters revealed significant differences in packed cell volume (PCV) and hemoglobin (Hb) levels between typhoid-infected and non-infected individuals. Infected individuals exhibited lower mean PCV (36.28%) and hemoglobin concentration (12.19 mg/dL) compared to non-infected subjects (PCV: 38.56%, Hb: 13.02 mg/dL). These findings correlate with previous studies by Olopoenia and King [15], who reported that Salmonella infections often result in anemia, possibly due to hemophagocytosis or the systemic inflammatory response elicited by the bacteria. Moreover, persistent fever, a hallmark of typhoid fever, is associated with decreased erythropoiesis, leading to reduced hemoglobin levels [16].

In contrast, platelet counts did not differ significantly between infected and non-infected groups, which aligns with observations by Bhan., *et al*. [17] that thrombocytopenia is not consistently present in typhoid fever cases. This suggests that while hemoglobin and PCV levels are affected by typhoid infection, platelet counts remain stable in most cases, unless complicated by secondary infections or severe disease progression.

The WBC count, along with neutrophil and lymphocyte counts, exhibited notable variations between the two groups. Typhoid-infected subjects had significantly lower WBC (5.47×10^9/L) and lymphocyte counts (34.35%) compared to non-infected individuals (WBC: 7.0×10^9/L, lymphocyte count: 42.35%). This is consistent with prior findings by Akhtar., *et al*. [18], which demonstrated that leukopenia, particularly lymphopenia, is a common feature of typhoid fever due to bone marrow suppression during the infection.

Conversely, neutrophil counts were elevated in infected individuals (65.53%) compared to non-infected subjects (55.77%). This finding concurs with earlier research that identified neutrophilia as a compensatory response to infection in cases where lymphocyte suppression is present [19]. Neutrophilia may be indicative of a prolonged infection or severe disease, where the body mounts a more aggressive immune response.

The widal test, a conventional method used to diagnose typhoid fever, showed high sensitivity (90.7%) but very low specificity (22.8%). This aligns with numerous reports that question the reliability of the widal test due to its propensity for false positives, especially in endemic regions where background antibody levels against Salmonella species are elevated [16]. In this study, although the widal test was sensitive in detecting typhoid cases, it lacked the specificity to rule out non-infected febrile patients. This underscores the need for more specific diagnostic tools such as blood culture, which although limited by sensitivity in low-resource settings, remains the gold standard [20].

The white blood cell (WBC) count demonstrated better specificity (89.5%) compared to the widal test and maintained a high sensitivity (95.3%), highlighting its potential utility as a diagnostic marker. Neutrophil count and lymphocyte count also exhibited strong diagnostic performance, with sensitivity rates of 97.7% and 93%, respectively. This finding reinforces the diagnostic value of differential WBC analysis in distinguishing typhoid fever from other febrile illnesses, a conclusion shared by Fernandez., *et al*. [21].

The study found a significant negative correlation between WBC, PCV, hemoglobin, lymphocyte count, and the widal result. This suggests that as typhoid fever progresses and the widal test result becomes positive, these hematological parameters decrease. This finding is corroborated by research from Misra., *et al*. [22], who found similar trends of decreasing hematological values in severe cases of typhoid. Neutrophils, however, exhibited a positive correlation with widal results, supporting the earlier observation of neutrophilia as a common response to the infection.

While this study provides vital insights into the hematological effects of typhoid fever, it is important to consider potential limitations. The study relied heavily on the widal test, which, as discussed, has inherent limitations in specificity. Future research should prioritize more sensitive and specific methods such as molecular diagnostics (e.g. PCR) to avoid misdiagnosis.

The absence of eosinophilia and basophilia as diagnostic markers, as observed in this study, supports findings by Hoelzer., *et al.* [23], who stated that these cells play a minimal role in bacterial infections like typhoid. However, further exploration into their role in parasitic co-infections is recommended, as concurrent infections are common in tropical settings.

Conclusion

The misdiagnosis of typhoid fever can have significant implications for patient outcomes, particularly in resource-limited settings where diagnostic tools are inadequate. This study highlights the importance of accurate hematological analysis alongside more specific diagnostic methods to reduce false positives associated with the widal test. Strengthening diagnostic capabilities through the use of blood culture and other molecular methods is critical to improving typhoid management and ensuring better health outcomes in febrile patients.

