International Journal of Research in Medical Sciences
Vaidya MS et al. Int J Res Med Sci. 2018 Feb;6(2):472-480
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20180284

Original Research Article

A comparative study of hematological profile on presentation in confirmed cases of malaria, dengue and leptospirosis

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Received: 05 January 2018
Accepted: 11 January 2018

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ABSTRACT

Background: Malaria, leptospirosis and dengue fever are the predominant monsoon related illnesses in the Indian subcontinent causing considerable mortality and morbidity. These have similar clinical profile and derangement in one or more haematological parameters. We have studied the haematological profile at presentation to differentiate one infection from the other as it presents a significant diagnostic challenge to the treating physician.
Methods: A prospective observational study of haematological profile in a total of 336 patients of malaria *(plasmodium falciparum, plasmodium vivax* and mixed malaria), dengue and leptospirosis were conducted over a period of 1 year in a tertiary care centre in western Maharashtra.
Results: In the age group of 20-40 years all the infectious subgroups were observed to have the maximum number of patients with a male preponderance. Maximum frequency of Haemoglobin in leptospirosis was 7-10gm%. Maximum mortality in mixed malaria and leptospirosis was seen with haemoglobin levels <7gm%. In *P. vivax* malaria, *P. falciparum* malaria and dengue mortality was not seen in patients with Hb<7gm%.
Conclusions: Leucocytosis is most commonly seen in leptospirosis. Patients presenting with leucopenia are most likely to have *P. vivax* malaria. Mixed malaria was most likely to have thrombocytopenia on presentation. Haemoglobin of <7gm% in leptospirosis and mixed malaria probably predicts a poor outcome.

Keywords: Dengue, Haemoglobin, Leptospirosis, Platelet count, Platelet count, Total leucocyte count

INTRODUCTION

Malaria, leptospirosis and dengue fever are the predominant monsoon related illnesses in the recent times in Indian subcontinent causing mortality and morbidity. All of them have derangement in one or more haematological parameters and monitoring is imperative in the management of these disease and their complications. We have studied the haematological profile at presentation to differentiate one infection from the other as it presents a significant diagnostic challenge to the treating physician due to clinical similarities.

Malaria, Dengue and Leptospirosis attribute to considerable morbidity and at times mortality in the Indian subcontinent. The clinical course ranges from benign presentation with early resolution to fulminant course with complications like bleeding, renal failure, respiratory distress, hypotension and death.

We have attempted to study the basic investigation comprising haemoglobin, complete blood count and platelet count values available even in a primary health care centre in relation to the probable diagnosis, need for intensive care therapy and mortality.

METHODS

An observational study was conducted from October 2011 to September 2012 at KEM hospital in Mumbai. Permission was obtained from Institutional ethics committee. A total of 336 diagnosed cases of *Plasmodium falciparum*, *Plasmodium vivax* malaria and mixed malaria (both *P. falciparum and P. vivax*), dengue and leptospirosis admitted in our wards and the intensive care unit were included in this study. Indoor patients in whom *Plasmodium falciparum* or *Plasmodium vivax* malaria was diagnosed on peripheral smear or test positive for antigen; dengue was diagnosed by test positive for NS1 antigen, positive IgM or PCR and leptospirosis was diagnosed by IgM antibodies against leptospirosis. Patients more than 12years were enrolled after taking written informed consent.

Detailed history, clinical examination, haematological profile (Hb, CBC and platelet count) at presentation, investigations and treatment were noted. Course of the patients in the ward was regularly followed till discharge or death.

Patients of malaria, degue fever and leptospirosis were divided on the basis of haemoglobin (Hb) levels into four groups: those having haemoglobin >15 gm%, between 11-15gm%, between 7-10gm% and <7gm%. Total leucocyte count was grouped as 4000cells/cmm, between 4000-1100cells/cmm and a count of >11000cells/cmm. Platelet count was studied as that <20,000 cells/cmm, between 20,000-50,000cells/cmm, 50,000-1 lac cells/cmm, 1-1.5lac cells/cmm and those with a count of more than 1.5lacs/cmm. These counts were recorded only at presentation to the hospital.

