

Original Research Article

Complications of Falciparum Malaria Infections among Ghanaian Children; from the Healthcare Personnel's perspective.

ABSTRACT

Background and Aim: Malaria is known to be the most widespread tropical disease and a chief cause of morbidity and mortality in Africa. This study seeks to determine some common complications of *falciparum* malaria from the perspective of healthcare personnel in Kumasi, Ghana.

Materials and Method: This questionnaire-based cross sectional study was carried out in KATH in Kumasi, Ghana. The study population includes the health care workers working at the children's unit at the various hospitals. About 80 healthcare personnel were recruited to partake in a survey for eliciting views on malaria. Questionnaires were used to capture some symptoms and complications of malaria from the health workers point of view.

Results: More than half of the healthcare personnels were males (52.5%). The majority of the participants were medical officers. The study participants elaborated on some common malaria symptoms among children. Fever recorded the highest frequency of symptoms, represented by 98.8%, followed by general malaise (97.4%), nausea and vomiting (93.8%), chills (78.8%) and headaches (72.5%). Prostration (45.0%), hyperpyrexia (38.75%) and hypoglycemia (13.75%) were the most frequently reported complications by the respondents. The majority of the participants reported cerebral malaria (30.0%), severe anemia (23.75%), acute respiratory distress (17.5%), repeated generalized convulsions (16.25%) to be the most lethal feature of complicated malaria infection in children. The overwhelming majority of the respondents (90.0%) use the WHO 2014 standard as guide for determining complicated malaria.

Conclusion: Prostration with hyperpyrexia and hypoglycemia were the most common features of *falciparum* malaria from the perspective of healthcare personnel in Kumasi.

Keywords: Malaria, children, complications, perspective, healthcare personnel, Ghana.

Comment [RGK1]: Abstract not revised as Ms contents require modifications

Comment [WU2]: The Abstract is true presentation of the whole study

Comment [RGK3]: What is KATH? Complete name in parenthesis or complete name first and then abbreviation in parenthesis.

Comment [WU4]: KATH is the abbreviation for Komfo Anokye Teaching Hospital.

Comment [RGK5]: Kindly state page/pages where these standards are mentioned in the WHO document 2014.

Comment [WU6]: Page 2 of the WHO 2014 standard

1.0 INTRODUCTION

Malaria, as a life-threatening disease affects millions of people worldwide [1]. Studies reveal that close to half of the world's population is at risk of being infected with malaria [1]. Those who are susceptible to the disease are infants, children under five years of age, pregnant women, HIV AIDS patients, mobile populations and migrants [1, 2]. Out of these categories of people, children below five years of age are the most susceptible due to weak immune system [2-4]. Currently, malaria is known to be the most

Comment [RGK7]: There are sooo many good publications with solid descriptive data, that the authors should be more detailed in describing the problem of malaria in the world or just in Africa or even only Ghana. This introduction does not give any real meaning of anything.

Comment [WU8]: The authors appreciate your view and correction is been done.

widespread tropical disease and a chief cause of morbidity and mortality, particularly in sub-Saharan Africa [1, 2]. There are 4 parasite species that cause malaria in humans, and two of these species – *P. falciparum* and *P. vivax* – pose the greatest threat. *P. falciparum* is the most prevalent malaria parasite on the African continent and the most lethal [5]. Over the years, malaria has been a major cause of morbidity in Ghana and still continues to kill a lot of people and *falciparum* malaria accounting for 44% of all reported cases in the hospitals for the year 2015 [6]. Most of malaria cases especially those with children under 5 years are brought to hospitals or clinics for treatment. Healthcare professionals most often the medical officers come into contact with these malaria patients. These patients depend on them for survival therefore they need to have in depth knowledge on malaria pathophysiology such as its complications to help improve diagnoses and treatment [7]. There are several complications of *P. falciparum* malaria in humans, but the most widespread and essential ones in children below twelve years are cerebral malaria, severe anemia, respiratory distress and hypoglycemia [1]. Even though it is the same *P. falciparum* parasite, due to metabolic differences in children and adults, there exist some differences in the manifestation of malaria between these two groups. Ghana is a malaria-endemic nation and as such has malaria as a major cause of death in the hospitals. However, there is no known study in Ghana that has focused on the common features to look for during complicated malaria infection in children. Therefore this study seeks to determine some common complications of *falciparum* malaria reported by the healthcare personnels. This will help the health policy makers and the other stakeholders in proper diagnosis and treatment of complicated malaria cases in Ghana.