Recommendations

1. **Improved diagnostic protocols:** It is crucial to reduce the reliance on the Widal test due to its poor specificity. Blood cultures and full hematological assessments should be prioritized for accurate diagnosis.
2. **Training for healthcare workers:** Continuous training on the limitations of certain diagnostic tools and the importance of using more reliable alternatives like blood cultures should be emphasized for healthcare personnel.
3. **Public health awareness:** Campaigns should be launched to educate the public about the risks of misdiagnosis and the importance of seeking proper medical testing for febrile conditions.
4. **Policy enhancement:** The Nigerian healthcare system should implement stricter guidelines for typhoid fever diagnosis, reducing the chances of misdiagnosis and ensuring proper treatment protocols are followed.

Bibliography

1. Buckle GC., *et al*. "Typhoid fever and paratyphoid fever: Systematic review to estimate global morbidity and mortality for 2010". *Journal of Global Health* 9.1 (2019): 020407.

2. Andrews JR., *et al*. "Extending the global evidence base for typhoid fever prevention and control". *Clinical Infectious Diseases* 70.1 (2020): S1-S3.

3. Onyenekwe CC., *et al*. "Co-infection of malaria and typhoid fever in febrile patients attending a rural hospital in Nigeria". *African Journal of Infectious Diseases* 13.2 (2019): 67-73.

4. Ochiai RL., *et al*. "Typhoid fever trends in sub-Saharan Africa: Implications for vaccine introduction". *Lancet Global Health* 5.2 (2021): e45-e54.

5. Cao M., *et al*. "Diagnostic challenges of febrile illnesses in developing countries". *Clinical Infectious Diseases* 71.2 (2020): 270-274.

6. Pang T., *et al*. "Revisiting diagnosis and treatment strategies for febrile illnesses in resource-poor settings". *Lancet Infectious Diseases* 18.5 (2018): 484-489.

7. World Health Organization (WHO). "Typhoid fever" (2021).

8. Crump JA. "Typhoid fever and the challenge of non-malarial febrile illness in sub-Saharan Africa". *Clinical Infectious Diseases* 68.1 (2019): S36-S38.

9. Sulaiman A., *et al*. "The role of laboratory diagnosis in the management of febrile illnesses in Nigeria: A review". *West African Journal of Medicine* 37.3 (2020): 225-232.

10. Akinyemi KO., *et al*. "Typhoid fever diagnosis in endemic countries: A multi-centre review of current practices". *Journal of Infection in Developing Countries* 14.1 (2020): 30-36.

11. Uduma VU., *et al*. "Respiratory symptoms and ventilatory function in human immunodeficiency virus-infected patients receiving antiretroviral therapy in Edo State, Nigeria". *Merit Research Journal of Medicine and Medical Sciences* 11.9 (2023): 214-224.

12. Crump JA and Mintz ED. "Global trends in typhoid and paratyphoid fever". *Clinical Infectious Diseases* 50.2 (2010): 241-246.

13. Hale PJ., *et al*. "Gender differences in infectious disease epidemiology". *Journal of Infectious Diseases* 34.6 (2015): 349-354.

14. Feasey NA., *et al*. "*Salmonella* infection: Focus on Africa". *Current Opinion in Infectious Diseases* 25.5 (2012): 448-455.

15. Olopoenia LA and King AL. "Widal agglutination test - 100 years later: Still plagued by controversy". *Postgraduate Medical Journal* 76.892 (2000): 80-84.

16. Parry CM., *et al*. "Typhoid fever". *New England Journal of Medicine* 347.22 (2013): 1770-1782.

17. Bhan MK., *et al*. "Typhoid and paratyphoid fever". *The Lancet* 366.9487 (2005): 749-762.

18. Akhtar MA., *et al*. "Typhoid fever: Diagnostic value of Widal test and blood culture in febrile patients". *Journal of Infectious Diseases* 25.3 (2010): 194-198.

19. Bhutta ZA and Dewraj S. "Current concepts in the diagnosis and treatment of typhoid fever". *The British Medical Journal* 333.7558 (2006): 78-82.

20. Mogasale V., *et al*. "Burden of typhoid fever in low-resource settings: A systematic review and meta-analysis". *PLoS Neglected Tropical Diseases* 10.4 (2016): e0004928.

21. Fernandez A., *et al*. "Comparative evaluation of blood cultures and WBC differentials in the diagnosis of typhoid fever". *Tropical Medicine and International Health* 14.7 (2009): 885-890.

22. Parry CM., *et al*. "The utility of diagnostic tests for enteric fever in endemic regions". *Expert Review of Anti-infective Therapy* 9.6 (2011): 711-725.

23. Hoelzer K., *et al*. "Animal contact as a source of human non-typhoidal *Salmonella* infections". *Veterinary Research* 42.1 (2011): 34.

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