Statistical analysis

The data was analysed using descriptive statistics. Results are expressed as percentage.

RESULTS

A total of 336 patients were enrolled in our study over a period of 1 year. Of these *Plasmodium vivax* malarias comprised the maximum number of patients 174/336 (51.79%) followed by 63/336 (18.75%) of falciparum malaria, 38/336 (11.31%) of dengue, 37/336 (11.01%) of leptospirosis and 24/336 (7.14%) of mixed malaria patients.

The patients were divided on the basis of age group, the mean age in vivax malaria was 37.63 years ±13.91, in mixed malaria was 38.67 years ±14.13, in falciparum malaria 36.84 years ±13.66, in dengue 34.58 years ±14.84 and in leptospirosis was 36.43 years ±14.00.

Maximum number of patients in each of the febrile illness subgroup belonged to age group of 20-40years viz: *Plasmodium vivax* (50%), *Plasmodium falciparum* (58.73%) and mixed malaria (54.16%), dengue fever (57.89%) and leptospirosis (67.56%). Gender wise distribution was seen as 242/336 (72.02%) of male and 94/336 (29.97%) of female patients. Haemoglobin distribution in confirmed cases of malaria, dengue and leptospirosis is given in Table 1.

Table 1: Haemoglobin distribution in confirmed cases of malaria, dengue and leptospirosis. (n=336).

Hb (gm%)	Final diagnosis					Total	Percentage
	Dengue (%)	Leptospirosis (%)	Mixed malaria (%)	Vivaxmalaria (%)	Falciparum malaria (%)		
<7	6 (15.78)	4 (5.40)	5 (20.83)	19 (10.91)	7 (11.11)	41	11.60
7-10	7 (18.42)	25 (67.5)	7 (29.16)	35 (20.11)	13 (20.63)	87	26.48
11-15	19 (50)	8 (21.62)	12 (50)	116 (66.66)	38 (60.31)	193	57.44
>15	6 (15.78)	0 (0)	0 (0)	4 (2.29)	5 (7.93)	15	4.46
Total	38	37	24	174	63	336	100

In all subgroups of febrile illnesses maximum number of patients had Hb of 11-15gm% except for 72.97% patients of leptospirosis in whom Hb of 7-10gm% was seen. Maximum number of patients with Hb<7 gm% were seen in 20.83% of mixed malaria.

Haemoglobin level of >15gm% was seen in 15.78% of dengue cases and 40% of patients presenting with a haemoglobin of >15gm% had dengue fever. Haemoglobin level in 2.29% of *Plasmodium vivax* malaria and 7.9% of *P. falciparum* malaria was >15gm%.

The maximum haemoglobin level was 18.6gm% in a patient of Plasmodium vivax malaria.

None of the patients with leptospirosis or mixed malaria infection had Hb>15gm%. The least haemoglobin level observed in our study was 3gm% in dengue fever who also had thrombocytopenia <20,000/cmm and was discharged after 11days of hospital stay.

Total leucocyte count in confirmed cases of malaria, dengue and leptospirosis is given in Table 2.

Table 2: Total leucocyte count in confirmed cases of malaria, dengue and leptospirosis (n=336).

	Final diagnosis						
Total leucocyte count(/cmm)	**Dengue (%)**	**Leptospirosis (%)**	**Mixed Malaria (%)**	**Vivax Malaria (%)**	**Falciparum Malaria (%)**	**Total**	**%**
<4000	0 (0)	3 (8.10)	3 (12.5)	40 (22.98)	10 (15.87)	56	16.66
4000-11000	29 (76.31)	8 (21.62)	15 (62.5)	130 (74.71)	43 (68.25)	225	66.96
>11000	9 (23.68)	26 (70.27)	6 (25)	4 (2.29)	10 (15.87)	55	16.36
Total	38	37	24	174	63	336	100

Leucocytosis at presentation was observed in 70.27% of patients with leptospirosis. The maximum leucocyte count was 27,900/cmm and was seen in dengue fever. None of the patients admitted with dengue fever had a total leucocyte count of <4000cells/cmm at presentation. A total leucocyte count of <4,000cells/cmm was observed in 16.6% of study population. Distribution of neutrophil count in confirmed cases of malaria, dengue and leptospirosis is given in Table 3.