2.0 MATERIAL AND METHOD

Study Design/Study Site

The study was a cross sectional one carried out in Komfo Anokye teaching hospital (KATH) in Kumasi, Ashanti Region, Ghana. KATH is located in Kumasi, the capital of Ashanti Region. Kumasi is a malaria endemic zone, has a total population of 4,780,380 [8].

Study population

The study population include the health care workers working at the children's unit at the various hospitals. Sample population in the hospital who are not willing to participate in the study were excluded from the study. Healthcare personnels were recruited to partake in a survey for eliciting views on malaria.

Ethical considerations

Ethical clearance for the study was obtained from the Committee on Human Research, Publication and Ethics (CHRPE) at the KNUST School of Medical Sciences/ Komfo Anokye Teaching Hospital in Kumasi-Ghana (Reference Number: CHRPE/AP/078/17). Permission was also given by the various Medical Directors/Superintendents or Heads of Departments of the study facilities. Consent was also obtained from health workers who were recruited into this study.

Data collection

A detailed questionnaire was then used to collect background information of study participants through interviews. Questionnaire also captured some complications of *falciparum* malaria from the health workers point of view.

Data Analysis

Data were entered into Microsoft Excel 2013 and cleaned before being subjected to analysis. Statistical analyses were performed using SPSS version 20.0 to determine frequencies and percentages of certain variables.

Comment [RGK9]: Maybe this sentence would be better placed after reference 1 above?

Comment [WU10]: Well noted.

Comment [RGK11]: No. 5 is a reference on plants in the Ghanaian market...

Comment [WU12]: Appropriate reference is been used now.

Comment [RGK13]: What does it mean a lot of people?

Comment [WU14]: High mortality rate in the population

Comment [RGK15]: Reported cases of what? Malaria? Death?

Comment [WU16]: A clearer statement is been used.

Comment [RGK17]: How are these cases diagnosed? By the caregiver? By the parents? By a nurse? Should it read instead: Most of the children under 5 years of age suspected with malaria are brought.... WHO document states ... less than half patients with suspected malaria infection are actually infected with a malaria parasite. I believe authors have to rethink how to write this Ms and their findings.

Comment [WU18]: A clearer statement is been used. And editors comment was taken into consideration.

Comment [RGK19]:suspected malaria ... [1]

Comment [WU20]: Corrected

Comment [RGK21]: In children?

Comment [WU22]: Corrected

Comment [RGK23]: This will help the ca ... [2]

Comment [WU24]: A clearer statement ... [3]

Comment [RGK25]: Any worthwhile con ... [4]

Comment [WU26]: Done

Comment [RGK27]: Any relevant data to ... [5]

Comment [WU28]: Data added

Comment [RGK29]: Included (past tense)

Comment [WU30]: corrected

Comment [RGK31]: Were (past tense)

Comment [WU32]: Corrected

Comment [RGK33]: Personnel. No s at the end.

Comment [WU34]: Corrected.

Comment [RGK35]: There is no descript ... [6]

Comment [WU36]: Corrected

Comment [RGK37]: Background informa ... [7]

Comment [WU38]: correctet

3.0 RESULTS

Socio-demographic characteristics of study participants.

This study constituted a total of 80 study participants. More than half of the healthcare personnels were males (52.5%). The majority of the participants were medical officers. Results are illustrated in Table 1.

Table 1: Frequency distribution of respondents by gender.

