Severe malaria in western Kenya: Analysis of hospital records to determine the influence of transmission level on clinical presentation

Okach D. O.¹, Ayisi J. G.²* and Onyango R.³

¹Ministry of Health, Kenya Medical Training College, Kisumu, Kenya.
³School of Public Health and Community Development, Maseno University, Maseno, Kisumu, Kenya.

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In western Kenya, malaria remains one of the major public health problems. Understanding of malaria severity across different transmission intensities is less understood in Kenya, yet, which is very important for implementation of intervention programmes. A retrospective study of all patients who were admitted to Kisumu (lowland area with high transmission) and Kapsabet (highland area, with low transmission) district hospitals due to severe malaria during the period from 1st January through 31st December 2006, were assessed. The age of patients who had severe malaria was compared between those from lowland area with high malaria transmission and highland area (Kapsabet) with low transmission. 19,817 cases were admitted to Kisumu and 21,915 to Kapsabet. 689 and 762 were randomly selected for this study from the two sites respectively. Most cases from Kisumu significantly presented with severe anaemia, pulmonary oedema and cerebral malaria (all P < 0.01). Those from Kapsabet presented with hyper-parasitaemia and hyperpyrexia (all P < 0.01). Jaundice, prostration and hypoglycemia were infrequently reported from the two study groups. Efforts directed at preventing severe malaria conditions at high malaria transmission areas have potential value to reduce impact of this disease, especially if targeted at children <5 years in high transmission areas, but to also include adolescents in low transmission areas.

Key words: Malaria, transmission, Kenya, intervention.

INTRODUCTION

Malaria is one of the most common causes of morbidity and mortality in sub-Saharan Africa; each year, an estimated number of 1 – 2.8 million persons, mostly children, die of Plasmodium falciparum malaria (WHO, 2005). In western Kenya, malaria epidemics have spread from 3 to 15 districts during the past 13 years, often with devastating effects. In response to this, the Kenyan government has declared 15 districts in the highlands as being prone to epidemics, meriting close surveillance, preparation, and intervention (MOH, 1999; Hay et al., 2002). Even though there has been a decreasing trend on malaria associated mortality in Kenya from 16.5% in 2010 to 12.2% in 2013, it’s still the leading killer disease of the total reported cases (GoK, 2014).

In malaria endemic areas, health facility records are important sources of malaria data, not only to describe the disease patterns, trends, treatment, as well as the underlying socio-demographic variables of the surrounding communities, but are also useful for planning malaria control and evaluating the impact of health interventions within the health facility catchment areas (Deressa et al., 2004). Thus, analysis of hospital data can give information on morbidity and mortality pattern which generally reflect the patterns in the surrounding community and therefore may be used to set priorities for health care provision and disease prevention.
strategies (Brewster and Greenwood, 1993, Nathoo et al., 1995; Campbell et al., 2004).

Although thousands of children and adults develop severe malaria in the highlands areas, there is only anecdotal information on the spectrum of clinical manifestations of severe malaria in these areas (Idro et al., 2005). To better understand the endemicity of malaria in this era of climate change and increased human economic activities, this study was designed to compare malaria-associated patients admitted at Kapsabet district hospital, in a highland area (altitude: 1900 – 2150 m) with highly seasonal transmission; and Kisumu, a lowland area (altitude 1131 m) with stable malaria transmission (MoH, 1999).

The study placed more emphasis on age as a marker of differences in immunity to malaria at the two sites (Ladeia-Andrade et al., 2009). The importance of studying the relationships between transmission levels in relation to age and the clinical picture of severe malaria is evident in view of the development of rational sustainable control strategies for malaria prevention and management in areas of differing transmission pressures such as the two studied areas and similar malaria-endemic resource constrained areas elsewhere in sub-Saharan Africa.

METHODS

Study area

Kapsabet district hospital is located in Kapsabet town in Nandi North District, Nandi County. The district is situated in the western part of the Rift Valley Province and covers an area of 1392 km². It lies between latitudes 0.111° South and 0.561° North and longitudes 34.737° and 35.435° east. The range of altitudes varies between 1900 m to 2150 m. Kapsabet district hospital is the main Government Hospital in the area and has 7 wards which include 2 male, 2 female, 1 maternity and 2 paediatric wards (DMOH, 2006). According to the 2009 National population census, the district had a population of 578,751 people (GoK, 2009).