Table 3: Distribution of neutrophil count in confirmed cases of malaria, dengue and leptospirosis (n=336).

	Neutrophil count			
	Neutropenia	**Normal**	**Neutrophilia**	**Total**
Dengue	0 (0%)	25 (65.78%)	13 (34.21%)	38
Leptospirosis	0 (0%)	11 (29.72)	26 (70.27)	37
Mixed malaria	0 (0%)	15 (62.5)	9 (37.5)	24
Vivax malaria	19 (10.91)	143 (82.18)	12 (6.89)	174
Falciparum malaria	1 (16.66)	49 (77.77)	13 (20.63)	63
Total	20 (5.95)	243 (72.32)	73 (21.72)	336

Neutrophilia was seen in 70.27% in leptospirosis and 34.2% in dengue fever. Distribution of lymphocyte count in confirmed cases of malaria, dengue and leptospirosis is shown in Table 4.

Table 4: distribution of lymphocyte count in confirmed cases of malaria, dengue and leptospirosis (n=336).

	Lymphocyte count			Total
	Lymphopenia	**Normal**	**Lymphocytosis**	
Dengue	17 (44.73)	19 (50)	2 (5.26)	38
Leptospirosis	24 (64.8)	10 (27)	3 (8.1)	37
Mixed malaria	8 (33.33)	13 (54.16)	3 (12.5)	24
Vivax malaria	89 (51.14)	82 (47.12)	3 (1.72)	174
Falciparum malaria	19 (30.15)	40 (63.49)	4 (6.34)	63
Total	140 (41.66)	177 (52.67)	19 (5.65)	336

Lymphocytosis was seen least in *P. vivax* malaria only. Distribution of platelet count in confirmed cases of malaria, dengue and leptospirosis is given in Table 5.

Of the total study population 94.34% had platelet count below 1.5lac/cmm on presentation and 51.78% of patients had platelet count between 20,000-50,000cells/cmm.

A platelet count of less than 1.5lac/cmm was seen in a striking 100% of patients of *P. vivax*, mixed malaria and leptospirosis.

Distribution of platelet count in patients with bleeding manifestation in confirmed cases of malaria, dengue and leptospirosis is given in Table 6.

Table 5: Distribution of platelet count in confirmed cases of malaria, dengue and leptospirosis (n=336).

	Final diagnosis						
Platelet count (/cmm)	**Dengue**	**Leptospirosis**	**Mixed malaria**	**Vivax malaria**	**Falciparum malaria**	**Total**	**%**
<20000	4 (10.52)	6 (16.21)	3 (12.5)	14 (8.04)	13 (20.63)	40	11.90
20000-50000	11 (28.94)	21 (56.75)	9 (37.5)	96 (55.17)	37 (58.73)	174	51.78
50000-100000	22 (57.89)	8 (21.62)	12 (50)	47 (27.01)	7 (11.11)	96	28.57
1 lac to 1.5 lac	0 (0)	0 (0)	0 (0)	6 (3.44)	1 (1.58)	7	2.08
>1.5 lac	1 (2.63)	2	0 (0)	11 (6.32)	5 (7.93)	19	5.65
Total	38	37	24	174	63	336	100

Table 6: Distribution of platelet count in patients with bleeding manifestation in confirmed cases of malaria, dengue and leptospirosis (n=336).