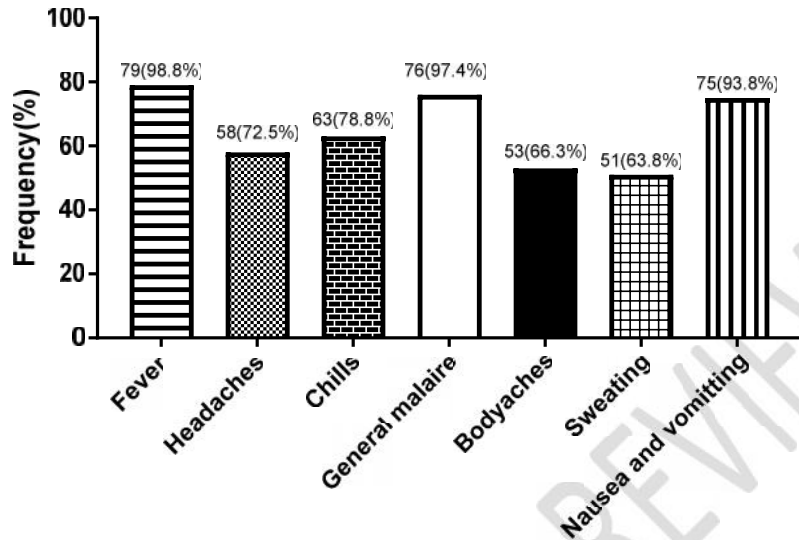
Table 1: Frequency distribution of respondents by gender and designations

Variables	Frequency (n=80)	Percentages (%)
Gender		
Male	42	52.5%
Female	38	47.5%
Designations		
Consultant	1	1.25%
House Officer	2	2.5%
Intern	5	6.25%
Medical Assistant (MA)	1	1.25%
Medical Officer	26	32.5%
Medical Sup	1	1.25%
Nurse	3	3.75%
Physician Assistant (PA)	22	27.5%
Paediatrician	1	1.25%
Resident	7	8.75%
SMO	5	6.25%
Senior Pharmacist	1	1.25%
SPA	1	1.25%
Specialist	4	5.0%

Comment [RGK39]: Instead of alphabetical order, could this table be in percentage or number order? From how many hospitals? Did some places/hospitals have less accurate responders than others? If the data are there, it should be not difficult to do the analysis; in that way one may discover weaknesses...

Comment [WU40]: The study was done in only one hospital thus KATH. It is unfortunate the data at the authors disposal couldn't account for that.

SMO=Senior Medical Officer, SPA= Superintendent Physician Assistants



symptoms of malaria in children from the study participants

Figure 1: Frequency of symptoms of malaria in children from the study participants.

Figure 1 shows the distribution of malaria symptoms in children according to healthcare personnel. Fever recorded the highest frequency of the symptoms, represented by 98.8%, followed by general malaise (97.4%), nausea and vomiting (93.8%), chills (78.8%) and headaches (72.5%).

Comment [RGK41]: Could the title for Fig. 1 be improved? Something like: "Signs and symptoms identified by study participants as suspected of complicated malaria"?

Comment [WU42]: corrected

Clinical manifestations of complicated malaria infections in children

Table 2 shows the frequency distribution of clinical manifestations of complicated malaria. Prostration (45.0%), hyperpyrexia (38.75%) and hypoglycemia (13.75%) were the most frequently reported complications. Complications which were distinctive feature of complicated malaria infection in children reported by healthcare personnel were hyperpyrexia (17.5%), prostration (12.5%), impaired consciousness (8.75%) and cerebral malaria (7.5%). The majority of the participants reported cerebral malaria (30.0%), severe anemia (23.75%), acute respiratory distress (17.5%), repeated generalized convulsions (16.25%) to be the most lethal feature of complicated malaria infection in children. The overwhelming majority of the respondents use the WHO 2014 standard guide for determining complicated malaria.

Table 2: Frequency distribution of complications of complicated malaria infections

Variables	Frequency	Percentages (%)
Complications which are almost always present		
Prostration	36	45.0%
Severe Anemia	8	10.0%

Comment [RGK43]: In reality, this is what participants thought or understood as complicated malaria, is it not?.

Comment [WU44]: What the study participants understood as complicated malaria

Comment [RGK45]: Complications which participants considered almost always present?

Hypoglycemia	11	13.75%
Impaired consciousness	2	2.5%
Repeated Generalized Convulsions	3	3.75%
Hyperpyrexia	31	38.75%
Thrombocytopenia	0	0

Complications which are distinctive feature

Thrombocytopenia	4	5.0%
Prostration	10	12.5%
Severe Anemia	1	1.25%
Cerebral Malaria	6	7.5%
Impaired consciousness	7	8.75%
Repeated Generalized Convulsions	4	5.0%
Hyperpyrexia	14	17.5%
Missing	46	42.5%