Kisumu district hospital on the other hand is located in Kisumu City, Kisumu district of Nyanza Province, western Kenya. The district lies within longitude 33 20'E and 35 20'E and latitude 0 20'S and 0 50'S. It is a port city at 1,131 m, with a population of 394, 684 people. Kisumu district hospital has 180 bed capacity with one paediatric, maternity, gynaecology, psychiatry, surgery, amenity and two medical wards.

Both Kapsabet and Kisumu hospitals are level four health facilities offering both out- and in-patient services. The two facilities routinely provide the standard of care defined by the World Health Organization (WHO) and Kenyan national guidelines for the treatment of severe malaria (WHO, 2006; GoK, 2010). We defined ‘severe malaria’ as *Plasmodium falciparum* infection requiring hospital admission (Snow et al., 1997), thereby distinguishing it from mild disease events.

Western Kenya has a bimodal pattern of rainfall with long rains occurring from April to June and short rains between November and December, which correspond to the high malaria transmission season. Obvious differences exist in malaria transmission levels between lowland and highland areas, with reported annual inoculation rates values ranging from 31 per person per year in lowland areas to less than one in the highland areas and the main malaria vectors are *Anopheles gambiae* (highlands), *A. arabiensis*, and *A. funestus* (lowlands) (Ndenga et al., 2011).

Selection of cases

The sampling frame comprised of records of patients who were admitted to these two health facilities within the period 1st January to 31st December 2006.

Training of data extractors

A data collection manual was prepared by the authors, who specified the aims of the study and variables to be collected to three research assistants that were trained on-site, and supervised by them. At the commencement of the study, the authors and field assistants dual-filled 20 records and compared their results to ensure they were collecting information consistently in accordance with data collection manual instructions.

Data collection

Data for cases with a diagnosis of malaria that accrued from 1st January to 31st December 2006 were extracted from medical records of inpatients onto a designed data collection form, and variables included age, admission and discharge history with supportive data for the diagnoses of clinical presentation and outcome (discharge or death). Supervision of information extraction from hospital records including discharge summaries was by the lead author, who by then was a Master of Public Health student, at the School of Public Health & Community Development, Maseno University, Kisumu, Kenya.

Data analysis

The Chi-square test was used for the analysis of proportions of each malaria condition according to geographic origin. The student’s t-test was used for the comparisons of continuous variables. Statistical Package for Social Sciences (SPSS) software for windows version 10.0 was used for data analysis. P < 0.05 was considered statistically significant.
Table 1. Severe Malaria by age and geographical area, western Kenya, 2006.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>1,451 Severe malaria cases</th>
<th>Kapsabet (n=762)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (± SD)</td>
<td>13.2 (16.9)</td>
<td>15.7 (15.9)</td>
<td>0.013</td>
</tr>
<tr>
<td>Range</td>
<td>(0.04 - 76)</td>
<td>(0.1-85)</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>3.5</td>
<td>14.0</td>
<td></td>
</tr>
<tr>
<td>IQR</td>
<td>(1.3, 18.0)</td>
<td>(4.0, 28.0)</td>
<td></td>
</tr>
</tbody>
</table>

SD: = standard deviation.
IQR: = Inter quartile range.

Table 2. Age Distributions of patients with severe malaria at Kisumu and Kapsabet district hospitals, western Kenya, 2006.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Study site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=1,451</td>
</tr>
<tr>
<td></td>
<td>Kisumu n (%)</td>
</tr>
<tr>
<td>≤ 5</td>
<td>370 (53.7)</td>
</tr>
<tr>
<td>6-10</td>
<td>51 (7.4)</td>
</tr>
<tr>
<td>11-15</td>
<td>23 (3.3)</td>
</tr>
<tr>
<td>16-20</td>
<td>33 (4.8)</td>
</tr>
<tr>
<td>21-25</td>
<td>47 (6.8)</td>
</tr>
<tr>
<td>26-30</td>
<td>52 (7.5)</td>
</tr>
<tr>
<td>31-35</td>
<td>31 (4.5)</td>
</tr>
<tr>
<td>36-40</td>
<td>18 (2.6)</td>
</tr>
<tr>
<td>&gt; 40</td>
<td>64 (9.3)</td>
</tr>
<tr>
<td>Total</td>
<td>689 (100)</td>
</tr>
</tbody>
</table>

Ethical considerations

This study received the approval of the two study hospitals’ Ethical Review Boards, and the hospital administration allowed access to the medical records. No personal identifiers were included in the abstracted information.