Patients with bleeding manifestation	**Platelet count (/cmm)**									
	< 20000		**20000-50000**		**50000-100000**		**Lac to 1.5 lac**		**>1.5 lac**	
	No. of pts	**Bleeding (%)**	**No. of pts**	**Bleeding (%)**	**No. of pts**	**Bleeding (%)**	**No. of pts**	**Bleeding (%)**	**No. of pts**	**Bleeding (%)**
Dengue (18/38)	4	4 (100%)	11	7 (63.6%)	22	6 (27.2%)	0	0 (0)	1	1 (100%)
Falciparum malaria (31/63)	13	10 (76.92%)	37	18 (48.6%)	7	2 (28.5%)	1	1 (100%)	5	0 (0)
Leptospirosis (21/37)	6	6 (100%)	21	12 (57.1%)	8	3 (37.5%)	0	0 (0)	2	0 (0)
Mixed malaria (10/24)	3	3 (100%)	9	7 (77.7%)	12	0 (0)	0	0 (0)	0	0 (0)
Vivax malaria (38/174)	14	6 (42.85%)	96	29 (30.2%)	47	3 (6.3%)	6	0 (0)	11	0 (0)
Total= 118/336	40	29	174	73	96	14	7	1	19	1

Bleeding manifestations were observed in (118/336) 35.5% of total population. Bleeding manifestations were seen in 56.75% of patients of leptospirosis followed by *P. falciparum* malaria, dengue fever, mixed malaria and *P. vivax* malaria. At a platelet count below 1 laccells/cmm 100% of cases of leptospirosis, mixed malaria, vivax malaria; 94% of dengue patients and 97% patients of falciparum malaria presented with bleeding.

Amongst patients with the platelet count below 20,000cells/cmm bleeding was seen in all patients of dengue fever, mixed malaria infection and leptospirosis. Bleeding was encountered in one patient of dengue fever with a platelet count of >1,50,000cells/cmm. In mixed malaria platelet count of less than 1,00,000cells/cmm was observed in all patients.

Distribution of total number of admissions, Medical Intensive Care Unit (MICU) and mortality in confirmed cases of malaria, dengue and leptospirosis is given in Table 7.

Admission to MICU was required in a total of 68 (20.2%) patients. Among the patients admitted to medical intensive care unit mortality was seen in 75% of patients of mixed malaria, 50% of patients of dengue, 33.3% each of *P. vivax* and *P. falciparum* and 30.76% of leptospirosis.

Table 7: Admission to MICU and mortality among confirmed cases of malaria, dengue and leptospirosis(n=68).

	Total admissions	**MICU admissions**	**Death**
P. vivax	174	6 (3.4%)	2
P. falciparum	63	12(19%)	4
Mixed malaria	24	4 (16.6%)	3
Leptospirosis	37	26 (70.2%)	8
Dengue	38	20 (52.6%)	10
Total	336	68	27

Admission to MICU in confirmed cases of malaria, leptospirosis and dengue and mortality with relation to haemoglobin values is given in Table 8.

Hb less than 10 gm% was seen in 80.76 % patients of leptospirosis amongst these haemoglobin level than

7gm% was seen in 50% of patients with mortality. Mortality was seen in 75% of patients with mixed malaria and all these patients had Hb less than 10gm%. In dengue fever mortality was not seen in patients with Hb of less than 7gm%. In *P. vivax* mortality was 100% in patients in patients admitted to MICU with Hb between 11-15gm%.

Table 8: Outcome in patients of malaria, dengue and leptospirosis admitted to MICU in relation to haemoglobin values.

Total no. Of patients =68	Hb<7 gm%		Hb7-10 gm%		Hb11-15 gm%		Hb>15 gm%	
	Expired	Recovered	Expired	Recovered	Expired	Recovered	Expired	Recovered
P. vivax malaria(6)	0	3 (50%)	0	1 (16.3%)	2 (33.3%)	0	0	0
P. falciparum malaria (12)	0	3 (25%)	2 (16.6%)	1 (8.3%)	2 (16.6%)	4 (33.2%)	0	0
Mixed malaria (4)	2 (50%)	0	1 (25%)	0	0	1 (25%)	0	0
Leptospirosis (26)	2(7.6%)	2 (7.6%)	4 (15.2%)	13 (50%)	2 (7.6%)	3 (11.5%)	0	0
Dengue (20)	0	6 (30%)	6 (30%)	2 (10%)	3 (15%)	2 (10%)	1 (5%)	0
Total (68)	4 (5.8)	14 (20.5)	13 (19.1)	17 (25)	9 (13.2)	10 (14.7)	1 (1.7)	0

Table 9: Outcome in patients of malaria, dengue and leptospirosis admitted to MICU in relation to total leucocyte count.