Complications which are most lethal

Thrombocytopenia	5	6.25%
Acute respiratory distress	14	17.5%
Severe Anemia	19	23.75%
Cerebral Malaria	24	30.0%
Hypoglycemia	16	20.0%
Impaired consciousness	6	7.5%
Repeated Generalized Convulsions	13	16.25%
Hyperpyrexia	1	1.25%

Complications which leads to misdiagnosis

Thrombocytopenia	13	16.25%
Acute respiratory distress	19	23.75%
Prostration	12	15.0%
Severe Anemia	4	5.0%
Cerebral Malaria	8	10.0%
Hypoglycemia	2	2.5%
Impaired consciousness	13	16.25%
Repeated Generalized Convulsions	17	21.25%
Hyperpyrexia	15	18.75%

Standards for determining complicated malaria

WHO 2014 Standard	72	90.0%
Standard Treatment Guideline	8	10.0%

Comment [RGK46]: Complications which participants believe are distinctive feature???

Comment [WU47]: Yes

Other complications of malaria from the healthcare personnel's point of view.

The data collection tool employed also required the healthcare personnel to report other malaria complications their patients have experienced which were not part of the list of complications on the questionnaires. Table 3 provides a list of such malaria complications.

Table 3: Frequency of other complications of malaria

Variables	Frequency (n=47)	Percentages (%)
Acute hemoglobinuria	1	1.25%
Acute renal failure	3	3.75%
Arthralgia	1	1.25%
Bitter taste	1	1.25%
Black water fever	10	12.5%
Excessive vomiting	1	1.25%
Splenomegaly	3	3.75%

Comment [RGK48]: Same as before: why not place higher percentages first rather than by alphabetical order? That is what the reader is interested on...

Comment [WU49]: corrected

Cerebral palsy	2	2.5%
Coma	1	1.25%
Shock	5	6.25%
Jaundice	8	10.0%
Polydipsia	1	1.25%
Intravascular hemolysis	2	2.5%
Metabolic acidosis	4	5.0%
Oliguria	2	2.5%
Neurological effect	1	1.26%
Opisthotonus	1	1.25%

4.0 DISCUSSION

The study revealed that the spectrum of healthcare professionals that come into contact with malaria patients were mostly medical officers. This means that there is 60% chance for a child suffering from malaria to come into contact with this cadre of healthcare professionals whenever they visit clinics or hospitals for treatment. It is therefore very necessary for this group of healthcare professionals to be always updated on all policies of malaria, in order to attain the malaria-free world that WHO has targeted to achieve by 2030 [1]. All healthcare professionals involved in the study followed WHO standards or the accepted Standard Treatment Guidelines, adopted by the Ghana Health Service in treating both complicated malaria and uncomplicated malaria conditions. Their knowledge base regarding the features of complicated malaria is very encouraging.

Fever, general malaise, nausea and vomiting are the most common symptoms of malaria in Ghanaian children below 12 years, according to the healthcare givers. This agrees with a report of WHO (2015) but not entirely with reports from other African studies [1]. For example, fever has been reported by Fordjour (2015) but not general malaise and vomiting. Headaches were also common in these children. Body aches and sweating were the least occurring symptoms, based on the experiences of the healthcare professionals interviewed [6].

Prostration (45.0%), hyperpyrexia (38.75%), hypoglycemia (13.75%) were reported as the three most prevalent manifestations of complicated malaria in children. This does not agree entirely with WHO report on tropical medicine and international health [1], as prostration was the only one highlighted in that report. This makes it clear that the manifestation of complicated malaria is varied, depending on the patients and their environments. Similarly, hypoglycemia was mentioned as one of the most prevalent complications of complicated malaria [9] but not prostration.

The current results agree in part with a complicated malaria study conducted at the KNUST Hospital, Ghana, and others in Mozambique [10], Yemen [10] and Burkina Faso [11]. It was revealed in the KNUST study that anemia, prostration, convulsions and fever are the major clinical manifestation of complicated malaria [6]; whilst in the other studies Reyburn (2004) and Gwer *et al.* (2007) prostration was found to be a common indicator of complicated malaria [10, 12]. Prostration was found in the current Ghanaian study and the previous Ghanaian (KNUST) study [6], all in the same region and city. Hence prostration should be given premium attention by healthcare givers in Ghana when treating malaria patients below 12 years. The presence of hyperpyrexia is not surprising as malaria is febrile. All febrile conditions elevate the body temperature, except in very rare cases.