RESULTS

In the lowland area (Kisumu), 19,817 severe cases of malaria were admitted to the study facility between 1st January to 31st December 2006. 689 of 19,817 were randomly selected for this study. In the highland area (Kapsabet) during the same period, it was found that 21,915 cases of severe malaria were admitted to the study facility, and 762 were also randomly selected for this study.

Malaria severity and mean age of patients by geographic area

Of the 689 malaria cases studied Kisumu, their mean age and standard deviation (SD) was 13.2 (16.9), range (0.04 - 76) years, with a median of 3.5 years, IQR, (1.3, 18.0) years. At Kapsabet the 762 study participants had the mean age of 15.7 (15.9), range (0.1-85) years, with a median of 14.0 years IQR, (4.0, 28.0) years. The differences in the ages of study participants from the two study areas were statistically significant (P = 0.013), (Table 1). Thus, patients from Kapsabet had a much higher median age, compared to those from Kisumu, suggesting that most malaria patients were more among older patients at Kapsabet compared with those from Kisumu, and this difference was statistically significant (Table 1).

Age distribution among the severe malaria cases by geographic area

We analyzed the distribution of severe malaria cases by study site in relation to age (Table 2). The group aged 5 years and below had the majority of the severe cases at both Kisumu and Kapsabet district hospitals, with Kisumu district hospital recording significantly more severe malaria cases in this age group (53.7%) than Kapsabet district hospital (34.8%). Kisumu district hospital also recorded a general but a significant decrease in number of cases in other age groups up to 16 - 20 year-old age group in comparison to Kapsabet (indicated in bold) (P < 0.04 for all, Table 2), after which there was no significant

<table>
<thead>
<tr>
<th>Clinical presentation</th>
<th>Study site</th>
<th>RR (95%CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=1, 451</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kisumu n (%)</td>
<td>Kapsabet n (%)</td>
<td></td>
</tr>
<tr>
<td>Severe anaemia</td>
<td>143 (20.7)</td>
<td>18 (2.4)</td>
<td>4.0 (2.6-6.1)</td>
</tr>
<tr>
<td>Cerebral malaria</td>
<td>51 (7.4)</td>
<td>7 (1.0)</td>
<td>3.4 (1.9-6.4)</td>
</tr>
<tr>
<td>Hyper-parasitaemia</td>
<td>12 (1.7)</td>
<td>345 (45.3)</td>
<td>0.1 (0.0-0.2)</td>
</tr>
<tr>
<td>Hyperpyrexia</td>
<td>65 (9.4)</td>
<td>297 (38.8)</td>
<td>0.2 (0.1-0.5)</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>327 (47.7)</td>
<td>36 (4.7)</td>
<td>5.7 (3.8-8.6)</td>
</tr>
<tr>
<td>Respiratory distress</td>
<td>7 (11.2)</td>
<td>48 (6.3)</td>
<td>1.6 (0.8-3.3)</td>
</tr>
<tr>
<td>Jaundice</td>
<td>12 (1.7)</td>
<td>0 (0.0)</td>
<td>-</td>
</tr>
<tr>
<td>Prostration</td>
<td>0 (0.0)</td>
<td>7 (1.0)</td>
<td>-</td>
</tr>
<tr>
<td>Hypoglycemia</td>
<td>0 (0.0)</td>
<td>4 (0.5)</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>689 (100.0)</td>
<td>762 (100.0)</td>
<td></td>
</tr>
</tbody>
</table>


difference in the remaining age groups between the two sites (Table 2).

Manifestations of severe malaria by geographic area

Compared to patients from Kapsabet, most severe cases from Kisumu district hospital significantly presented with severe anaemia, pulmonary oedema (suggestive of long term effects of chronic malaria infection); and cerebral malaria (P < 0.01 for all, Table 3). Those from Kapsabet presented with hyper-parasitaemia and hyperpyrexia (Table 3). No significant differences were observed in the proportion of patients with respiratory distress in the two areas. Jaundice, prostration and hypoglycemia were infrequently reported from the two study facilities.