	<4000/cmm		4000-11000/cmm		>11,000/cmm	
	Expired	Recovered	Expired	Recovered	Expired	Recovered
P. vivax malaria (6)	2 (33.3%)	0	0	3 (50%)	0	1 (16.6%)
P. falciparum malaria (12)	0	1(8.3%)	2 (16.6%)	3 (25%)	2 (16.6%)	4 (33.3%)
Mixed malaria (4)	2 (50%)	0	0	0	1 (25%)	1 (25%)
Leptospirosis (26)	0	0	3 (11.5%)	6 (23%)	5 (19.2%)	12 (46.1%)
Dengue (20)	0	0	5 (25%)	8 (40%)	5 (25%)	2 (10%)

Outcome in patients admitted to MICU in relation to total leucocyte count is given in Table 9.

Leucocyte count of <4000/cmm was not seen in patients of leptospirosis or dengue infection requiring admission to intensive care. In *P. vivax* malaria mortality was seen in 33.3% of patients admitted to MICU, a total leucocyte count of <4000/cmm was seen in all these patients. In patients with *P. falciparum* malaria there was no mortality in patients with leucocyte count <4000cells/cmm. In mixed malaria mortality was seen in all the patients with leucocyte count <4,000 cells/cmm and in 50% of patients with counts >11,000cells/cmm at presentation. In leptospirosis mortality of 33.3% was seen in patients with leucocyte count between 4000-11000 cells/cmm and in 29.4% of patients with leucocyte count >11000/cmm.

In dengue fever mortality was 71.4% in patients presenting with leucocyte count >11000/cmm. Outcome in patients admitted to MICU in relation to platelet count is given in Table 10.

Table 10: Outcome in patients of malaria, dengue and leptospirosis admitted to MICU in relation to platelet count.

	<20,000		20,000-50,000		50,000- 1.0 lac		1 – 1.5 lac		>1.5 lac	
	Death	Recovery	Death	Recovery	Death	Recovery	Death	Recovery	Death	Recovery
P. vivax malaria(6)	0	116.6%	2(33.3%)	3(50%)	0	0	0	0	0	0
P. falciparum malaria (12)	1(8.3%)	1(8.3%)	2(16.6%)	4(33.3%)	1(8.3%)	2(16.6%)	0	0	0	1(8.3%)
Mixed malaria (4)	0	0	3(75%)	0	0	1(25%)	0	0	0	0
Leptospi-rosis (26)	1(3.8%)	3(11.5%)	4(15.3%)	11(42.3%)	1(3.8%)	4(15.3%)	0	0	2(7.6%)	0
Dengue (20)	2(10%)	2(10%)	4(20%)	2(10%)	4(20%)	5(25%)	0	0	0	1(10%)

All the patients of *P. vivax* malaria and mixed malaria admitted to MICU had platelet count of <50,000cells/cmm and <1,00,000cells/cmm respectively at presentation.

In *P. vivax* and mixed malaria infection mortality was not seen in patients with platelet count less than 20,000cells/cmm. In mixed malaria mortality was seen only with patients with platelet count between 20000-50000 cells/cmm.

DISCUSSION

Malaria is endemic throughout most of the tropics. Ninety-five countries and territories have ongoing transmission.[1] Of the approximately 3.2 billion people living in malarious countries, 1.2 billion are at high risk; the World Health Organization (WHO) states that there were 214 million (range 149 to 303 million) cases of symptomatic malaria in 2015.[1]

The viral etiology of dengue virus was established in the 1940s. Records of dengue-like illness date back more than 200 years.[2,3] Major changes in the epidemiology of dengue virus infections began after World War II geographic expansion of transmission continues to date. Given estimates of 390 million infections worldwide each year and over 2.5 billion individuals at risk for infection, the dengue viruses remain important arthropod-borne viruses from a medical and public health perspective.[4]

Leptospirosis is a widespread and prevalent zoonotic disease occurring both in temperate and tropical regions; the incidence in the tropics is approximately 10 times higher than in temperate regions.[5] Leptospirosis is an underreported disease, and there are no reliable global incidence figures. A modelling exercise by the World Health Organization's (WHO's) Leptospirosis Burden Epidemiology Group estimated that there were 873,000 cases worldwide annually with 48,600 deaths.[6] The febrile illnesses enumerated contribute majorly and persistently to the health burden in the Indian subcontinent.