It has been reported elsewhere [9] that respiratory distress is the most lethal complicated malaria complication. This study shows this to occupy the third position. Studies in Kenya revealed that impaired consciousness, together with respiratory distress were extremely lethal as it predicted as high as 84.4%

Comment [RGK50]: Suspected?

Comment [WU51]: corrected

Comment [RGK52]: To train other health personnel in recognizing these signs/symptoms? How about if there is no medical officer at the moment or in that particular health center any time of day and night? I would train other health personnel since medical officers are so well informed....

Comment [WU53]: A clear and modified recommendation is been used to replace the statement.

Comment [RGK54]: SUSPECTED

Comment [WU55]: corrected

Comment [RGK56]: I have not continued with the revision. Authors have to reconsider what the contents of this Ms should be and rewrite it for IJTDH acceptance.

Comment [RGK57]: Meaning?

Comment [WU58]: Kwame Nkrumah University of Science and Technology.

of 64 deaths in 1844 children [13]. Respiratory distress is common to two reports on the lethality of complicated malaria [13].

The finding of this current study on the lethality of the various malaria complications agree with two previous Ghanaian complicated malaria studies. Oduro *et al.* (2007) and Gyapong (2009) have reported the predominant complications of complicated malaria as severe anemia (36.5%), followed by respiratory distress (24.4%), prolonged or multiple convulsions (21.6%) and cerebral malaria (5.4%). Extra care should be taken by healthcare professionals in Ghana especially when any of the above four complications affect a malaria patient as this could be fatal [14, 15].

Another revelation from this current study is that the 23.75% prevalence of acute respiratory distress is a major malaria complication which may lead to misdiagnosis in Ghanaian children (Table 3). This is primarily due to its resemblance in manifestation with other febrile conditions, especially Pneumonia [9]. In addition to acute respiratory distress repeated generalized convulsions (21.25%), hyperpyrexia (18.75%), thrombocytopenia (16.25%) and impaired consciousness can all be misleading especially in a high transmission area like Ghana. Hence, extra care and vigilance should be used in managing these patients.

5.0 CONCLUSION

Medical personnels especially the doctors should be alert on these complications to improve diagnosis of malaria. Higher number of study participants should be recruited into similar study to validate some of the findings in this study.

LIMITATIONS OF THE STUDY

Further study on this topic should focus on a comparative one thus comparing health professionals views on complicated falciparum malaria from different setting of hospitals.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee and participant's written consent has been collected and preserved by the authors.

ACKNOWLEDGEMENT

The authors are grateful to the study participants and staff of the biochemistry department especially Prof K. Nsiah, KNUST for their immense support in making this work a success.

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between all authors. Author BB contributed to the conception of the research idea, data collection. Author BOA contributed to the interpretation, paper drafting and revision of the manuscript. Author SD contributed to data collection and sample analysis. Author DMT contributed to patient recruitment and sample collection. All authors approved the final manuscript before publication and agree to be accountable for all aspects of the work

REFERENCES

1. Organization WH: **World malaria report 2014**: World Health Organization; 2015.
2. Narsaria N, Mohanty C, Das B, Mishra S, Prasad R: **Oxidative stress in children with severe malaria**. *Journal of tropical pediatrics* 2011, **58**(2):147-150.

Comment [RGK59]: Reference citing require careful revision. Journal names have capital letter: Journal of Tropical Pediatrics. One can also use abbreviations: Trans R Soc Trop Med Hyg. References Nos. 4,6, 14 are missing journal name. Uniformity is also required. Kindly consult journal guidelines.