Discussion

This study was carried out to determine the effect of age and the manifestations of severe malaria among admitted patients in two areas of western Kenya with differing malaria transmission intensities. Several findings from this hospital record-based study of malaria morbidity among patients admitted at the two level 4 (district) hospitals at Kisumu (lowland) and Kapsabet (highland) areas showed that there were higher cases of severe malaria among those aged five years and below at Kisumu compared Kapsabet.

Our study compared the mean age of patients from Kapsabet and those from Kisumu district hospitals, which showed that patients from Kisumu district hospital presented with a statistically significant lower mean age compared to the patients from Kapsabet district hospital. This indicated that the risk of severe malaria tended to be higher amongst lower-age groups within Kisumu district hospital compared to Kapsabet district hospital. Our findings support those of O'Meara and others (O'Meara et al., 2008) who stated that on comparisons of hospital data between areas of differing transmission intensity, the mean age of hospitalized clinical malaria cases is higher under relatively lower transmission.

However, at the highland areas, higher rates of infections persisted in the older age groups, until after 20 years of age. This concurs with findings by Warrell (1993) who postulated that individuals living in areas of stable transmission acquire protection against clinical attacks after several years, and the disease therefore affects mainly children, whereas highland areas with low intensity transmission significant rates of disease occur well into adolescent and adult hood. Lusingu and others (2005) further affirms this when they state that in areas of stable transmission, immunity is acquired during childhood, while under conditions of very low transmission such as the highlands, the risk of clinical malaria extends into adulthood. This also agrees with previous studies that show the rate limiting factor for malaria infection in the lowlands to be “immunity” (DMOH, 2006; Baird, 1993).

Analysis of the clinical presentation of severe malaria at the lowland area showed that most common presentations at this area were severe anaemia, pulmonary oedema, and cerebral anaemia; while those at highland area were hyper-parasitaemia and hyperpyrexia. Hyperpyrexia has been shown to be a resultant of hyperparasitaemia, while severe anaemia is a function of high, early and repeated exposure to chronic malaria infection that is commonly associated with holoendemic (lowland) transmission areas (Idro et al., 2005; Giha et al., 2000) as is the case with Kisumu study site.

Our study also established a higher death rate due to malaria in Kisumu district hospital (171/10,000 admissions) compared to Kapsabet district hospital (152/10,000 admissions). This may be because we found patients from this high malaria transmission area (Kisumu) to have a higher proportion of life threatening features. This calls for the need for more research to
establish a possible difference in malaria mortality at the two regions with more emphasis on the observed differences in clinical presentations of severe cases at the two study sites; noting that previous studies in malaria endemic areas have shown pulmonary edema, cerebral malaria and anaemia to be associated with high mortality (Satpathy et al., 2004), especially if the patients present with multiple indicators of life threatening illness (Marsh et al., 1995). Therefore efforts directed at preventing these conditions at high malaria transmission areas such as Kisumu have potential to reduce impact of this disease.

Awareness of the pattern of severe malaria based on the level of transmission is of crucial importance in identifying appropriate control measures and treatment protocols tailored for the specific local characteristics of the disease. In the lowland study areas, the confirmed importance of severe anaemia should lead to the study of appropriate means of prevention and treatment of this type of presentation of severe malaria, while in highland areas, attentions needs to be focused more on hyperpyrexia and hyper-parasitaemia.

Study limitations

This study only looked at records of patients admitted at the two study hospitals and the use of hospital data has been found to be problematic (Smith et al., 1991), among them being missing data on certain variables, and lack of access to hospitals for patients in many parts of Africa, hence potential for selection bias as patients who did not come to these facilities or sought care in other hospitals were not included.

Conclusion

Our study shows that the use of hospital data can provide useful information imperative for policy, practice and estimation of disease impact.

Acknowledgements

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Authors’ contributions

ODO, AJG conceived the study and participated in its coordination. All authors participated in the study design. ODO and AJG carried out the study. AJG did the analysis and data interpretation. AJG, ODO and OR drafted the manuscript. All authors read and approved the final manuscript and confirm that the content has not been published elsewhere and does not overlap or duplicate their published work.

Competing interests

The authors declare that they have no competing interests.

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