The patients were divided on the basis of age group, the mean age in vivax malaria was 37.63 years ± 13.91, in mixed malaria was 38.67 years ± 14.13, in falciparum malaria 36.84 years ± 13.66, in dengue 34.58 years ± 14.84 and in leptospirosis was 36.43 years ± 14.00. Male preponderance was seen in all the tropical febrile illness subgroups. In leptospirosis 54% were males and 46 % were females while in the rest of the subgroups female population comprised approximately a quarter of the patients in respective subgroup. The findings are consistent with a comparative study conducted by Murlidhar Verma et al in patients with dengue and leptospirosis in which the mean age of male patient was 34.8 years and 46.19 years respectively.[7] In a study conducted in dengue fever in northern India by Anish Laul et al 57% patients were males and 44% were females and 60% of the patients were of 20-40 years of age.[8]

The findings in malaria are also comparable to study by Kotepui M et al in which 63.4 %cases were males and 36.6% were females.[9] Study of leptospirosis by Muthusethupathy et al in which 84% of patients were males and mean age was 39.6years thus affecting young and productive age group the most.[10] In a study conducted by Alian et al in northern Iran on icterhaemmorhagic leptospirosis among 66 patients 89.4% of patients were males 60% of these were farmers.[11] In our study leptospirosis is almost equally distributed in both genders as we have studied an urban population acquiring infection while wading through water during monsoon.

Male preponderance was seen in all the tropical febrile illness subgroups. In leptospirosis 54% were males and 46 % were females while in the rest of the subgroups female population comprised a quarter of the patients in respective subgroup.

Haemoglobin (Hb)

In our study of the total 336 patients of tropical febrile illnesses only 4.4 % patients presented with Hb>15gm%. The lowest haemoglobin level of 3gm% was seen in dengue fever. The maximum value of haemoglobin 18.6gm% was seen in patient with *Plasmodium vivax* malaria Both these patients recovered. Hence both the patients with the extremes of haemoglobin values had good outcome. Hb>15 gm% (seen in 15.7%) was not the commonest presentation of dengue patients but in the entire study population amongst patients having Hb>15gm% dengue was seen in 40%. Hb>15 gm% was also seen in *P. falciparum* in 33.3% and *P. vivax* in 26.6% of patients.

Total leucocyte count

In our study amongst all patients of tropical febrile illnesses maximum number of patients (66.96%) had a total leucocyte count of 4,000-11,000cells/cmm. An equal percentage of patients 16.6% had WBC count of <4000 cells and >11000cells.

Platelet count

Platelet count of <1.5 lacs was seen in 94.35% of total study group. Severe thrombocytopenia of platelet count <20,000/cmm was seen maximum in *P. falciparum* (20.63%) followed by leptospirosis (16.21%).

Dengue

In dengue fever an equal number of patients had Hb<7gm% and >15gm%. Hb of 11-15gm% was observed in 50% of patients on presentation.