3. English M, Punt J, Mwangi I, McHugh K, Marsh K: **Clinical overlap between malaria and severe pneumonia in African children in hospital.** *Transactions of the Royal Society of Tropical Medicine and Hygiene* 1996, **90**(6):658-662.
4. Sakyi SA, Ephraim RK, Antoh EO, Obirikorang C, Berchie GO: **Lipid peroxidation and catalase levels among children presenting with severe falciparum malaria in the Sefwi Wiaso Municipality, Ghana.** 2012.
5. Osei-Djarbeng SN, Agyekum-Attobra E, Nkansah R, Solaga D, Osei-Asante S, Owusu-Dapaah G: **Medicinal plants constituting antimalarial herbal preparations in the Ghanaian market.** *British Journal of Pharmaceutical Research* 2015, **5**(3):153.
6. Fordjour F: **Antimalarial usage in pregnancy: a cross-sectional study in selected health facilities in the Brong Ahafo Region of Ghana.** 2015.
7. Kokwaro G: **Ongoing challenges in the management of malaria.** *Malaria journal* 2009, **8**(1):S2.
8. Jerven M, Duncan ME: **Revising GDP estimates in sub-Saharan Africa: lessons from Ghana.** *African Statistical Journal* 2012, **15**:13-24.
9. Organization WH: **Global technical strategy for malaria 2016-2030:** World Health Organization; 2015.
10. Gwer S, Newton CR, Berkley JA: **Over-diagnosis and co-morbidity of severe malaria in African children: a guide for clinicians.** *The American journal of tropical medicine and hygiene* 2007, **77**(6_Suppl):6-13.
11. Reyburn H, Mbatia R, Drakeley C, Carneiro I, Mwakasungula E, Mwerinde O, Saganda K, Shao J, Kitua A, Olomi R: **Overdiagnosis of malaria in patients with severe febrile illness in Tanzania: a prospective study.** *Bmj* 2004, **329**(7476):1212.
12. Reyburn H: **New WHO guidelines for the treatment of malaria.** *BMJ (Clinical research ed)* 2010, **340**:c2637.
13. Marsh K, Forster D, Waruiru C, Mwangi I, Winstanley M, Marsh V, Newton C, Winstanley P, Warn P, Peshu N: **Indicators of life-threatening malaria in African children.** *New England journal of medicine* 1995, **332**(21):1399-1404.
14. Gyapong R: **Characterization of Severe Malaria and Treatment-Related Adverse Drug Reactions among Hospitalised Children, at the KNUST Hospital, Kumasi, Ghana.** 2009.
15. Oduro AR, Koram KA, Rogers W, Atuguba F, Ansah P, Anyorigiya T, Ansah A, Anto F, Mensah N, Hodgson A: **Severe falciparum malaria in young children of the Kassena-Nankana district of northern Ghana.** *Malaria journal* 2007, **6**(1):96.

Page 2: [1] Comment [RGK19]	Rina Girard Kaminsky	1/23/2019 3:47:00 PM
------------------------------------	-----------------------------	-----------------------------

....suspected malaria patients....

Page 2: [2] Comment [RGK23]	Rina Girard Kaminsky	1/23/2019 4:17:00 PM
------------------------------------	-----------------------------	-----------------------------

This will help the caregivers in proper diagnosis and treatment as well as assist health policy makers and other stakeholders in decision making?... better teaching?... diminishing death rate?... better drug provisions? etc

Page 2: [3] Comment [WU24]	Windows User	1/30/2019 11:56:00 PM
-----------------------------------	---------------------	------------------------------

A clearer statement is been used.

Page 2: [4] Comment [RGK25]	Rina Girard Kaminsky	1/23/2019 3:33:00 PM
------------------------------------	-----------------------------	-----------------------------

Any worthwhile concise and informative description of the Ashanti Region?

Page 2: [5] Comment [RGK27]	Rina Girard Kaminsky	1/23/2019 3:40:00 PM
------------------------------------	-----------------------------	-----------------------------

Any relevant data to add here?

Page 2: [6] Comment [RGK35]	Rina Girard Kaminsky	1/23/2019 3:39:00 PM
------------------------------------	-----------------------------	-----------------------------

There is no description of any of the parameters considered in the questionnaire. What is fever? Maybe for me means something different than for him/her? What is the definition for anemia? For severe anemia? Hyperpyrexia? Thrombocytopenia? Etc. There is not even a definition for malaria.... Is it defined based on signs/symptoms only? Does it include any lab results? How do authors define "complications". To reply in a uniform fashion, one requires descriptions or definition of terms.

Page 2: [7] Comment [RGK37]	Rina Girard Kaminsky	1/23/2019 3:38:00 PM
------------------------------------	-----------------------------	-----------------------------

Background information of study participants? To determine what level of knowledge participants had in the definition of complicated malaria? I understand the study tried to figure out what participants knew regarding complicated malaria, regardless of their background, is that so?