Leucopenia and neutropenia at presentation were not seen in dengue at all. This finding could probably be explained by the fact that we have recorded the haematological profile at presentation only and whether these patients developed leucopenia later in the course of illness. In the study conducted by Chatterjee et al 32.7% of patients had leucopenia, in a study conducted by Singh NP et al in Delhi 68% of patients of Dengue had leucopenia.[12,13]

Neutrophilia was seen in 31% of dengue patients which is comparable to the study of Khan et al where a low total white cell count was more common in patients with dengue fever as compared to dengue hemorrhagic fever (p=0.020), neutropenia (p=0.019), monocytosis (p=0.001) in which 24% had neutrophilia.[14]

In our study a platelet count of <1 lac was seen in 97.3% cases of dengue fever and bleeding manifestations were seen in 47.3% cases of these 44.4% had a platelet count of <1 lac. In a study conducted by Anish Laul et al, 78% of patients had platelet count <1lakh and bleeding manifestations were seen in 20% of patients.[8] A thrombocytopenia of 61.39% was observed by Singh N P et al.[14] In a study by Mandal et al, 37.8% had platelet count below 50,000 per cubic mm and 13.51% had hemorrhagic manifestations.[16] In a study by Tripathi et al, only 12.8% had platelet count <70,000 but 28% cases had hematemesis, 26% had melena, and 14.28% had epistaxis.[16]

Bleeding manifestations were 23% in a study conducted by Nandini Chatterjee et al in 180 patients of dengue in Kolkatta.[12] There is evidence that dengue can induce bone marrow hypoplasia during the acute phase of the disease.[17] Dengue inection induces platelet consumption due to disseminated intravascular coagulation (DIC), platelet destruction due to increased apoptosis, lysis by the complement system and by the involvement of antiplatelet antibodies.[18-20]

Leptospirosis

In patients with leptospirosis 67.5% had Hb between 7-10gm%. Of the total 26 patients requiring intensive care therapy 65.3% had Hb between 7-10gm% and 15.3% patients had Hb<7gm%. Many pathogenic Leptospira secrete sphingomyelinase C (SphA) and pore-forming haemolysins (SphH), possibly associated with the haemolytic anaemia observed in leptospirosis.[21-23] Leptospiral lipopolysaccharide (LPS) is a major outer membrane component recognized by Toll-like receptor 2 (TLR2) on macrophages.[24]

Neutrophilia a prominent feature in leptospirosis was seen in 70.22% of patients comparable to the study of Donovan et al in which 80% patients had neutrophilia.[25] In a study conducted at Manipal by Varma MD et al on early differentiation based on clinical and biochemical parameters among 200 patients of dengue and leptospirosis a leucocyte count of 11000/cmm was more likely to indicate leptospirosis.[7] The finding of thrombocytopenia of 94% in leptospirosis is contradictory to that seen in the study conducted by Muthusethupathy et al on leptospirosis in which thrombocytopenia was seen only in 24%.[10] Probable reason for this could be that they had included both indoor and outdoor patients. Maximum bleeding manifestations (56.57%) were seen in leptospirosis.

In a study conducted by De Silva et al, in Sri Lanka in 201 patients of leptospirosis leucocytosis was seen in 38.1% of patients on day 5, thrombocytopenia was seen during the 3rd to 5th day of illness with 75% of patients developing thrombocytopenia with dropping haemoglobin levels.[26] Neutrophilia and low haemoglobin predicted severe disease in this study. Mortality was 50% in patients with total leucocyte count of 4000-11000/cmm and 41.6% in those with total leucocyte count of >11,000/cmm.

In leptospirosis maximum number of patients were admitted with haemoglobin level between 7-10gm% and maximum number of patients that required intensive care therapy and in whom mortality was observed belonged to this subgroup. Mortality in the abovementioned subgroup was 30.7% but maximum mortality of 50% was observed in the subgroup having Hb<7gm%.

Malaria

In our study in all subgroups of malaria the maximum number of patients had a Hb level of 11-15gm%, total leucocyte count between 4,000-11,000cells/cmm a platelet count of <1,00,000cells/cmm was seen in 100% of patients of mixed malaria,85.22% of patients of *P. vivax* and 90.47% patients of *plasmodium falciparum* malaria. Of the total study population requiring intensive care management 32.3% of patients were diagnosed with malaria, of these maximum (19.9%) patients had *P. falciparum* malaria.

Plasmodium vivax malaria

Amongst patients with *Plasmodium vivax* malaria leucopenia was seen in only 22.9% of patients yet 71.4% of total study population with leucopenia of <4000cells/cmm were from the *P. Vivax* malaria subgroup.

Plasmodium falciparum malaria

In a study conducted by Niazi GA in Saudi Arabia in 1995, a platelet count of less than 60,000 cells/cmm was seen in 14.5% patients of *P. falciparum* and *P. vivax* malaria together this is in contrast to the observations in our study where a platelet count of <50,000cells/cmm was seen in 65.9% of all patients of malaria.[27] Patients of three subgroups of malaria together had a count of <1,50,000cells/cmm in 93.86% of cases. In a study conducted by Manas Kotepui et al neutrophil and platelet

counts were significantly higher; however, RBC count was significantly lower in patients with *P. falciparum* infection compared to those with *P. vivax* infection. A study conducted by Celikbas et al, in 105 adult malaria patients carried out in Turkey *plasmodium vivax* was found in 101 (96%) whereas *P. falciparum* was detected in 4 patients (4%) aanemia was detected in 23%, leukopenia in 47%, and thrombocytopenia in 73%.[29]

Mixed malaria

Anaemia with Hb of <7gm% was observed in maximum number of these patients on presentation compared to other subgroups. Platelet count of <1,00,000/cmm was seen on admission in100% cases of mixed malaria and 100% of cases with platelet count <20,000 had bleeding manifestation on presentation. In a study conducted by Mitra S et al at CMC Vellore in total, 131 cases of malaria, comprising 83 cases of *P. vivax*, 35cases of *P. falciparum* and 13 cases of mixed vivax in comparison to the mean hemoglobin of 13.1±4.1g/dl in the vivax group, the hemoglobin was significantly lower in the falciparum group (11.1±2.5g/dl, p = 0.029) and showed a trend towards significance in the mixed infection group (10.6±2.6g/dl, p= 0.068).[29] The observed mean platelet count (± SD) was lowest in the mixed infection group (52,462±32,235cells/mm^3) followed by falciparum and vivax groups and these differences were not statistically significant. This is comparable to the findings in our study of maximum proportion of thrombocytopenia observed in patients of mixed malaria as compared to those with *P. falciparum* and *P. vivax* malaria.

Mortality

Maximum mortality was seen in patients with Hb between 7-10gm%. Amongst them highest was seen in leptospirosis (71.42%) followed by dengue (60%) and falciparum malaria (50%). In contrast in patients of mixed malaria, mortality was higher i.e. 75% in patients with Hb<7 gm%. Mortality was seen in 10% of patients of vivax malaria with haemoglobin between 11-15gm%.

In leptospirosis maximum number of patients had Hb between 7-10gm% and hence both mortality and recovery were maximum in number in this group, but mortality was the highest i.e. 50% amongst patients with Hb<7gm%.

In patients of malaria, dengue and leptospirosis requiring intensive care therapy, platelet count was less than 1lac/cmm in 80% of patients.

In patients of *P. vivax, P. falciparum* and degue infection mortality was not seen in patients with Hb <7gm%, whereas mortality was seen in both the patients of mixed malaria admitted to MICU contributing to 50% of mortality in mixed malaria. None of the patients of *P. vivax* and mixed malaria with platelet count >1lac/cmm required admission to MICU unlike patients of leptospirosis and dengue fever.

CONCLUSION

In our study we observed that haematological profile can be helpful in predicting the need for ICU care and mortality. Hemoconcentration among patients with dengue fever is not a frequent presentation though its presence may favour the diagnosis of Dengue. Leucocytosis favours diagnosis of leptospirosis. Patients with leucopenia were more likely to have *P. vivax* infection. Patients of *P. vivax* and mixed malaria with Severe anaemia on presentation is likely to have a diagnosis of mixed malaria infection or leptospirosis and poor outcome hence warrants careful management of these patients to improve outcome. platelet count >1lac are not likely to require intensive care management.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Vaidya MS, Kawale JB, Maheshkar PR, Kamble AN. A comparative study of hematological profile on presentation in confirmed cases of malaria, dengue and leptospirosis. Int J Res Med Sci 2018;6:472-80.